Changes in the flora of the Netherlands in the 20th century

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Summary

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Throughout the world, biodiversity is under major threat from human activity. As the gravity of the situation unfolds, critical analysis shows that our knowledge and understanding of these developments is still very incomplete, both globally and in individual countries. This study is concerned specifically with changes in abundance of the approximately 1,500 species of vascular plant growing wild in the Netherlands. Using species checklists, in the course of the 20th century no less than 10 million individual distribution records have been obtained for these plants at a scale level of about 1 km^2. These data are stored in two large databases: pre-1950 data in FLORIVON (in 'quarter cells'), and post-1975 data in Florbase (in 'kilometre cells').

The principal aim of this study is to provide a quantitative description and interpretation of the changes in the Dutch flora during the 20th century. This aim has been elaborated in four chapters with the following main themes: floristic survey bias and correction thereof (chapter 2); overall ecological changes in the Dutch flora, and the impact of 'traditional' environmental factors such as eutrophication, acidification and groundwater depletion (chapter 3); changes in the Dutch flora associated with climate change (chapter 4); and changes in the Dutch flora due to influx of alien species (chapter 5). Appended to the main text is the 2003 edition of the 'Standard List of the Flora of the Netherlands', in which use has been made of some of the ecological and methodological insights to have emerged from this study.

Chapter 2 opens by describing the various types of floristic survey bias and goes on to develop several new methods to analyse and correct for them. For five kinds of survey bias full or partial solutions are presented. In the first place a new method has been developed that makes due allowance for (topographical) differences in scale and cartographic projection pre- and post-1950 and for differences in species distribution patterns. By implementing this method a corrected data set was obtained that is far more consistent than the one available to date. A second key issue is cross-country variability in the amount of data collected, and a method was also developed to address this problem as satisfactorily as possible. The other categories of survey bias considered are incomplete species lists, differences in survey intensity and duration, and problems with species recognition. For these, too, solutions have been articulated and practically implemented.

Chapter 3 describes the changes in the Dutch flora as these relate to the 'traditional' factors cited above. The extent to which Dutch conservation efforts and environmental policies of recent decades have already had a tangible effect is also examined. To this end the approximately 10 million, now-corrected distribution data were broken down into three periods: pre-1950 and two roughly equal periods post-1975. Each plant species was then assigned to one of 83 'ecological groups' indexed to soil salinity, vegetation structure, moisture regime, nutrient availability and pH. The changes in national distribution of these ecological groups were then described

and statistically tested. Of the factors examined in this study, eutrophication proved by far the most important cause of floristic change. Species of oligotrophic, pH-neutral habitats have undergone serious decline, with those of eutrophic habitats exhibiting a marked increase. The second main cause is loss of saline habitats, particularly during the first half of the 20th century. A third important change relates to vegetation structure, *viz.* a decline in grassland species with an attendant increase in species of woodland and ruderal herbaceous vegetations. In terms of conservation and environmental policy, it was found, based partly on the results of the next chapter (see below), that despite emission reduction measures, for the century as a whole eutrophication still ranks as the single most important cause of floristic decline in the Netherlands. Acidification, by comparison, was found to constitute far less of a problem and there are also signs that it declined in importance during the last decade of the century. Finally, it was found that restoration projects have achieved a measure of success, especially for certain kinds of wet, oligotrophic ecosystems like bogs and dune slacks.

Chapter 4 examines the possible effects of climate change on the Netherlands' flora. To this end it was investigated whether the floristic changes could be explained by observed increases in average temperature, precipitation or CO_2 levels. Again, use was made of the corrected data set, as described above. In this part of the analysis, changes in individual plant species presence was the issue of interest. Prior to about 1980 there was a demonstrable but small increase in both 'warmth-loving' (thermophilic) and 'cold-loving' species. The increase in the latter group can be explained by the historic growth in the area and quality of Dutch woodland. After about 1980 the only trend to be observed is a pronounced increase in thermophilic species, coinciding with a marked rise in temperature during the same period. More specifically, there has been a definite increase in species of drier habitats. No clear-cut effect of increased precipitation on the Dutch flora could be established. As a separate issue, it could be demonstrated that increased urbanisation – and the warmer climate of urban environments – has also been a key factor contributing to the increased abundance of thermophiles. In the last two decades of the 20th century, climate change was the second most important cause of changes in the Dutch flora, behind urbanisation but before eutrophication. As yet, the effects of climate change are asymmetrical: an increase in thermophiles, but as yet no decline in 'cold-loving' species, contributing to what is probably only a temporary rise in the total number of species.

In the literature, non-native ('alien' or 'exotic') species are cited as a major threat to biodiversity worldwide. To investigate the role of the approximately 360 exotic species now naturalised in the Netherlands, reported in chapter 5, a distinction was made between archeophytes and neophytes: species naturalised before and after 1500, respectively. One-quarter of the Netherlands' wild flora consists of non-native species, about one-third of them archeophytes and two-thirds neophytes. The pattern of change among archeophytes is virtually identical to that among indigenous species, with a minor increase in common species and a decline in rarer species. In contrast, all groups of neophytes show an increase that is inversely proportional to the period of naturalisation. Of the hypotheses tested to explain the success of common or rapidly expanding exotics, two are best able to explain the facts: escape from the 'predator-pathogen complex' and increased availability of disturbed, eutrophic sites. As regards the relative number of species on the Red List, no difference was found between indigenous species and archeophytes; there are even several neophytes on the List. Neither was any significant difference found between indigenous species, archeophytes and neophytes with respect to the percentage now extinct. *Contra* the claims of exotic plant species having a major negative impact on indigenous floras, there are as yet no indications of these posing a threat to the Dutch flora at the national level.

Finally, a number of important issues emerging from the study are discussed and the overall conclusions and recommendations presented in the final chapter. The main focus of the methodological discussion are the corrections made for survey bias. Despite the various options developed for correcting the raw floristic data, there is still a major need for a new and more coherent procedure for use in future surveys. A proposal to that end is made, proceeding from the same overall effort as at present. In the discussion on substantive issues a wide range of topics is considered in more detail, two of which are cited here by way of illustration. In evaluating biodiversity impacts as a function of scale level, it should be noted that despite the sensitivity of km-cell data to changes, on a smaller, micro-scale changes may be greater still. At the micro-scale, exotic species may indeed be having an impact on the Dutch indigenous flora. The effects of climate change also need to be further disentangled from those of urbanisation and exotics, to gain a better idea of climate impacts.

Samenvatting

Veranderingen in de flora van Nederland in de 20^e eeuw

Wereldwijd wordt de biodiversiteit door de mens sterk bedreigd. In het licht hiervan blijkt bij kritische analyse dat onze kennis en inzichten over de veranderingen ervan onvoldoende zijn, zowel op mondiaal als op nationaal niveau. Dit proefschrift gaat over de veranderingen in het voorkomen van de ca. 1500 Nederlandse plantensoorten. In de 20ste eeuw zijn er van deze planten maar liefst 10 miljoen floristische verspreidingsgegevens verzameld op het schaalniveau van ca. 1 km^2 op zogenaamde streeplijsten. Die verspreidingsgegevens zijn opgeslagen in twee grote databestanden: die van vóór 1950 in FLORIVON ("kwartierhokken") en die van na 1975 in Florbase ("km-cellen").

De centrale doelstelling van dit onderzoek is te komen tot een kwantitatieve beschrijving en interpretatie van de veranderingen van de Nederlandse flora in de 20ste eeuw. Deze doelstelling is uitgewerkt in vier hoofdstukken met als belangrijkste thema's: de waarnemersfouten en de correctie daarvan (hoofdstuk 2); de algemene ecologische veranderingen in de Nederlandse flora in relatie tot de "traditionele" milieufactoren als vermesting, verzuring en verdroging (hoofdstuk 3); de veranderingen in de Nederlandse flora door klimaatverandering (hoofdstuk 4); en de veranderingen in de Nederlandse flora door uitheemse soorten (hoofdstuk 5). In de bijlage is de Standaardlijst van de Nederlandse flora 2003 opgenomen. Hierin is een deel van de ecologische en methodologische informatie verwerkt die is voortgekomen uit dit proefschrift.

In hoofdstuk twee worden de verschillende typen fouten van floristische verspreidingsgegevens opgespoord, en worden nieuwe probleemanalyses en correctiemethoden ontwikkeld. Voor vijf typen van waarnemingsfouten worden gehele of gedeeltelijke oplossingen gepresenteerd. In de eerste plaats is een nieuwe methode ontwikkeld die rekening houdt met topografische verschillen in schaal en kaartprojectie vóór en na 1950 en met verschillen in verspreidingspatronen van soorten. Hierdoor is een gegevensset ontstaan die veel consistenter is dan de vroegere. Een belangrijk tweede probleem is dat niet overal in het land evenveel gegevens verzameld zijn. Er is een methode ontworpen om dit probleem zo goed mogelijk op te lossen. De andere onderscheiden typen problemen zijn incomplete soortenlijsten, verschillen in inventarisatie-intensiteit en –duur en problemen bij het herkennen van soorten. Ook hiervoor zijn oplossingen uitgewerkt en toegepast.

In hoofdstuk drie staat de beschrijving van de veranderingen in de Nederlandse flora in relatie tot de "traditionele" factoren centraal. Daarbij is tevens aandacht besteed aan de vraag in hoeverre effecten van milieu- en natuurbeschermingsbeleid in de laatste decennia reeds merkbaar zijn. De ca. 10 miljoen bewerkte verspreidingsgegevens zijn over drie periodes verdeeld: vóór 1950 en twee ongeveer gelijke perioden ná 1975. Alle plantensoorten werden ingedeeld in 83 'ecologische groepen', op basis van zoutgehalte van de bodem, vegetatiestructuur (d.w.z. licht), vochttoestand, voedselrijkdom en zuurgraad. De veranderingen in de landelijke verspreiding van deze ecologische groepen worden beschreven en statistisch geanalyseerd. Het blijkt dat, wat de hier onderzochte factoren betreft, eutrofiëring ('vermesting') verreweg de belangrijkste oorzaak is geweest van veranderingen in de flora. Soorten van voedselarme, neutrale standplaatsen nemen sterk af, en die van voedselrijke standplaatsen nemen sterk toe. De tweede belangrijke oorzaak is het verdwijnen van zoute habitats, met name in de eerste helft van de 20e eeuw. Een derde belangrijke verandering betreft de vegetatiestructuur: de afname van graslandsoorten ten koste van ruigte- en bossoorten. Wat de effecten van het milieu- en natuurbeleid betreft, blijkt mede op basis van de resultaten in het volgende hoofdstuk (zie hieronder), dat ondanks maatregelen om milieu-emissies te reduceren vermesting over de gehele eeuw bezien nog steeds de grootste bedreiging voor de Nederlandse flora vormt. Verzuring blijkt in verhouding daarmee een duidelijk minder groot probleem te vormen en er zijn ook indicaties van een afnemende invloed van deze factor in het laatste decennium van de vorige eeuw. Tenslotte blijkt dat natuurherstelprojecten met name succesvol zijn voor bepaalde typen natte voedselarme ecosystemen zoals vennen en duinplassen.

De effecten van klimaatverandering op de flora in Nederland worden geanalyseerd in hoofdstuk vier. Er is onderzocht of temperatuurstijging, toename van neerslag dan wel toename van de CO_2-concentratie, de veranderingen kunnen verklaren. Daarbij is gebruik gemaakt van de bewerkte gegevens zoals hierboven beschreven Bij deze analyse staan de veranderingen in het voorkomen van individuele plantensoorten centraal. Vóór ca. 1980 is zowel een kleine toename van warmteminnende soorten als van koudeminnende soorten aantoonbaar. De toename van de koudeminnende soorten kan worden verklaard door de toename van het areaal en kwaliteit van het bosgebied in Nederland. Na ca. 1980 is alleen een sterke toename van warmteminnende soorten te zien, die samenvalt met een sterke toename van de temperatuur in deze periode. Het gaat daarbij vooral om een toename van soorten van drogere standplaatsen. Er is geen duidelijk effect van de toegenomen neerslag op de Nederland flora aantoonbaar. Apart daarvan kon worden aangetoond dat ook de toegenomen urbanisatie – en daarmee het warmere klimaat in steden – een aanzienlijke factor is bij de toename van warme soorten. Klimaatverandering is in de laatste decennia van de 20e eeuw de tweede belangrijkste oorzaak verandering in de Nederland flora, na urbanisatie maar vóór vermesting. De effecten van klimaatverandering zijn vooralsnog asymmetrisch: wel een toename van warmteminnende soorten, maar vooralsnog geen afname van koudeminnende soorten, hetgeen bijdraagt aan een waarschijnlijk tijdelijke toename van het totale aantal soorten.

Uitheemse soorten worden in de literatuur als een belangrijke bedreiging genoemd van de biodiversiteit in de wereld. Bij het onderzoek naar de rol van ca. 360 in Nederland ingeburgerde uitheemse soorten, beschreven in hoofdstuk 5, is een onderscheid gemaakt tussen archeofyten (ingeburgerd vóór 1500) en neofyten (ingeburgerd vanaf 1500). Een kwart van de Nederlandse wilde flora bestaat uit uitheemse soorten, waarvan eenderde archeofyten en tweederde neofyten. Het patroon van verandering voor archeofyten is vrijwel identiek aan dat van inheemse soorten: met een kleine toename van algemene soorten en een afname van zeldzame soorten. Daarentegen vertonen alle groepen van neofyten een toename, die afneemt naarmate het langer geleden is dat inburgering plaatsvond. De hypothesen die het succes van algemene of snel toenemende exoten het beste kunnen verklaren zijn de "ontsnapping aan de antagonisten" (begrazers, ziekten en plagen) en de toename van verstoorde voedselrijke gronden. Er is geen verschil gevonden tussen inheemse planten en archeofyten in het aandeel van soorten op de Rode Lijst. Er staan zelfs een aantal neofyten op de Rode Lijst. Verder is geen significant verschil tussen inheemse soorten, archeofyten en neofyten in het percentage uitgestorven soorten in elke groep. In tegenstelling tot grote negatieve invloed die uitheemse plantensoorten zouden hebben op de inheemse flora, zijn er vooralsnog geen aanwijzingen gevonden dat zij op nationale schaal een bedreiging vormen voor de Nederlandse flora.

Tenslotte worden enkele belangrijke discussiepunten aan de orde gesteld, en worden de algemene conclusies en aanbevelingen op basis van het proefschrift in het laatste hoofdstuk geformuleerd. In de methodologische discussie is het belangrijkste onderwerp de uitgevoerde correcties voor waarnemersfouten. Ondanks de ontwikkelde mogelijkheden tot correctie van uiteenlopende gegevens, bestaat toch een sterke behoefte aan een samenhangende nieuwe opzet van toekomstige inventarisaties; hiervoor worden voorstellen gedaan waarbij uitgegaan wordt van een gelijkblijvende totale inspanning. In de inhoudelijke discussie wordt op een groot aantal punten nader ingegaan, waarvan hier een paar punten voorbeeldsgewijs worden genoemd. Bij de evaluatie van de effecten op de biodiversiteit in relatie tot schaalniveau moet bedacht worden dat ondanks de gevoeligheid van km-cel gegevens voor veranderingen, op nog kleinere, microschaal veranderingen nog groter kunnen zijn. Op microschaal niveau zouden effecten van uitheemse soorten op de inheemse flora mogelijk wél aanwezig kunnen zijn. De verstrengeling van klimaatseffecten met effecten van urbanisatie en exoten dient verder te worden uitgewerkt, opdat een nog helderder beeld wordt verkregen van klimaatseffecten.

1. General introduction

1.1. Global and national biodiversity: the data problem

Biodiversity is under major threat from human activity throughout the world. For policy-makers and scientists alike this has now become a priority issue, particularly since the United Nations Conference on Environment and Development, UNCED, held in Rio de Janeiro in 1992 (e.g. McNeely *et al.* 1990, Heywood and Watson 1995, UNEP 1997, Walther and Gillet 1998, Loh *et al.* 1999, Hilton-Taylor 2000, Groombridge and Jenkins 2000, Secretary of the Convention on Biological Diversity 2001, McNeely 2001, Flavin *et al.* 2002). Although biodiversity can be defined to embrace a variety of aspects and levels, the present study is restricted in scope to biodiversity as measured at the species and subspecies level.[1]

Both internationally and nationally a wide range of actions have been undertaken to halt or reverse this decline in biodiversity. Internationally, for example, there are conventions to protect ecologically valuable areas (e.g. the RAMSAR Convention, 1971, see Navid 1994) and improve environmental quality (e.g. FCCC, the Framework Convention on Climate Change, drawn up in 1992 at UNCED) as well as guidelines for preventing loss of biodiversity due to introduction of exotic species (IUCN 2000). In many cases these international initiatives have been translated into national policies affording specific areas and species legally protected status. For provisions on species and area protection in the Netherlands, see for instance (Natura 2000) and (LNV 2000) and on climate policy (Tweede kamer 1990, 1995).

As the gravity of these threats to biodiversity emerges, critical analysis shows that our knowledge and understanding of these trends is still very incomplete, both globally and within individual countries, even at the species level. The magnitude of the worldwide decline in biodiversity is currently estimated by extrapolating data on habitat loss and number of Red List species or extinctions in a limited number of areas only, in particular on tropical islands. Much of the information that is available relates to the status and decline of vertebrate biodiversity in the course of the 20th century, moreover, and the most threatened and species-rich regions of the tropics have in fact been least extensively studied (e.g. Guruswamy and McNeely 1998, Groombridge and Jenkins 2000, Secretary of the Convention on Biological Diversity 2001, Flavin *et al.* 2002). Even in those areas that have been well studied, however, there is major variation in the scale level of data collection, in taxonomic sophistication, and in the expertise available (e.g. Heywood and Watson 1995, Delbaere 1998, EEA 1999). In a wide range of international forums, systematic surveying and monitoring have consequently been recommended as being of the utmost priority (Article 7: CBD 1992 (Johnson 1993, Glowka *et al.* 1994), Chapter

[1] In the UNCED Convention on Biological Diversity, biodiversity is defined as "the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (Article 2, Use of Terms, in the Convention on Biological Diversity signed at the UNCED in Rio de Janeiro in 1992).

15.5: Agenda 21 (Johnson 1993), Global diversity strategy (WRI/IUCN/UNEP 1992), Guidelines for country studies on biological diversity: UNEP (UNEP 1993), Global Plant Conservation Strategy (COP7 2004), Hawksworth 1995, Heywood and Watson 1995).

This study is concerned specifically with the diversity of vascular plants in the Netherlands, thus encompassing the ferns, gymnosperms and angiosperms. In this country, data on vascular plant distribution have been gathered throughout the 20th century on the relatively detailed scale of 1 sq. km grid cells. It may therefore be concluded that we here have an ideal dataset on biodiversity status and trends in at least one country, for at least one section of the natural world. Unfortunately, though, these data are still deficient in many respects. The problems are largely technical in nature and include various kinds of bias in the databases due to data having been collected in different periods, using different methods, by (mainly amateur) botanists with varying degrees of expertise. There are also more fundamental problems, however, among them a skewed focus on species decline compared with species increase. Lastly, there are problems relating to the interpretation of trends, which has always been derived mainly from expert judgment and was therefore qualitative and somewhat subjective rather than quantitative and objective.

In the Netherlands, then, there are many ways in which the collection, processing and use of data on vascular plant distribution might be improved. The following section begins by looking more closely at the situation with regard to these floristic data, as collected in the course of the 20th century.

1.2. Floristic distribution data in the Netherlands

1.2.1. Vegetation relevés versus species checklists

In the Netherlands national floristic distribution data have been obtained by means of surveys conducted using two main methods: vegetation relevés and species checklists.

A relevé is a survey of the species of vascular plants (and often mosses, too) growing in a specific area, together with information on their abundance, in quantitative or at least semi-quantitative terms. The area, or quadrat, surveyed is relatively small, ranging from a few square metres to several dozen, depending on the type of vegetation. Sometimes a permanent quadrat is used to carry out follow-up relevés at repeated intervals. One of the key premises of this kind of survey is that the vegetation should be homogeneous, and the location of the quadrat is therefore determined entirely by the area and physical shape of the vegetation. The resultant records of species presence and abundance are then used to identify the plant community or communities present (e.g. Weeda *et al.* 2000, Schaminée 2000).

A species checklist is a complete list of the vascular plant species occurring in a particular country or region. These checklists, using a compact printing format and abbreviated scientific names can be used in the field for rapid inventories of species occurrences in square grids by ticking off species present. In the past decade, the abundance of rare or unusual species is usually also recorded using a semi-quantitative code. Species checklists are generally used for comparatively large-scale floristic inventories. In the Netherlands today most such surveys are carried out in 'kilometre cells' (1 × 1 km) or 'atlas cells' (5 × 5 km). Prior to 1950, these cells were of a slightly different size (see textbox). The cells are referenced to a fixed topographic map grid, thus giving each cell an unambiguous location. Given their size, these grid cells contain a range of landscapes and types of vegetation and, in contrast to the relevé quadrats, are thus heterogeneous.

As already becomes apparent from these brief descriptions, these methods obviously have their strengths and weaknesses when it comes to building up an accurate picture of national plant species distribution. The main strength of relevé surveys is that they yield quantitative data on species abundance and are based on homogeneous vegetational units. Their main weakness is the frequent over-representation of unusual vegetations, their limited geographical coverage and the fact that the quadrats have no fixed location. The greatest strength of checklists is that all the species present in a given area are, in principle, surveyed in a geographically comprehensive fashion on a fixed grid, thus avoiding any problems of location. Their main weakness is the lack of quantitative floristic information and the heterogeneity of the survey area.

There has been little research on the influence of the respective survey methods on recorded vascular plant distribution. As an exception, Van der Meijden *et al.* (1996) reported that Dutch provinces using checklist methods to collect floristic data record 20% more species per km cell on average than those using relevé-type methods. Witte (1998) has shown, furthermore, that at the square-km scale level 'ecological groups' are a more suitable vegetational unit for recording floristic data than plant communities. In the present study we shall be concerned solely with checklist data recorded at the square-kilometre scale level and it is these that will be referred to when using the terms 'floristic survey' and 'floristic data'.

1.2.2. The FLORIVON and FLORBASE databases

In the Netherlands, floristic study in the 20th century can be divided into three main periods, characterised by differences in survey method and in processing of the resultant distribution data.

The first period runs from 1902 up to 1950. This is a long period in which data were collected mainly with reference to 'quarter cells' measuring approximately 1 by 1 km. Distribution data were entered and stored on paper maps. In the 1990s these original data were digitised for the FLORIVON database.

The second period is from 1950 to about 1980 and essentially embodied a repeat of the work of the first period, but now using a grid of 'atlas cells' of 5 by 5 km. These data were subsequently digitised to create the ATLAS database. Because of the anomalous scale level involved, these data have been disregarded in the present study.

The third period runs from about 1975 up to 2000. During this period data were collected in km cells measuring precisely one by one km and digitally recorded in FLORBASE. This database comprises a vast number of floristic observations and

Text box: the FLORIVON database

The Dutch floristic surveys carried out during the period 1902–1950 are described at length in Part 1 of the 'Atlas of the Netherlands Flora' (Mennema *et al.* 1980, 1985, Van der Meijden *et al.* 1989). The data were collected in 'quarter cells' measuring 1.250 km × 1.042 km (cf. section 2.2 of the next chapter). The checklist data were transferred manually to transparent maps, with a topographic underlay on one side and the map grid on the other, with individual species finds indicated by dots in relevant grid cells. These data were later used to prepare distribution maps for the Atlas, in which records were aggregated to a scale level of 'hour cells' measuring 5.00 km × 4.17 km.

In the 1990s the original maps with quarter cell records were digitised (Kloosterman and Van der Meijden 1995) for the FLORIVON database, which only includes data on geographical presence, however, with no recording of dates. For an impression of the distribution and density of floristic observation in the Netherlands, the reader is referred to the maps in Groen *et al.* (1997). The FLORIVON data have been used by Witte *et al.* (2000) to prepare maps representing floristic mapping quality for individual ecological groups (for a similar analysis of post-1975 data, see Witte and Van der Meijden 2000).

The FLORIVON database has a number of important limitations hampering usage, in particular its anomalous grid format (and anomalies in cartographic projection), technical errors arising during digitisation, taxonomic errors (outdated and erroneous nomenclature), miscellaneous problems with the original and digitised data and, finally, the undated nature of the records. Correction for the anomalous grid format is one of the topics of the present dissertation (see section 2 in chapter 2). In two separate projects, the FLORIVON database has been purged of most of the technical and taxonomic errors, across all species (Groen *et al.* 1999). Several years ago a project was started to digitise the original checklists for the period 1902–1950. Unfortunately, this project had to be abandoned for lack of funds. In 2003, however, the results of original data digitisation for the province of Drenthe were published in the Dutch journal *Gorteria* (Tamis *et al.* 2003b). That study showed that many species were already clearly in decline between 1902 and 1950, as illustrated for one particular species in Fig. 1 below. In its day, this floristic survey of the Netherlands was unique in the world and served as an inspiration for the '1st Atlas of the British Flora' (Perring and Walters 1962).

Fig. 1. Distribution of Greater yellow rattle (*Rhinanthes angustifolius*) in the Dutch province of Drenthe, 1902–1932 (left) and 1932–1950 (right). Records of this species are indicated by a black dot, with records of other species in grey. Source: Tamis *et al.* (2003b).

has a high degree of geographical coverage. FLORBASE has been described at length in several publications, in particular by Witte (1996). Despite its major historical interest, FLORIVON has never enjoyed that privilege, however. The text box below is meant to address that deficit to some extent.

1.3. Core objective and specific issues

The core objective of this study is:

To arrive at a quantitative description and analysis of the changes in vascular plant species presence that have occurred in the Netherlands in the 20th century and to hypothesise the causes of these changes.

This overall objective is pursued by addressing the following specific questions:

- What are the main types of bias in floristic survey data and how can these be corrected in order to arrive at a more consistent dataset?
- What, in a general sense, are the most important changes that have occurred in the flora of the Netherlands, and to what extent can these be explained in terms of eutrophication, acidification, desiccation and so on?
- Which particular changes in the Dutch flora can be explained as resulting from climate change?
- Which particular changes can be explained as a result of the colonisation by or introducton of non-native species?

Within this framework, the basic approach of the study was as follows. Departing from Dutch nation-wide data on 20th century vascular plant presence on a grid scale of 1 sq. km (or approximately so), the various forms of survey bias were first corrected to the extent feasible. Subsequently, the corrected data were broken down into periods and for each period national presence was calculated for each species or, in some cases, combinations of species making up an 'ecological group'. The trends observed from period to period were then described and a series of causal hypotheses tested by statistically analysing species' functional characteristics and other parameters. The methodology is explained in detail in the subsequent chapters.

1.4. Reader's guide

Chapter 2 opens by describing various types of floristic survey bias and examining some traditional as well as novel methods of analysing and correcting for them. A combination of correction methods is then proposed.

Chapter 3 provides a general description of 20th century trends in the Dutch flora. To this end, plant species are classified in terms of 'ecological groups' characteristic of the various types of ecosystem found in the Netherlands. This chapter also assesses which specific ecological groups that suffered a serious decline during the 20th century have shown (some) recovery as a result of Dutch conservation efforts and environmental policy from about 1980 onwards.

Chapter 4 analyses the possible effects of climate change on the Netherlands' flora. To this end it was examined what aspects of climate change, temperature rise and increased precipitation or CO_2 concentration can explain the observed trends and the significance of these effects in comparison with those of other forms of environmental stress.

Chapter 5 considers the impact of naturalised non-native species. The entire set of non-native species is analysed and characterised in terms of geographical provenance, period of naturalisation, rarity, increase in abundance and other parameters. A number of hypotheses to explain the success of exotic plant species are discussed. It is also investigated whether these species may in some cases be partly responsibility for vascular plant extinctions or Dutch Red List status.

This thesis concludes with a chapter with conclusions, discussion and recommendations. A short summary (In English and Dutch) is also present. Appended to the main text is the 2003 edition of the 'Standard List of the Flora of the Netherlands', which also discusses some of the ecological and methodological issues, and which forms the more general background of the study presented here.

2. Coping with recording bias in floristic surveys

2.1. Introduction

In the Netherlands, floristic surveys fulfil a key function in environmental and conservation research and policy. In the course of the 20^{th} century over ten million floristic records were created; no other country in the world has such a wealth of floristic observations spanning the entire country and the whole of the 20^{th} century. Despite its size, however, this huge reservoir of distribution data has several shortcomings. In particular, over the years Dutch survey data have not generally been collected on the basis of systematic sampling, one of the most fundamental requirements for scientific research (e.g. Sokal and Rohlf 1969). There are consequently all kinds of artefacts in the survey data, which we shall refer to further as 'recording bias'. If not properly accounted for, this recording bias may lead to erroneous interpretation of the survey data, including under- or overestimation of abundances or changes in floral composition (e.g. Sipkes and Mennema 1968, Weeda 1985, Plate 1990, Rich and Woodruff 1992, Rich 1997, 1998, Heikinnen 1998, Witte 1998, Wohlgemuth 1998, Williams 2000, Van der Meijden *et al.* 2000). In this chapter we deal with five types of survey bias and the different solutions thus far adopted in the Netherlands. In addition, a number of new problem analyses and possible solutions are presented and discussed.

Many authors (e.g. Weeda 1985, Plate 1990, Van der Meijden *et al.* 1996, Groen *et al.* 1996, 1997, Witte 1998) have discussed various aspects and causes of recording bias. The main causes recognised are that floristic survey data are collected:

1) by a wide variety of individuals and institutions, both voluntary and professional, with greatly differing skills;
2) using different sampling strategies for different purposes, including environmental or conservation policies (both mapping and monitoring), ecological research, or just to satisfy curiosity;
3) using different sampling methods, e.g. limiting sampling to rare species or habitats, or sampling permanent quadrates or permanent transects only, rather than entire areas.

All these aspects vary across space and time, moreover.

In practical terms this methodological, spatial and temporal variability in sampling causes five types of problems, addressed in turn in the following sections: section 2. Differences in grid scale and map projection; section 3. Incomplete geographical coverage; section 4. Incomplete species coverage (incomplete species lists); section 5. Differences in survey intensity and length of survey period and, also in section 5. , Plant identification problems and taxonomic changes.

In previous studies and analyses of the Dutch flora a variety of methods have been adopted to overcome or correct recording bias. Although these methods have enabled significant improvement of existing data, there is still a need for further improvement, as one major shortcoming has thus far not yet been addressed: the key problem of incomplete geographical coverage. This study attempts to address all forms of recording bias in an integrated manner.

2.2. Differences in scale and map projection

2.2.1. General

Floristic survey data are generally sampled and presented using a fixed map grid[1]. Important determinants of this grid are scale and map projection. The scale of the grid is simply the length and width of a component grid cell, which is usually square. Depending on the goal and scope of the study, grid cell size ranges from very small (sq. cm, e.g. Kunin 1998) to very large (50 × 50 km for European studies, e.g. Jalas and Suominen 1989, Bakkenes *et al.* 2002, or square half or whole degree of latitude/longitude, e.g. Taplin and Lovett 2003). In Europe, current national scales range between 1 and 100 sq. km.

Scale is an important aspect of distribution data because:

1) the number of species increases with area: the species-area relationship (e.g. Preston 1962, MacArthur and Wilson 1967);

2) changes in abundance or frequency are more marked at more detailed scales (e.g. Thomas and Abery 1995, Groen 1996, Van der Meijden *et al.* 2000, De Bruyn *et al.* 2003);

3) the commonness or rarity of a species may be different at different scale levels, depending on its distribution characteristics, aggregated or diffuse (Groen *et al.* 1997, Witte 1998);

4) statistical relations between biodiversity and landscape-ecological characteristics are often different at different scale levels (e.g. Kunin 1998, Rahbek and Graves 2000).

Map projection is also an important aspect of distribution data. Map projections provide a means of projecting the earth's spherical surface onto a flat map (Van der Linden 1981, Snyder 1993, Snyder and Voxland 1994). A spherical surface cannot be mapped onto a plane without introducing distortions, which will be least pronounced at the centre of the map and greatest at its edges. Because the Netherlands is a small country, edge distortions have generally been neglected, although different projections have been used.

Some floristic studies have used observations in linked individual grid cells (i.e. cells with the same topographical characteristics in different periods) before and after 1950 (Groen *et al.* 1997, Van der Meijden *et al.* 2000) to obtain an unbiased estimate of floristic change. However, one general problem of using linked grid cells is the uncertainty regarding the exact location of the linked cells due to differences

[1] In a small number of floristic studies (e.g. those undertaken by North Holland provincial authority) data collection was based on landscape units.

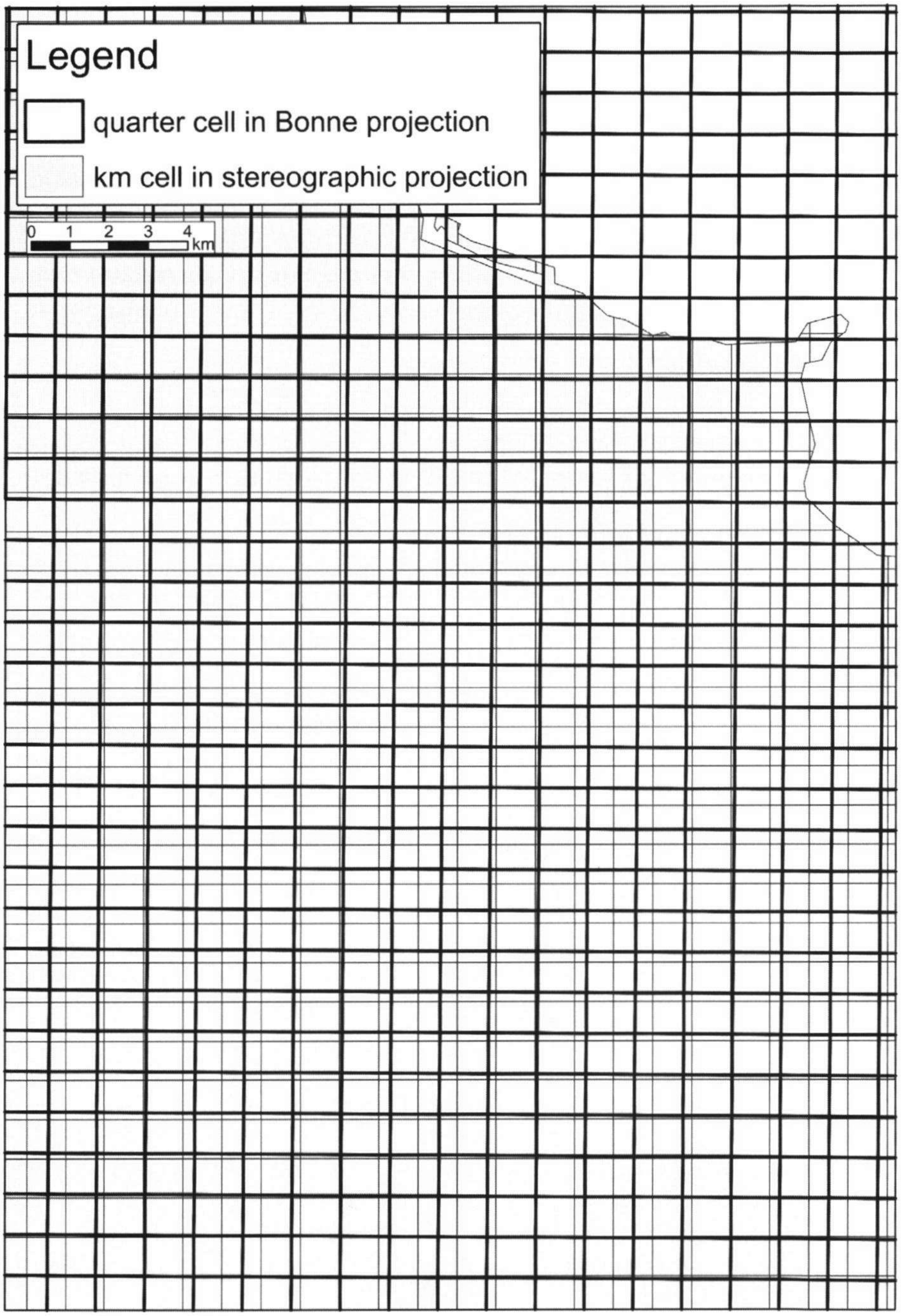


Fig. 1. Overlay of quarter grid with Bonne projection (before 1950) and kilometre grid with stereographic projection (after 1950) in the north-east of the Netherlands.

in map projection. If distribution data have been sampled on different scales and different projections, there can be no proper comparison of results, which will need to be adjusted to avoid misinterpretation. For example, comparison of species presence sampled at two different scales will lead to an overestimate of particularly rare species on the less detailed scale.

In the course of the 20th century a variety of different scales and projections have been used in Dutch floristic research. These are described in the present section, along with the various strategies adopted to address the attendant problems, as well as their respective shortcomings. In addition, a new GIS-based downscaling method is presented.

2.2.2. Different scales

For a proper understanding of the different scales used in the Netherlands in the 20th century for floristic mapping it is important, first, to know that the topographic map of the Netherlands has always been divided into map sheets of forty km wide (E–W) and twenty-five km high (N–S).

Prior to 1950, each map sheet was divided into eight (horizontal, E–W) times six (vertical, N–S) 'hour cells' (5.000 × 4.167 km; area = 20.833 km^2). Each of these hour cells was divided into four times four 'quarter cells' (1.250 × 1.042 km; area = 1.302 km^2). Before 1950, then, grid cells were not square.

As of 1950, each map sheet was divided into eight (horizontal) times five (vertical) 'atlas cells' (5.000 × 5.000 km; area = 25.000 km^2). Each of these atlas cells was divided into five times five 'km cells' (1.000 × 1.000 km; area = 1.000 km^2). Fig. 1 shows an overlay of the grids used pre- and post-1950. For more detailed and historical information on the different scales used in Dutch floristic research, the reader is referred to Mennema *et al.* (1980).

Floristic distribution data in the Netherlands have thus been sampled and used at different scales in the 20th century. Before 1950 sampling took place at the scale of quarter cells, between 1950 and about 1975 at the scale of atlas cells and, to a lesser extent, km cells and after 1975 only at the km cell scale. For presentation and analysis of distribution data prior to 1995, quarter cell data are aggregated to hour cells and km cell data to atlas cells. Since 1995 only the more detailed scale data of quarter and km cells have been used for the presentation and analysis of distribution data.

Various approaches have been adopted to properly allow for these differences in scale, both within and between periods:

1) For the Atlas of the Dutch flora the number of hour cells pre- and post-1950 were classified on the same ten-point scale (UFK) for each species, with no correction made for scale differences. For the species distribution maps in the Atlas, however, the exact pre- and post-1950 dimensions of the hour cells and atlas cells were used.

2) In her analysis of changes in the floristic quality (based on the number of species with a small ecological amplitude) of ecosystem types called ecotope groups pre- and post-1950, Plate (1990) added a constant ten percent (derived from the general formula $S = c.A^z$, with a default value for z) to the number of

species in the atlas cells post-1950 to compensate for the 20% difference in area per grid cell between the two periods.
3) In their analysis of the changes in species frequencies in quarter cells pre-1950 and km cells post-1975, Groen *et al.* (1997) did not correct for scale difference. They argued that such correction was unnecessary, because the greater probability of finding a species in a quarter cell, due to its larger area, is compensated by the lower survey intensity pre-1950.
4) Witte (1998) extrapolated threshold values for different floristic quality classes (based on the number of species and their ecological amplitude) of ecotope groups from km cells to larger grid sizes.
5) For the Dutch Red List, Van der Meijden *et al.* (2000) extrapolated threshold values for the various categories of threat from (post-1950) atlas cells to km cells on the basis of the uncorrected frequencies at different spatial scales.
6) Witte and Torfs (2002) recently extrapolated species frequencies at different scales on the basis of distribution data from 1975 onwards. This extrapolation method had not yet been applied in floristic research.

All the approaches thus far used to correct for differences in scale have their shortcomings. In most Dutch studies comparing floristic data pre- and post-1950, no corrections were made, or only very crudely, leading to a general overestimation of species presence prior to 1950. The new method of Witte and Torfs (2003) makes no allowance for regional differences in distribution patterns, does not permit linkage of data from individual grid cells across different periods and is presently based solely on national distribution patterns of plant species post-1975.

2.2.3. Different map projections

In 1950 the Bonne projection (a pseudoconic projection) used for the grid cells in Dutch topographic mapping, was superseded by a stereographic projection (an azimuthal, stereographic projection using the '*Rijksdriehoekmeting*' (or RD coordinate system). According to Kloosterman and Van der Meijden (1994) the switch from a Bonne to a stereographic projection can be regarded as "a small non-disruptive shift of the quarter cells in the northern part of the Netherlands". According to Groen *et al.* (1997) this shift amounts to about 1 km. In Fig. 1 it can be observed as a slight rotational displacement of the respective grid axes.

Because of the presumed minor effect of this change in projections pre- and post-1950, this difference has generally been neglected in Dutch floristic studies. The only researchers to have included included quarter cells just over the German and Belgian borders (according to post-1950 geographical co-ordinates) have been Van der Meijden *et al.* (1996), as part of a control procedure to evaluate recent rare and unusual observations.

Some floristic studies have made use of observations of linked individual grid cells pre- and post-1950 (see section 2.1), but without correcting for the difference in projection. The researchers assumed that the recent topographic co-ordinates of the map sheets were the same before and after 1950. Since quarter cells are larger than km cells, a choice had to be made as to which specific km cell a quarter cell could be linked to. The decision was taken to link the quarter cell to the km cell containing the centre of the quarter cell (Groen *et al.* 1997, Van der Meijden *et al.* 2000). One major consequence of this procedure was that there was no proper inter-period linkage between individual cells, especially in the coastal and border regions of the Netherlands.

From the overlay between the quarter cell and the km cell grid system we measured an approximately 0.4 degree clockwise rotation of the grid axes of the Bonne projection relative to those of the stereographic projection (Fig.1). This rotational shift appears to be the same in different parts of the Netherlands and the same for the horizontal and vertical axis. In contrast to earlier conclusions, it is not restricted to the northern part of the Netherlands but occurs in all coastal and border regions and is approx. 2–3 km across the country.

2.2.4. A new GIS-based method for downscaling distribution data

In this section a new GIS-based method is presented for downscaling data on the presence of individual plant species from quarter to km cells. This method takes into due account the following: a) differences in map scale and projection, b) differences between species in national distribution patterns and within species in regional distribution patterns, and c) border and coastline effects. The method converts observations from quarter cells to km cells for individual species, allowing observations pre-1950 and post-1975 to be precisely linked on a one-to-one basis. The method comprises the following steps:

1) First an overlay was made of the quarter and km grids (Fig. 1), using a Geographic Information System (GIS) (ArcView).[2] As a consequence, each quarter cell is divided by the km grid into several km parts and vice versa.

For each individual species of interest, the following four steps:

2) Species presence in a quarter cell is expressed as 130 ha of land (including small fresh waters), which is equivalent to 100% presence in a quarter cell, and divided proportionally over its km cell parts.
3) In each km cell, the parts are added up.
4) If at least 50 ha (equivalent to 50% presence in a km cell) of the parts composing the km cell show species presence, an individual species is assumed to be present in that km cell.
5) Each quarter cell observation is linked at least to that km cell with the highest sum of hectares. The last step is required for coastal and border quarter cells, much of which may lie in the sea or in neighbouring countries. The reason for this step is that these cells contain less than 130 ha of land.

[2] The overlay was prepared by Mr. R. van Ek of the Dutch Institute for Inland Water Management and Waste Water Treatment (RIZA), Lelystad.

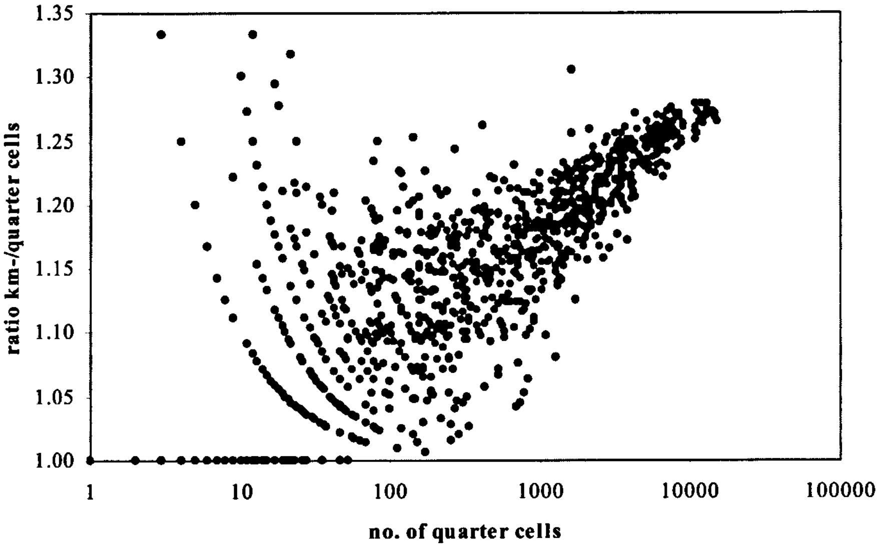


Fig. 2. Ratio of no. of grid cells per species after conversion from quarter cell to kilometre cell grid.

The result of this GIS method is a km-cell version of the quarter-cell-based FLORIVON database, which contains all available data on Dutch plant species presence prior to 1950. Less detailed scale mapping means an increase in the number of observations per species, and the total number of records in the km cell version of FLORIVON is 2.1 million, a factor 1.23 higher than the original. Fig. 2 shows the number of records per species after conversion of quarter to km cells for all Dutch plant species. For individual species, the precise increase in the number of records after conversion depends on the specific distribution pattern, especially in the case of rare species. For rare species with a very clumped distribution pattern, the increase is by a factor of 1.3, dropping to about 1.0 for the most widespread species.

The method outlined above is a simplified version of the method originally developed for the national model DEMNAT (Claessen *et al.* 1996, Witte 1998, Runhaar 1999, Van Ek *et al.* 2000), which has been used for scenario studies to assess the impact of water management policies on terrestrial vascular plants. The original method focuses on floristic quality in quarter cells rather than species presence and also includes site suitability of the quarter cell parts as a weighting factor in the above procedure (Tamis *et al.* 2000).

2.3. Differences in geographical coverage

2.3.1. General

The following key problem confronting biodiversity surveys is incomplete geographical coverage by *sufficiently* surveyed grid cells, especially at more detailed scale levels. This also holds true in the Netherlands, affecting surveys of virtually all groups of plants and animals (Vereniging Flora en Fauna 1997, Van Nieukerken and Van Loon 1995), including vascular plants (e.g. Groen *et al.* 1997, Witte 1998). Gaps in geographical coverage often go hand in hand with uneven distribution in time and space of the grid cells that have been surveyed. (The precise meaning of 'sufficiently surveyed' will be discussed below, in section 2.4.)

The main reasons for incomplete geographical coverage in the Netherlands are uneven distribution of observers (more in densely populated areas); limited means of transportation prior to 1950; lack of botanical interest in the main agricultural regions, which have few if any natural areas, as in the provinces of Friesland and Groningen and the Flevoland polders; and differences in provincial monitoring practices (e.g. Weeda 1985, Groen 1997, Witte 1998, Tamis *et al.* 2000). Given this incomplete geographical coverage, no reliable estimates of plant species presence are available for the country as a whole. The partial estimates are biased, furthermore, towards better investigated regions and periods, hampering correct interpretation of changes, both spatial and temporal.

In this section we describe the regional and temporal variation in geographical coverage of sufficiently surveyed grid cells in the Netherlands, the solutions adopted until now in international and Dutch floristic research, and their respective shortcomings. Finally, a weighting method is described to correct for incomplete geographical coverage of floristic distribution data in the Netherlands.

2.3.2. Geographical coverage of floristic observations in the Netherlands

The degree of geographical coverage varies in the different regions of the Netherlands. As an example, in Fig. 3 the IJsselmeer polders and the northern marine clay region have a large number of unsurveyed or insufficiently surveyed grid cells, while in the western peat region, for example, there is almost complete coverage. Geographical coverage varies not only in space but also in time. In Fig. 4 we see that the fraction of insufficiently surveyed grid cells is approx. 65% for the periods 1902–1950 and 1975–1985 and approx. 50 % for 1985–2000.[3] [4]

Four basic strategies can be distinguished for tackling the problem of incomplete geographical coverage, viz.:

1) Upgrading by experts: *total* national values (for species presence, changes, etc.) are upgraded by means of expert judgement (e.g. Van der Meijden *et al.* 1991, Ellenberg *et al.* 1992).

[3] Period definiton in this study: from year (e.g. 1902) – = up to (thus *not including*) year (e.g.1950).

[4] For the purpose of this figure, km cells with at least 90 species present were defined as sufficiently surveyed in that study (Tamis *et al.* 2000); see also section 3.3.

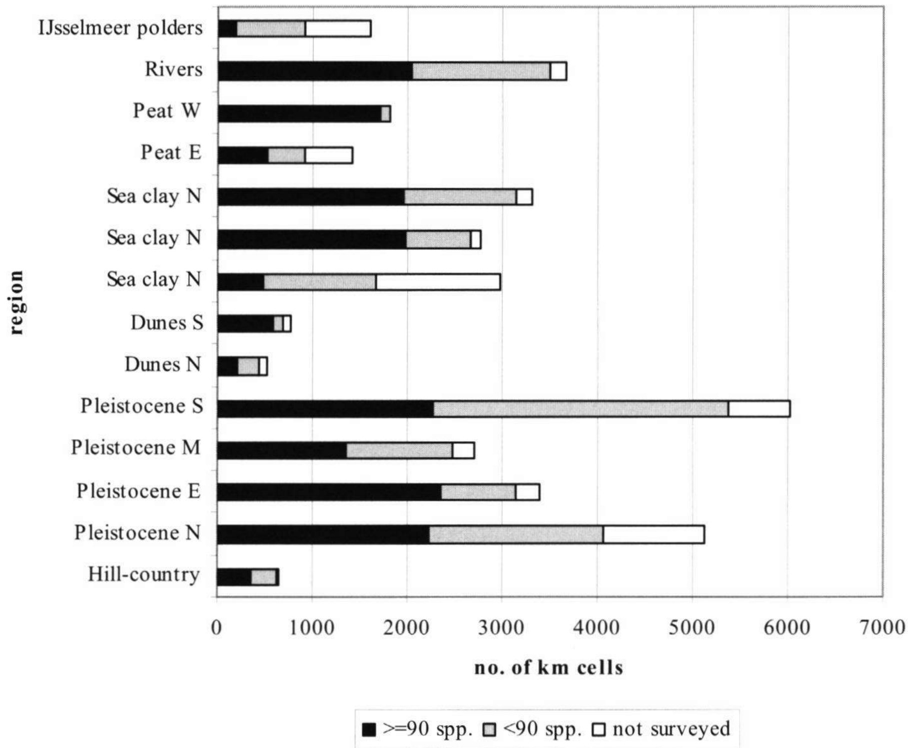


Fig. 3. Number of sufficiently surveyed (at least 90 species), incompletely surveyed (fewer than 90 species) and non-surveyed km-cells per eco-region (see also Fig. 6) in the period 1975–2000; source: Tamis *et al.* (2000).

2) Extrapolation: values for *individual* insufficiently surveyed grid cells are predicted using statistical regression methods, including spatial statistics (e.g. Augustin *et al.* 1996, Iverson and Prasad 1998, Wolgemuth 1998, Heikkinen 1998, Guisan *et al.* 1999, Bio 2000, Pebesma *et al.* 2000). This method takes the presence of species or species number in sufficiently surveyed grid cells as a dependent variable and regresses it against independent landscape-ecological variables such as soil type, water level and management.
3) Aggregation: data collected on a more detailed scale are aggregated to a less detailed scale (e.g. Mennema *et al.* 1980, Rich and Woodruff 1996, Telfer *et al.* 2002, Preston *et al.* 2002).
4) Repeated sampling: a sample of sufficiently surveyed grid cells is taken which have been repeatedly investigated over several periods. Although this does not solve the problem of incomplete coverage, it does yield an unbiased estimate of changes if the sample is representative (e.g. Rich and Woodruff 1996, Groen *et al.* 1997, Van der Meijden *et al.* 2000, Telfer *et al.* 2002).

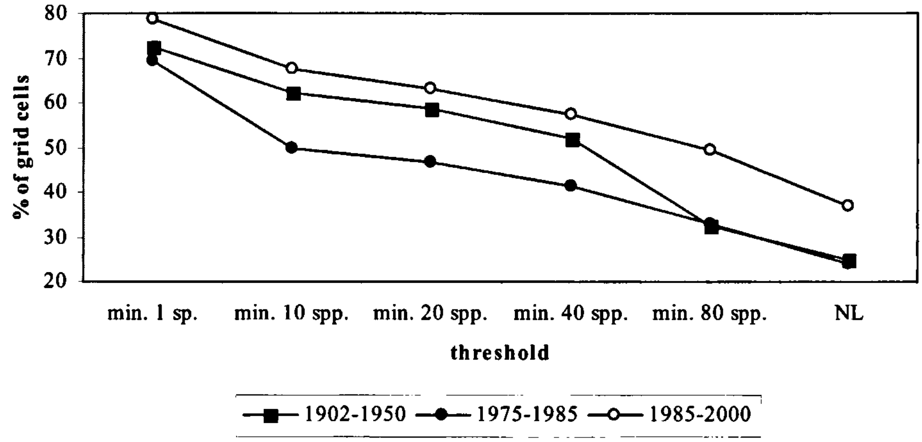


Fig. 4. Percentage of km-cells with at least 1, 10, 20, 40, 80 or NL species (NL = number of species for which the noise level is exceeded; see section 4) for three different periods.

Several of these solutions have been implemented in the Netherlands, often in combination. Before about 1990, data on vascular plant species presence in the Netherlands were first aggregated to the hour cell or atlas cell level. The resulting total frequencies were then classified on a simple ten-point scale (UFK). These UFK-values were then evaluated and if necessary upgraded or downgraded by experts (Mennema *et al.* 1980, Plate 1990, Van der Meijden *et al.* 1991). More recently, Tamis *et al.* (2000) extrapolated floristic quality for insufficiently surveyed km cells for moist and wet ecosystems, based on the number of species and their ecological amplitude. Pebesma and Bio (2002) developed an extrapolation procedure for predicting species presence in insufficiently surveyed km cells[5]. Groen (1996), Groen *et al* (1997) and Van der Meijden *et al.* (2000) used the repeated sampling procedure, but reported that the samples were biased towards the better investigated regions.

The various methods used to correct for incomplete geographical coverage cited above all have their disadvantages. The upgrading method is held to yield the best estimates, but depends on (limited) availability of experts in the floristic field. Extrapolation methods are complex and time-consuming, but have the advantage of objectivity and reproducibility. With the aggregation method, important detailed information is lost. The repeated sampling hinges on samples being representative. Recent Dutch floristic studies do not allow for the incomplete geographical coverage of sufficiently surveyed km cells, or only partially. Distribution studies in other

[5] Witte (1997) developed a particular variant of the extrapolation method which uses the presence of so-called 'guiding species' (Witte's term for 'indicator species) in a km cell to predict the presence of other (non-observed) species in the same km cell. This method cannot be used for unsurveyed or poorly surveyed grid cells and will therefore be considered further in the next paragraph, which deals with the problem of incomplete species lists.

European countries generally use much larger grid cells, as in the UK (10 km grid), for example, while the EU employs a 50 km grid. In these cases, geographical coverage is consequently often complete, or almost so.

2.3.3. A new correction method for incomplete geographical coverage

We chose to develop a new method to tackle the problem of incomplete geographical coverage of sufficiently surveyed km cells. The ultimate goal of this method is to produce unbiased total estimates of presences of plant species at a national level. We developed a method we term 'regional filling-up', explained in detail below. The main elements of this method are division of the Netherlands into ecological regions and the assumption that the samples of sufficiently investigated grid cells within each region are representative. We also investigated, qualitatively, the representativeness of regional samples. Finally, by way of partial validation, we compare the upgraded UFK-values (Van der Meijden *et al.* 1991) with the results of our method. The upgraded UFK-values are generally interpreted as being the best total estimates of the Dutch flora at the hour cell level.

The regional filling-up method consists essentially of the following steps:
1) Division of the Netherlands into twenty-five eco-geographical regions (E) (based on Weeda 1996 and Klijn 1997, see Fig. 5); in each region the total number (T_E) of km cells was counted.
2) In each of these eco-geographical regions the number (N_E) of sufficiently surveyed km cells was counted; a km cell was considered sufficiently surveyed if at least 80 species had been recorded in it (see next section).
3) The regional ratio (W_E) was calculated as the ratio of the total number (T_E) of km cells in the region divided by the number of sufficiently surveyed km cells:
$W_E = T_E / N_E$.

Then, for each plant species and each ecogeographical region:
4) The number of presences (or frequency) F_E within the well-surveyed grid cells was counted.
5) The total presence of a species in a region was calculated by multiplying the regional ratio by the frequency: $F_E \times W_E$.
6) The total presence values for all regions were then summed (see formula below), yielding the total national frequency of the species in question.

To obtain a readily interpretable number:
7) The total national frequency is divided by the total number of km cells in the Netherlands (which differs from period to period), A_{Neth} (see formula below)
8) and multiplied by one thousand to yield total national presence, P_{Neth}, expressed as a permillage (see formula) of the total number of km cells in the Netherlands.

$$P_{Neth} = \frac{1{,}000}{A_{Neth}} \times \sum_{E=1}^{E=25} F_E \times W_E$$

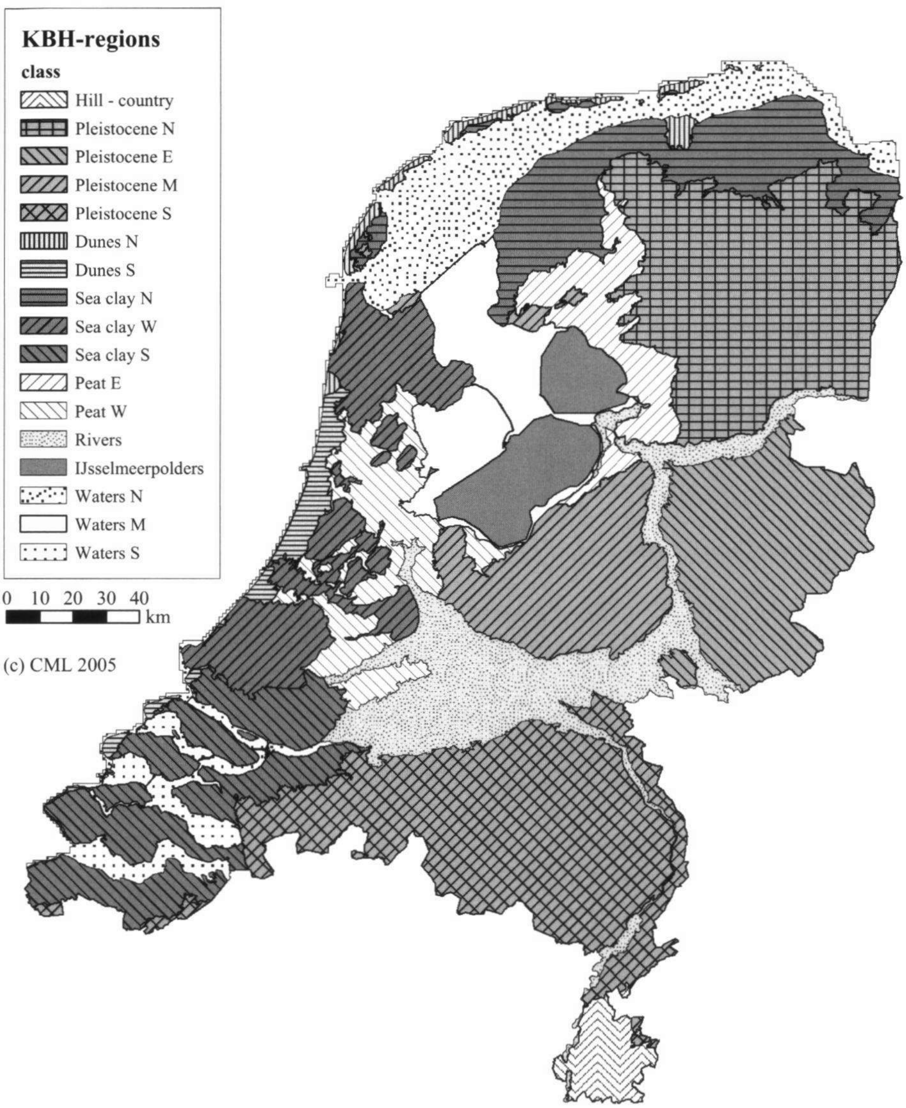


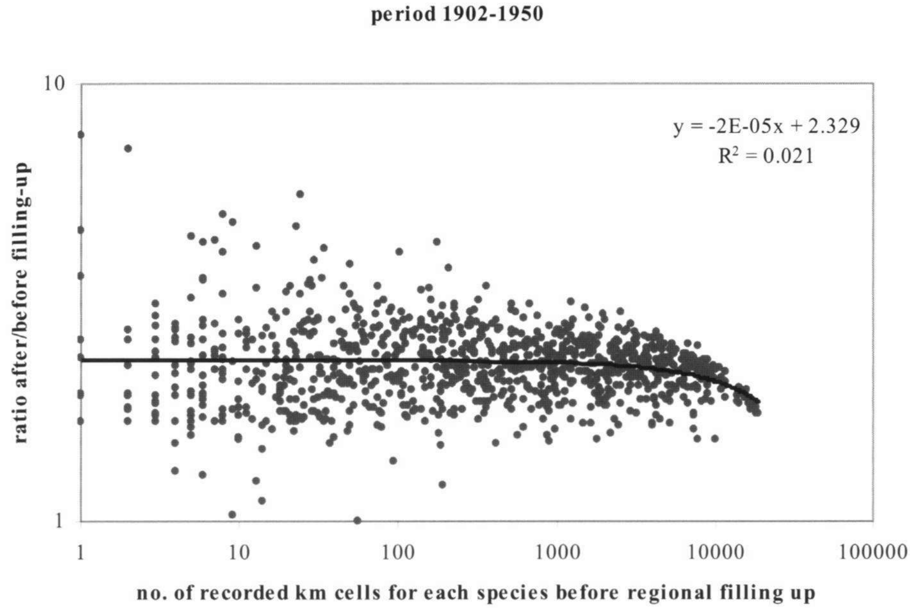
Fig 5. Eco-geographical region classification of the Netherlands used for the regional filling-up method; source: Tamis *et al.* (2000).

These permillages were calculated for all species for the different periods and applied in analysing the various changes in the Dutch flora. They were also classified on a new, simple 10-point classification scale, called the KFK (Dutch acronym for *KilometerFrequentieKlassen*, see Appendix and Tamis and Van 't Zelfde 2003). Fig. 6 shows the result of applying this regional filling-up method for two periods (1902–1950 and 1988–2000) and at two scale levels (hour/atlas and km cells). As the regional filling-up method yields a figure for total national presence, its effect is greater for the less well-investigated period and the more detailed scale. The effect of the new method for each species has been expressed as the ratio between total national presence after and before its application. From Fig. 6 we see that this effect is greater for the period 1902–1950, with less complete geographical coverage (ratio: 2.3). We also see that, on average, the effect of regional filling-up is not different for rare and common species, although the former have a larger range of ratios than the latter. The smaller range for the common species is obviously an effect of the 'bounded conditions': *in extremo*, a common species present in all sample cells can have only one ratio, viz. the ratio between the area of the Netherlands and the area of sufficiently surveyed grid cells. Finally, we see that the effect of this regional filling-up method is far smaller for hour cells or atlas cells (almost one) than for km cells, which nicely illustrates the effect of the aggregation procedure on geographical coverage.

One of the basic assumptions of the regional filling-up method is that the stratified regional samples are representative. As there is no independent information with which to evaluate the true representativeness of the samples (for which purpose we would require information on all grid cells, but then we would obviously no longer need to correct for incomplete coverage), we used an indirect approach, comparing the results of the regional filling-up method described above with a second, more elaborate method. This second variant also takes into account the site suitability of regional samples and regions (e.g. Klijn 1997, Witte 1998), thereby automatically correcting for any non-representativeness. As each plant species has specific site requirements, the second variant of the method is far more complex, because calculations must incorporate the different ecological requirements and amplitudes of each plant species.

The comparison was carried out for four species with very different ecological requirements: *Alisma plantago-aquatica*, *Aristolochia clematites*, *Blechnum spicant* and *Cicendia filiformis*. In doing so, we used several different thresholds to define whether a grid cell has been 'sufficiently surveyed' (an issue discussed in detail in the next section), performing the analysis for all three periods. Application of the regional filling up method leads to a corrected figure for total national presence of the investigated species that is about twice as high as the uncorrected figure. The results of the two procedures appeared to be almost identical, as can be seen in Fig. 7, indicating that our own, simpler regional filling-up method is almost as valid as the more detailed habitat-based variant of the method. We interpreted this as an indication that the available samples in the different regions are representative.

By way of partial validation, for two periods we compared the UFK-values, upgraded by experts (as described in section 3.2), with the results of our regional



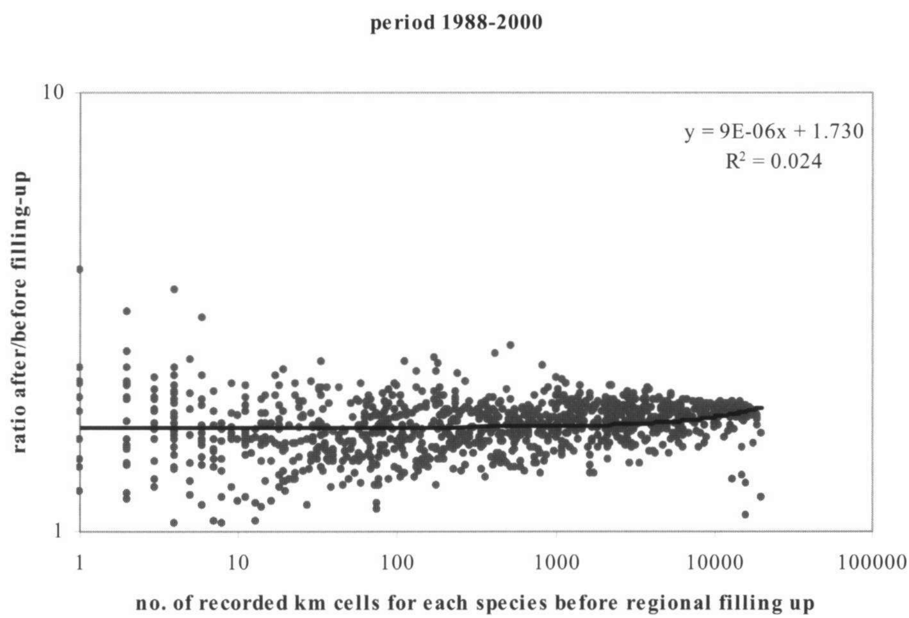
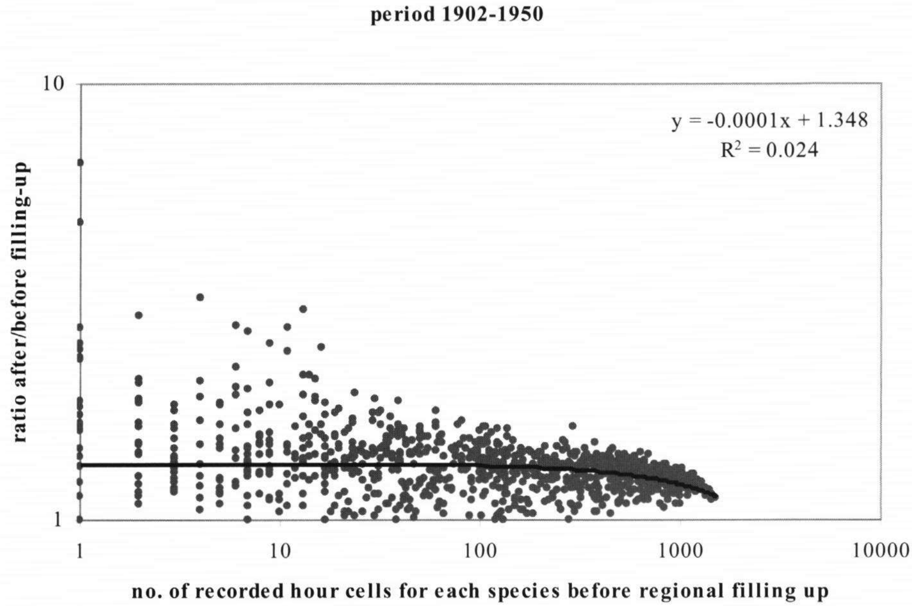


Fig. 6. Ratio between no. of grid cells per species after application of regional filling-up method for two periods at two scale levels; horizontal axis: left, rare species and right, common species. Continued on next page.



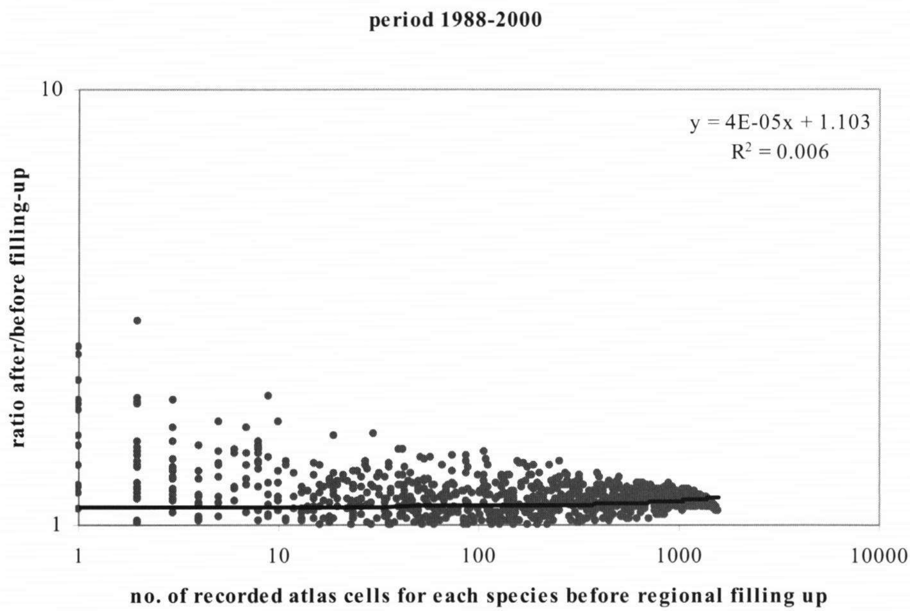


Fig. 6. Continued

filling-up method, which were classified on the UFK-scale; see Fig. 8. The present method can be seen as a fully formalised version of the upgrading by experts of the UFK-values. The latter method includes important expert judgement steps; still it is regarded to produce the best available estimates.

For about 70% of the species the UFK-values of the two methods are identical. For the two periods examined, the measure of concordance, kappa, is 0.68 and 0.62 and highly significant ($P<0.001$). The fact that the regional filling-up methods yields results that are comparable to those of the latter method can be seen as indication of its reliability. The higher UFK results for the commoner species after weighting are intuitively supported by a number of experts (pers. comm. Van der Meijden).

2.4. Incomplete species coverage

2.4.1. General

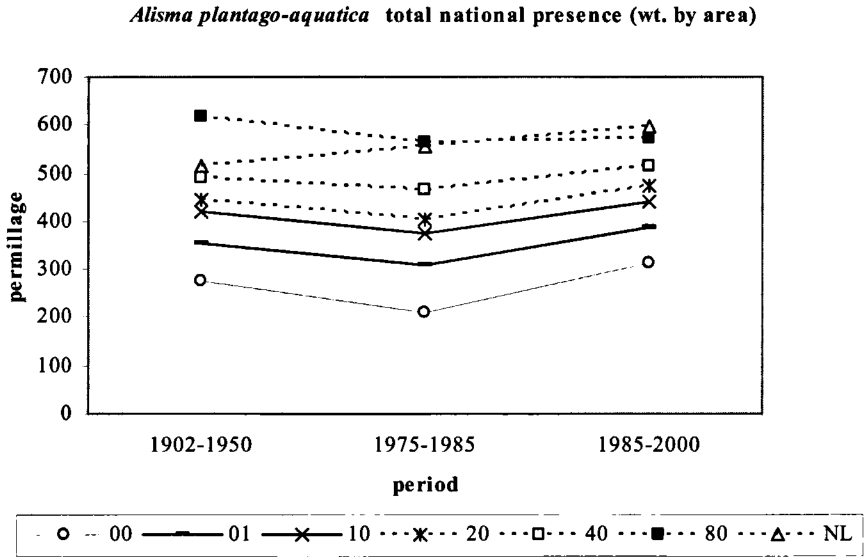
The number of species present in a given grid cell depends on a multitude of factors, rising with area (species-area relationship), habitat diversity, extensiveness of land use/management, age and geographical connectivity (a.o. Feekes 1936, Joenje 1978, Di Castri 1989). The number of species actually *observed* in a particular grid cell will depend additionally, of course, on how the data are collected. In this respect we can distinguish sufficiently surveyed, partially surveyed and unsurveyed grid cells.

The problem of geographical coverage of sufficiently surveyed grid cells was discussed in the previous section. In this section we focus on the issue of when a grid cell is to be deemed 'sufficiently surveyed'. A particular field survey may be 'partial' in several respects, including seasonality (only summer records, say, with none in spring), duration and number of visits *within* a year, and selective surveying of rare habitats, rare species or accessible sections or habitats of a given cell (Rich and Woodruff 1992, Rich 1997, 1998a, b, c). According to Witte (1998), for example, in the early 20th century wet and aquatic habitats were relatively poorly surveyed because in that era there were no cheap boots available.

One particular problem relates to multiple visits to the same grid cell over different years. This problem of 'survey intensity' will be discussed below, in section 5.

A partial survey of a grid cell yields an incomplete species list and is therefore a form of inventory bias. If no allowance is made for incomplete lists there may be erroneous interpretation of results on species trends, for these lists are generally taken to have an overrepresentation of less common and of easy recognisable species (Witte 1998, Williams 2000).

In this section we examine the various options for tackling the problem of incomplete species lists and consider their respective drawbacks. For one of the solutions – selection of sufficiently surveyed grid cells – we also examine the consequences for estimates of national presence of rare and common species and national increase or decline.



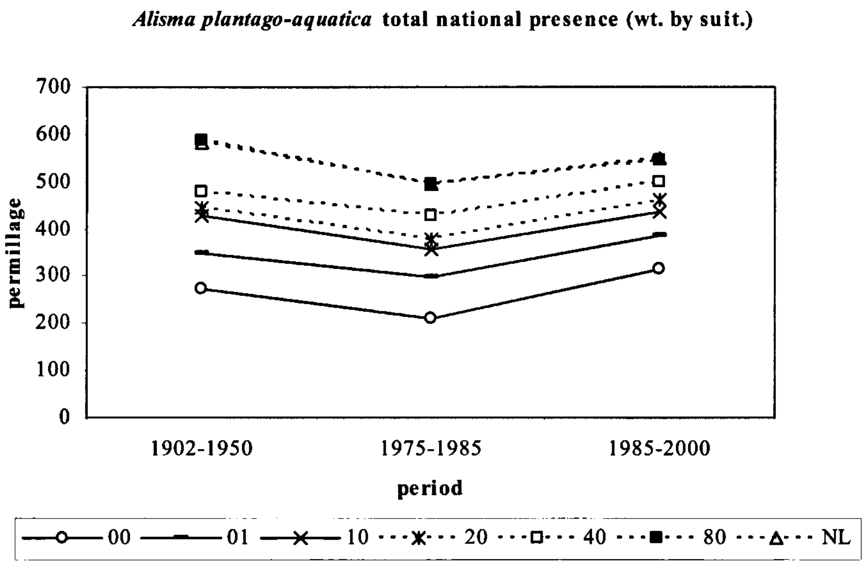
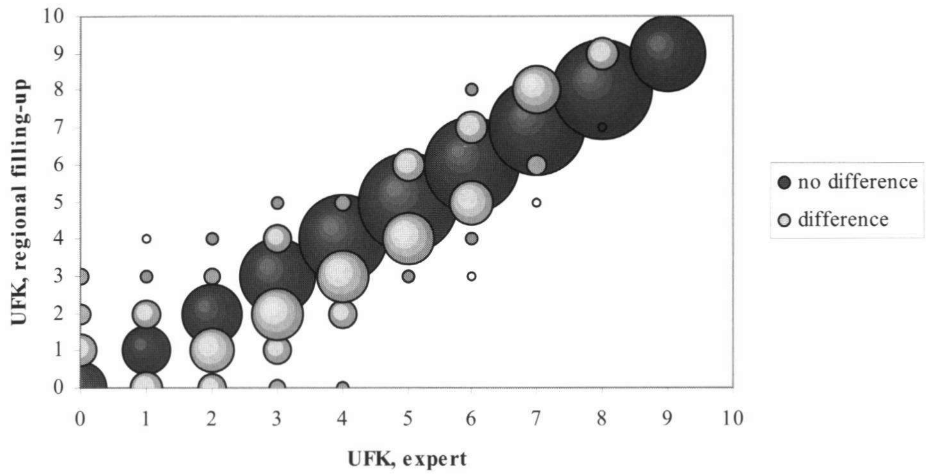


Fig. 7. Total national presence (expressed as permillage) of four plant species after application of regional filling-up method (with various selection thresholds) for three periods. Two variants of this procedure were investigated: weighting (abbreviated: wt.) by area and by site suitability (abbreviated: wt. by suit.). See text and Fig. 4. for further explanation. Fig. 7. is continued in the annex of this chapter.

period 1902-1950



period 1975-1985

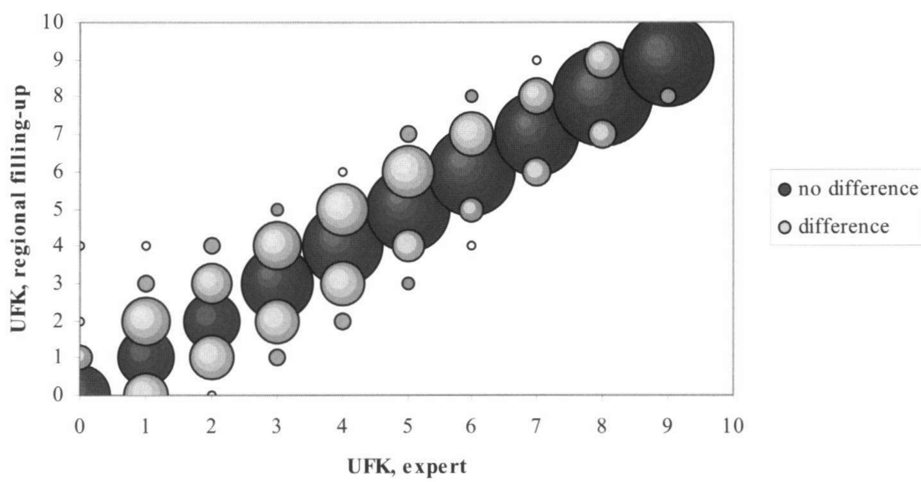


Fig. 8. Comparison of original UFK and UFK based on regional filling-up method for two periods (see text). Bubble size represents number of taxa, the largest standing for about 135 taxa. The black bubbles represent the number of species yielding the same UFK in each method; in the case of the white bubbles the two methods yield different UFK's.

2.4.2. *Sufficiently surveyed grid cells*

It is estimated by experts that the number of vascular plant species in a well-surveyed km cell in the Netherlands lies between 100 and 300, depending on land area, landscape-ecological diversity and the other factors cited above. Van der Meijden *et al.* (1996) and Groen (1996) report an average figure of 150–180 species per sq. km. Van der Maarel (1970) cites an average of 70–120 species per quarter cell (1.30 km^2), but Van der Meijden *et al.* (1996) consider this an underestimate. Fig. 3 shows the median number of species per sq. km in the various regions of the Netherlands. This figure ranges from about 120 for marine clay areas to about 180 for the dunes.

There are several options for addressing the problem of incomplete species lists:

1) Selection: only those grid cells are included in which the number of recorded species exceeds a certain threshold set arbitrarily by experts.

2) Extrapolation: the presence of species that have not been recorded is predicted by means of statistical regression analysis (cf. section 2.3); one particular extrapolation variant is the 'gap-filling' method developed by Witte (1998), described below.

3) Standardisation: rather than incomplete species lists being augmented, the number of visits to the grid cells in question within a region is standardised to the number of visits to neighbouring cells to permit comparison of results (Prendergast *et al.* 1993).

Selection is the approach most often adopted in Dutch floristic studies, with Witte's variant of the extrapolation method used to a lesser extent. The situation to date can be summarised as follows. Many studies have employed a *fixed*, nationwide threshold for the number of species recorded in a given (quarter or km) cell for it to qualify as 'sufficiently surveyed' (Groen 1996, Groen *et al.* 1997, Witte 1998, Witte *et al.* 2000, Van der Meijden *et al.* 2000, Tamis *et al.* 2000, Pebesma and Bio 2002). In all these studies a threshold of between 50 and 100 species was taken. Some of these studies used only commoner species for this selection process, or applied selection after the original data had been augmented in some way.

It is also possible to use *variable* thresholds for the number of species per grid cell. Witte and Van der Meijden (1995), for example, defined well-surveyed km cells as those for which there are sufficient data available to make the presence of at least one ecotope plausible, a threshold they term the Noise Limit. Today FLORON employs a threshold that varies from region to region (pers. comm. C.L.G. Groen).

Witte (1998) developed an extrapolation variant termed the 'gap-filling' method, which proceeds from the observation that rare species can often act as 'guiding species' (Witte's term) for commoner species. The presence of such species in a given grid cell thus allows the species list to be augmented with the 'associated' commoner species.

These correction methods for processing incomplete lists all have their drawbacks. One major problem with the standard selection method is the use of a fixed threshold for the number of recorded species. This means that a certain portion of species lists remains unused, even though many records of important rare species may be contained precisely in the lists in question. Excluding these lists then leads to an underestimate of rare species and an overestimate of commoner species. A second issue is the effect of selection on the assessment of species increase and decline. In particular, the selection method is problematical for species-poor ecosystems like brackish and saltwater systems and raised bogs, which will then be underrepresented (Van der Meijden *et al.* 2000). On the other hand, Witte's gap-filling method (Witte 1998) only works if there are a sufficient number of 'guiding species' present and takes no account of regional variation, moreover.

In other countries there has been little research into the effect of incomplete species lists. Williams (2000) examined the average rarity of bumble-bee species in England in 10 km grid cells as a function of number of species observed. On average, he did not find a higher share of rare species in incomplete inventories (with the exception of a limited number of grid cells). This is in agreement with the results of our own study.

A study by Prendergast *et al.* (1993) showed that standardising the number of survey visits has only a limited effect on the distribution pattern of biodiversity hotspots. Heikkinnen (1998) has demonstrated that although the impact of number of visits on species lists is significant, it was still only marginal (2%). This means that despite the existence of survey errors, differences in species richness are so large that even uncorrected data yield useful results.

2.4.3. Further analysis of consequences of selection method

We have developed no new alternatives for addressing the shortcomings of existing methods for augmenting incomplete species lists. However, we did take a closer look at one of the methods most commonly used, viz. the selection method, examining, on the one hand, the presumption that incomplete lists contain more rare species and, on the other, its consequences for estimating species increase and decline.

In this part of the research, which was qualitative in nature, six species were selected for study, varying in terms of rarity, increase or decline in the 20th century, and habitat type: *Alisma plantago-aquatica* (common, unchanged, aquatic), *Angelica sylvestris* (common, unchanged, wet), *Aristolochia clematites* (rare, unchanged, dry), *Blechnum spicant* (rare, in decline, woodland), *Cicendia filiformis* (rare, in decline, wet) and *Hydrocotyle ranunculoides* (rare, increase, aquatic).

For the minimum number of species in a grid cell for the species in question to be included in subsequent analysis we applied a series of ever larger thresholds, from 1 up to 80. To this we added a Noise Limit, as outlined above. In practice, this latter limit proved to mean that more than a minimum of 80 species was present. For comparison, the results of *no* selection were also included.

The presumption that incomplete lists contain more rare species was investigated in two ways for the six species (both rare and common) cited. The first approach proceeded from the fact that if the presumption is correct, exclusion of incomplete lists (and thus selection of more complete lists) will lead to selection of grid cells with a smaller share of observations of individual rare species. We examined this by

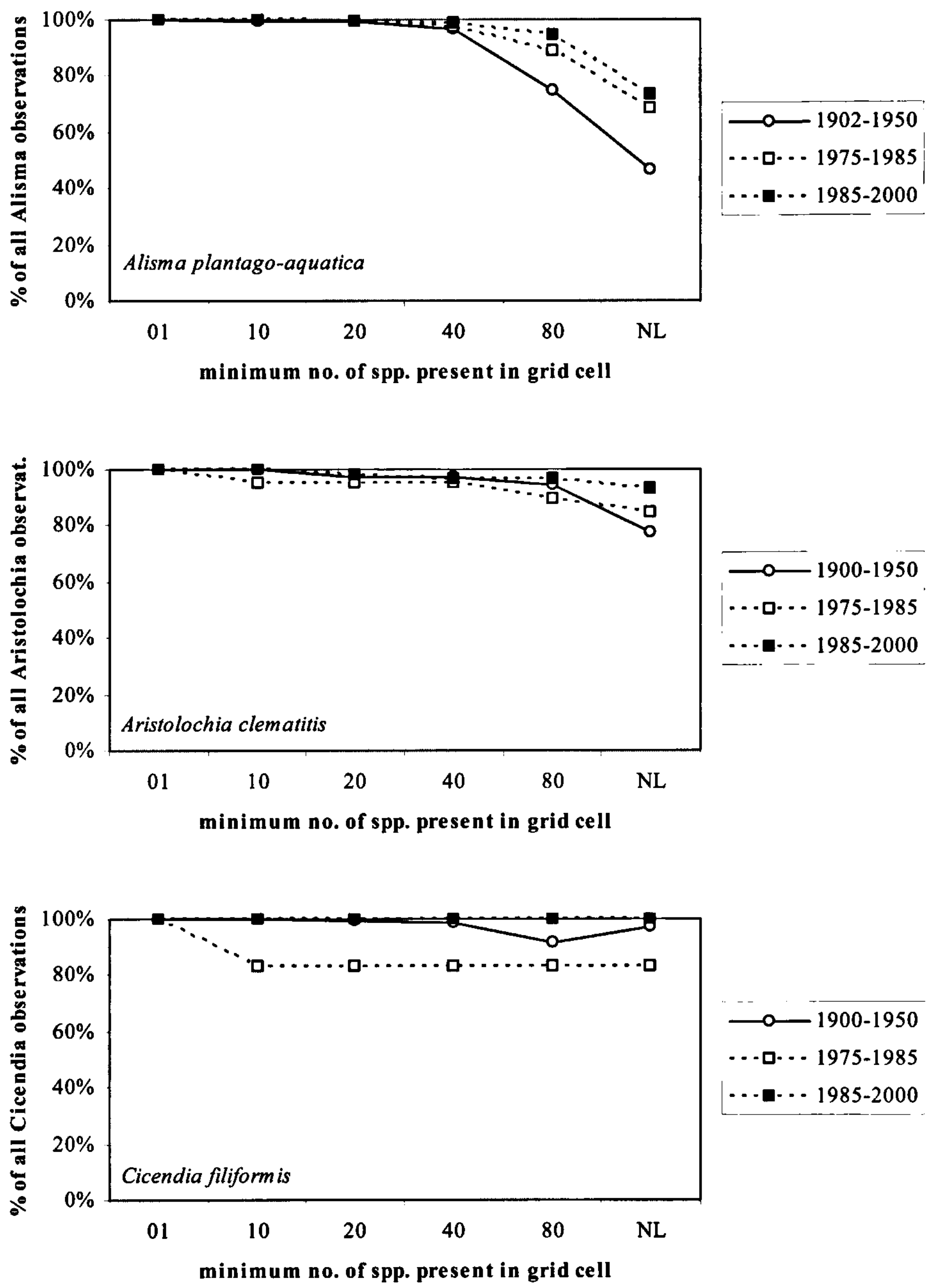
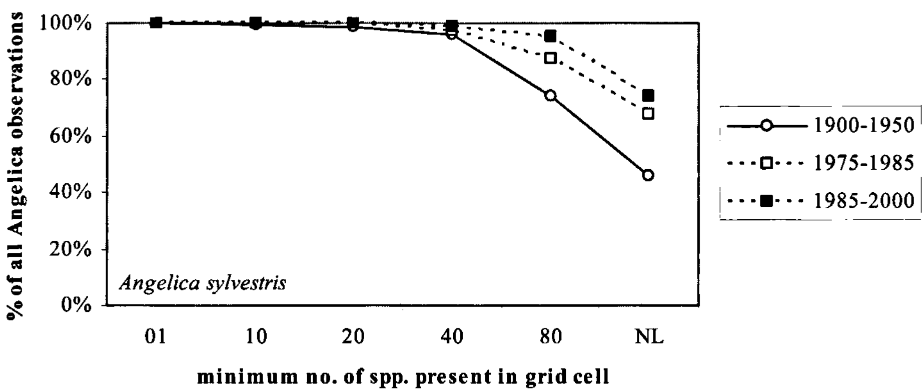
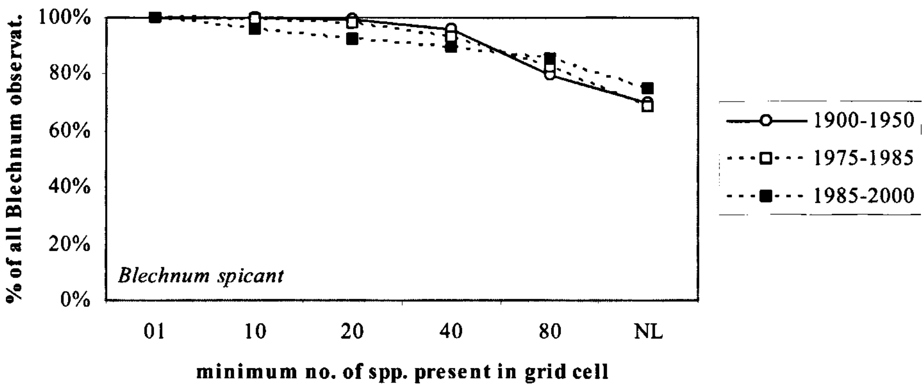


Fig. 9. Percentage of all observations for six species in three periods in selections of km cells with at least 1, 10, 20, 40, 80 or NL species (cf. Fig. 4); continued on next page.





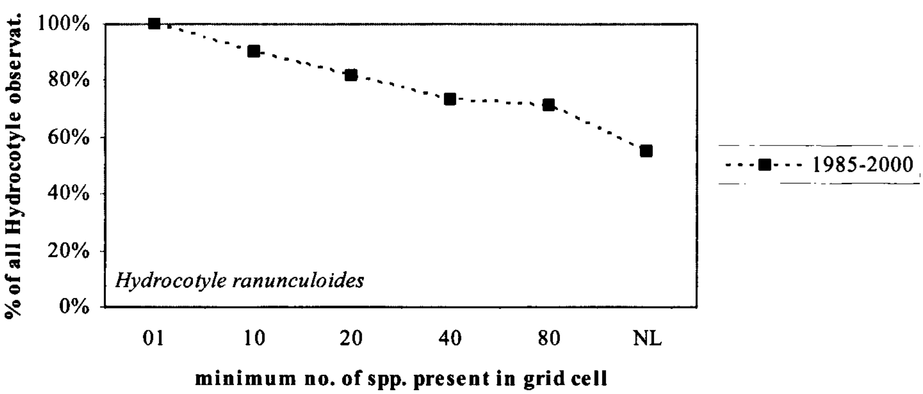


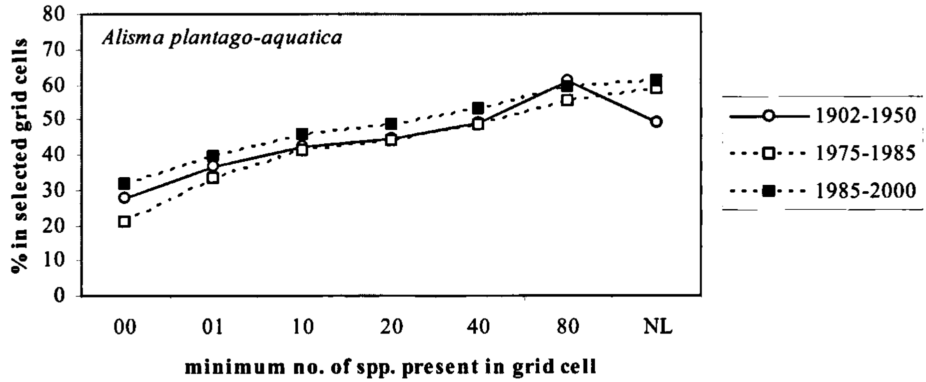
Fig. 9. Continued.

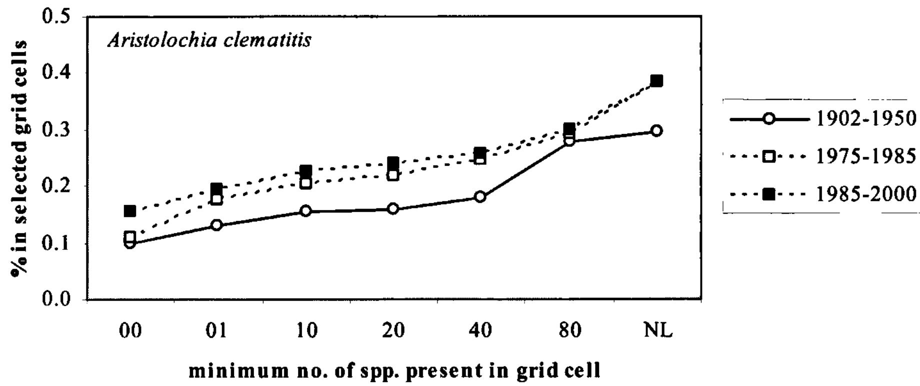
plotting the cumulative share of observations of a given species against the rising threshold for the number of species. At a threshold value of at least 1 species, 100% of the observations of both rare and common species are present in the selected grid cells. This percentage decreases with rising threshold and the decrease should be more pronounced for rare species. The analysis is shown in Fig. 9. When selection is based on thresholds of 40 and 80 species we see that the selected species lists contain, respectively, 90% and 80% of observations for all six species, i.e. irrespective of rarity (correlation between rarity and percentage of observations: –0.18 n.s.).

In the second approach we examined the species frequency in the selected grid cells for the various different thresholds. 'Frequency' is defined here as the percentage of grid cells containing a given species, with rare species scoring low and common species high. If the cited presumption were valid, then rare species presence should decrease with rising threshold, with the presence of common species increasing. This was investigated by plotting species presence against rising threshold value; the results are shown in Fig. 10. We see that the presence of all selected species increases with rising threshold value, irrespective of rarity, with the exception of the neophyte *Hydrocotyle ranunculoides*. This is probably due to the fact that individual observations of this species are generally reported because of its novelty.

For the overall floristic study described in this dissertation we adopted a pragmatic approach, taking a threshold of 80 species for a grid cell to be deemed sufficiently surveyed.

The effect of the selection method on estimated trends in species presence was examined by plotting the degree of change against the threshold value, the former calculated as the ratio between national presence in the periods 1988–2000 and 1902–1950. The results are shown in Fig. 11 for the two variant weighting methods (cf. section 3). The selection procedure proves to have only a small impact on the degree of change thus calculated. In general it can be said that as the threshold rises there is a decline in percentage increases and rise in percentage declines. For *Alisma plantago-aquatica* there is an increase at low thresholds and a small decline at high thresholds.





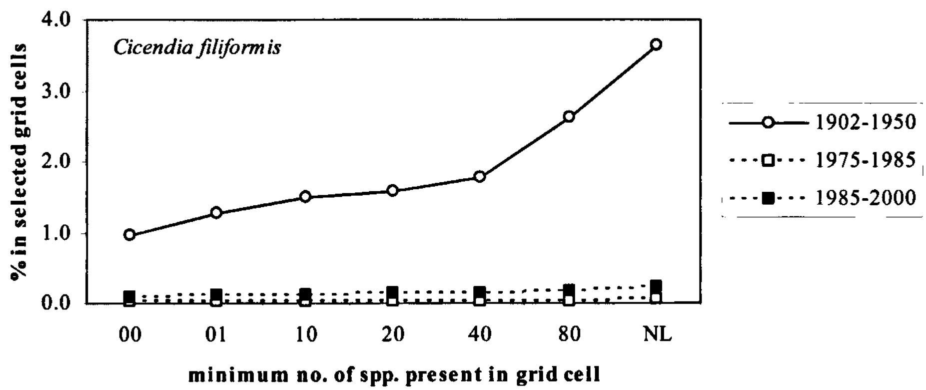
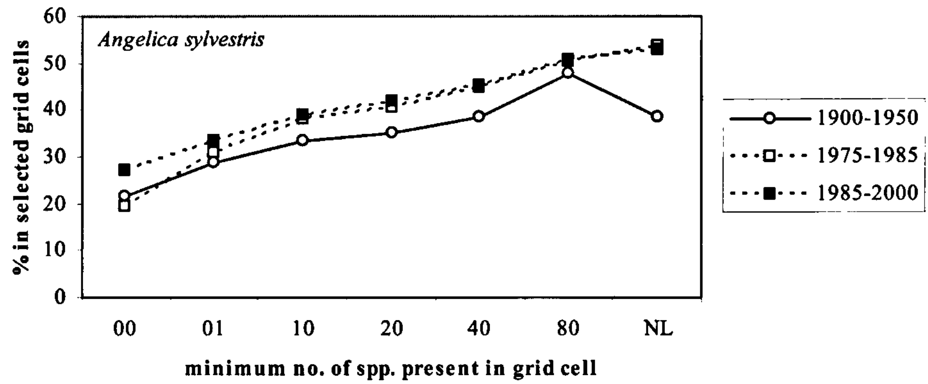
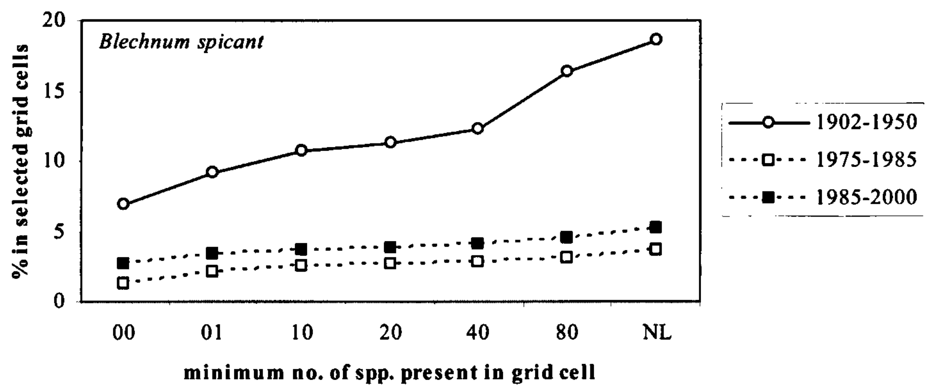


Fig. 10. Presence of six species in three periods in selections of km cells with at least 1, 10, 20, 40, 80 or NL species (cf. Fig..4).





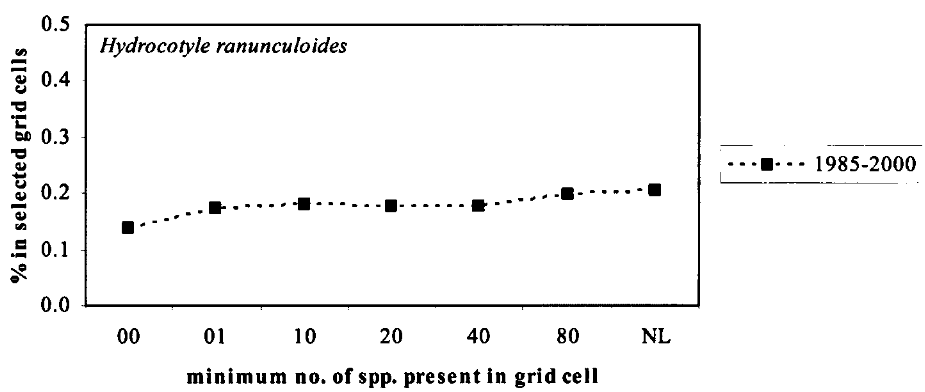
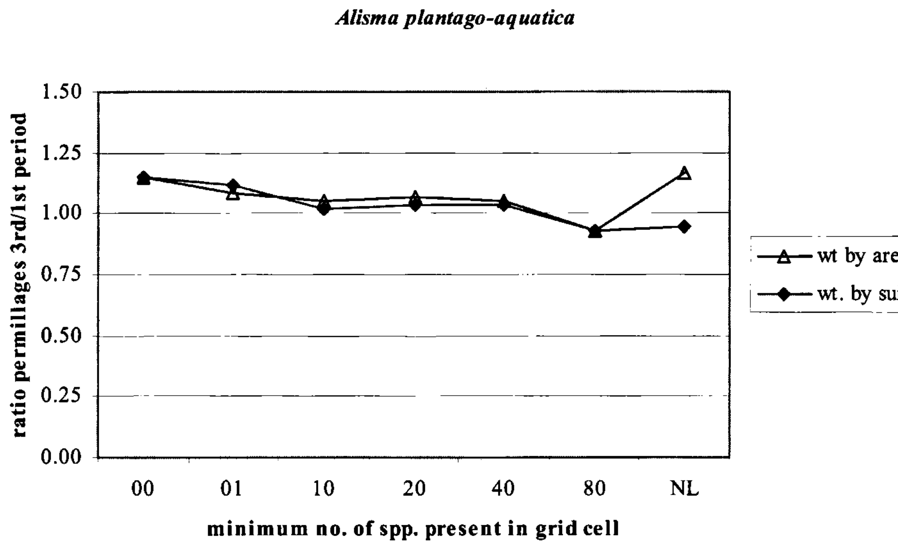


Fig. 10. Continued.



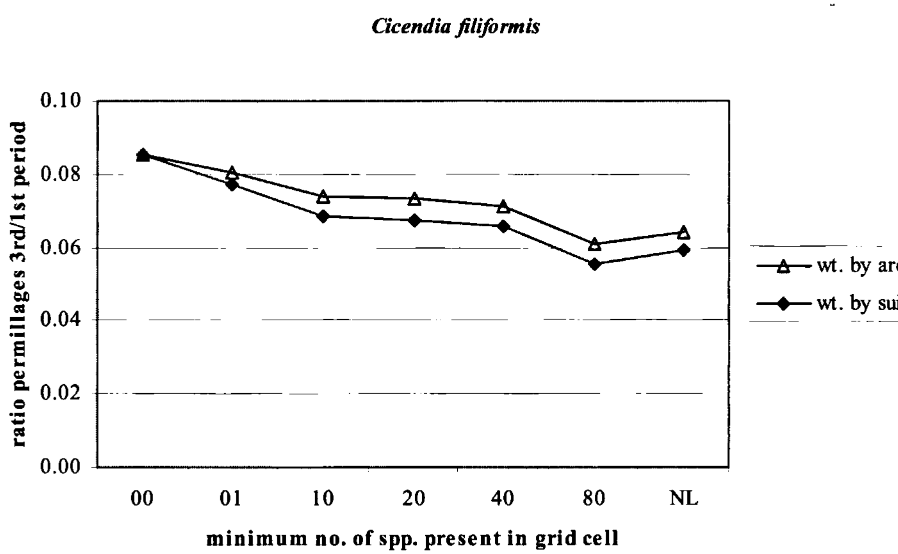
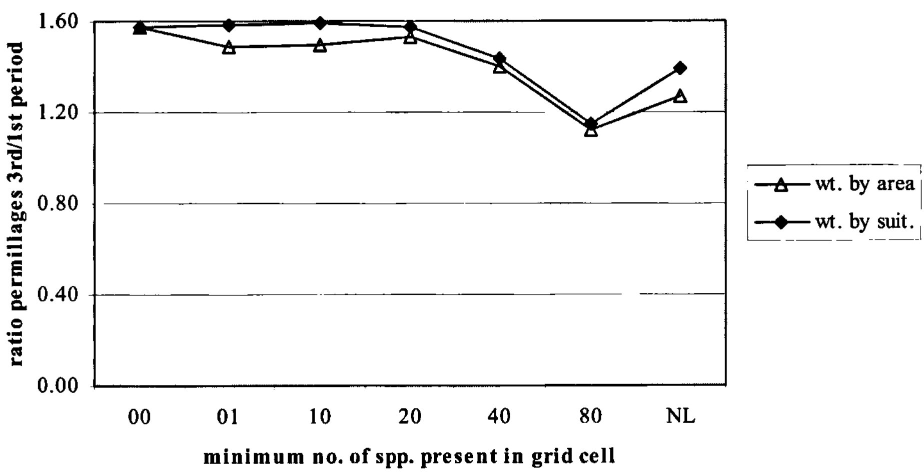


Fig. 11. Degree of change (increase or decline, expressed as a ratio of total national presences) of four species between 3rd period (1985–2000) and 1st period (1902–1950) for the two variants of the regional filling-up method (see Fig. 7) in selections of km cells with at least 1, 10, 20, 40, 80 or NL species (cf. Fig. 4).

Aristolochia clematitis



Blechnum spicant

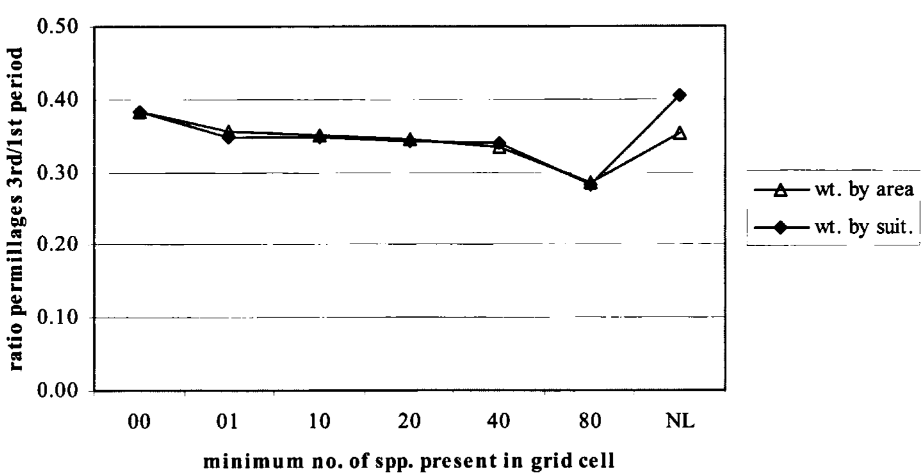


Fig. 11. Continued.

2.5. Differences in survey intensity and problems with plant identification

2.5.1. General

This section considers two other kinds of survey bias: differences in survey intensity and problems with species identification, describing the issues involved, and presenting some possible solutions.

2.5.2. Differences in survey intensity and length of survey period

One particular form of survey bias arises because floristic data collected in different years are aggregated, by species and by grid cell, into extended periods for the purpose of analysis. The basic reason is that geographically comprehensive surveys are never completed within a single year or even several years. In the Netherlands, for example, the first nation-wide survey of vascular plants took about 50 years to complete (Mennema *et al.* 1980). An added complication for this particular period was that the years of site visits have not (yet) been digitised, rendering further analysis impossible (Kloosterman and Van der Meijden 1994, but see Tamis *et al.* 2003). Aggregation of data into extended periods leads to two problems, related to differences in survey intensity and in length of survey period, occurring separately or in combination.

Survey intensity refers to the number of visits made over a *multi-year* period. This may vary from area to area, as well as from survey period to period. Although in the past few decades there is solid information as to which years particular grid cells were visited, (far) less is known about the quality of those surveys in individual years. What we have here, then, is an overlap between the problem of incomplete species lists (cf. section 4) and that of survey intensity. The issue is worth discussing separately, though, because even sufficiently surveyed grid cells may exhibit differences in species number arising through differences in survey intensity. Obviously, those periods or areas in which surveying has been more intensive will generally comprise a greater number of observations. One group of plants for which this is particularly true are those of ephemeral habitats, found at different locations in different years depending on habitat availability. Taking into account the in distribution over the period concerned, the aggregate result will represent an overestimation. In the Dutch literature this is referred to as the 'summation effect' (e.g. Weeda 1985, Plate 1990).

Generally speaking, survey intensity has been greater in more recent periods. Some areas of the Netherlands (the dunes, for example) have also been more intensively surveyed than habitats in farming regions, say. If no allowance is made for this fact, it might be erroneously concluded, for example, that certain species have increased over the years or become commoner than they in fact are, as in the case of ephemeral species.

Survey periods, measured in years, may differ in length. The main problem here, of course, is that there may be major floristic changes over such a long period that are subsequently masked by the process of data aggregation. The scope for identifying changes also depends on the choice of cut-off points, i.e. the beginning and end of the period in question (Plate 1990).

In the international literature a limited number of solutions have recently been proposed to account for differences in survey intensity. Telfer *et al.* (2002) developed a "relative change index" that corrects for a general change in the presence of all species due to an increase in recording effort and based on grid cells that have repeatedly been sufficently surveyed. Rich and Woodruff (1996) developed a method in which the increase in the total number of records due to an increase in recording effort is used as an inter-period correction factor, particularly for rarer species.

In Dutch floristic studies differences in survey intensity have been tackled as follow. Generally speaking, no attempts at correction have been made, as in the case of the Atlas of the Dutch Flora, for example. Similarly, Groen *et al.* (1997) did not correct for differences in survey intensity or survey period, reasoning that survey intensity could be taken as approximately the same in the long period 1902–1950 as in the shorter periods of about 10 years since 1975. Van der Meijden (internal EKI report) distinguished a number of species for which a 'summation effect' is to be anticipated. He then applied correction factors of ½ and ¾ for presence of these species in the longer period to render them comparable with the results for shorter periods. As yet, then, Dutch floristic studies have shown little concern for differences in survey intensity and duration of survey period.

In the research described in this dissertation we statistically analysed changes between survey periods by means of regression analysis. This makes automatic allowance for general unexplained changes across all species, as in the method of Telfer *et al.* (2002). Changes between periods (D) are analysed using statistical regression methods, with a constant (C) being included alongside the explanatory environmental variables (E), viz.:

$$D = C + a_1 \times E_1 + a_2 \times E_2 + \text{etc.}$$

The constant C now describes the general change between two periods that cannot be explained by the other model variables.

This method proceeds from the key assumption, however, that the general inter-period change across all species is related to differences in survey intensity. In the Netherlands, however, the widespread change in plant presence in the course of the 20^{th} century due to such factors as changes in land use is seen as a real change. Until data on these changes are collected in a systematic fashion, no distinction can be made between a real change and one due to an increase in survey intensity.

2.5.3. Plant identification problems and taxonomic changes

Three kinds of identification and taxonomic problems can be distinguished:
- 'difficult' species and species groups
- species apparency ('showiness')
- taxonomic changes over time.

Floristic surveys are carried out largely by volunteers, augmented by a relatively small number of professional botanists. Within the former, expertise varies substantially when it comes to finding and correctly identifying plant species. According to Rich and Woodruff (1992), Rich and Smith (1996) and Rich (1997, 1998a, b, c) this variation in expertise is the principal source of differences in the number of records between grid cells, areas and periods.

The problem is particularly acute for taxa that are hard to identify, such as hybrids and subspecies, and for certain species groups like grasses, sedges and rushes and yellow crucifers and composites. However, at the same time identification skills have improved in the course of the 20th century as better floras and keys have become available and amateur botany courses have greatly improved in quality. If no allowance is made for this variation in identification skills, there is a risk of certain 'difficult' groups being erroneously identified as increasing in presence.

Apart from this problem of 'difficult' taxa, species also vary considerably in apparency and likelihood of being found. Important features in this respect include plant height, flower size, flower colour, duration of visible presence and physical accessibility of the vegetation.

Furthermore, the twentieth century has seen a great many taxonomic changes, with some taxa being split up and others lumped together at the subspecies or species level. In the Netherlands, summaries of these changes are provided in the various editions of Heukel's 'standard' flora. Among the many cases in point is division of *Alisma plantago-aquatica* into three species: *A. plantago-aquatica*, *A. lanceolatum* and *A. gramineum*. If this is not strictly accounted for in trend analysis, species will be erroneously held to be 'new' or 'extinct' (locally, regionally, nationally). Such species will then still be present in the database, but as part of a different taxon.

There are two basic strategies for tackling these problems:
1) exclusion of 'difficult' or unreliable species and
2) aggregation of these species to species or species groups that are more readily identifiable (e.g. Wohlgemuth 1998).

In Dutch floristic studies the following strategies have been adopted. in the case of the Red List for the year 2000, Van der Meijden *et al.* (2000) corrected the number of records based on expert judgment. Witte (1998) and others excluded a set of species on which data is held to be unreliable or unusable. Tamis *et al.* (1997) classified some 600 rare Dutch species according to the various aspects of ease of finding and of recognition and selected a homogeneous set of rare species for a national monitoring grid.

Although all (amateur) botanists are familiar with differences in ease of finding and of recognition, the impact of these differences on the comparability of distribution data has never been systematically investigated. In the research described in this dissertation we employed a combination of methods to this end:

- categorisation of all Dutch species as easy, moderately difficult or difficult to identify. Depending on the period under analysis, difficult and/or moderately difficult species were excluded;
- aggregation of 'difficult' species (e.g. *Alchemilla* and *Callitriche* species); see Table 2 of the Annex of this study for a full review;
- aggregation of species that have been split or lumped in the 20th century; see Table 2 of the Annex of this study for a full review.

2.6. Conclusions

2.6.1. General

In the Netherlands over 10 million records of vascular plant observations from the 20th century have been digitised at a scale level of (approx.) 1 km^2, creating enormous scope for research relating to nature conservation and environmental policy, among other areas. As this vast reservoir of data has not been collected according to any systematic procedure, however, there is inevitably a certain amount of survey bias. We identified five categories of bias, for some of which we have developed new corrective strategies or re-examined existing strategies In the review of the changes in the Netherlands' flora in the 20th century described in this dissertation, a combination of strategies has been employed. In this section we present and discuss the main conclusions regarding survey bias.

2.6.2. Differences in scale and map projection

Earlier Dutch floristic analyses paid little attention to the effects of differences in scale and map projection in the pre- and post-1950 era, leading to overestimation of the presence of rare species prior to 1950. We have developed a new GIS-based method that duly allows for these differences in scale and projection, as well as for differences in species distribution patterns and the effects of coastal and border regions with incomplete cells. The results obtained can be used at the local, regional and national level. Even with this GIS method for correcting for the effects of scale and projection differences, however, there are still several issues requiring further study, such as quantification of the effects, refinement of the procedure on the basis of site suitability and different thresholds for species presence at the new scale (in relation to rarity of the species) after division of species presence at the old scale.

2.6.3. Incomplete geographical coverage

A major problem when using distribution data at the more detailed scale level of about 1 km^2 is incomplete geographical coverage, which again leads to incomplete estimates of species presence. To address this problem we designed a simple regional 'filling-up' method based on representative sampling of various regions of the Netherlands and compared the results with experts' best estimates of national species distribution. The two methods proved to yield very similar results. As an alternative to the regional filling-up method, statistical extrapolation methods can also be used (for the Netherlands, see Pebesma 2000, Tamis *et al.* 2000, Pebesma and Bio 2002). Although the latter may provide better results (predictions at the local, regional and national scale level that duly allow for differences in regional distribution patterns), they are rather laborious and have not been used in this thesis.

2.6.4. Incomplete species coverage

There are always certain grid cells that have been only partially surveyed, and the incomplete species lists for these cells are generally regarded as containing mainly rare species. One of the most common strategies to tackle this problem – simply excluding such lists – might therefore well lead to underestimation of rare species. However, further investigation of the effects of excluding these lists showed that rare species are not in fact better represented in them and that their exclusion does lead to more reliable estimates of national species presence. When incomplete lists comprising fewer than 80 species were excluded, 80% of the individual records were still found to be included on the remaining lists, irrespective of the rarity of the species in question. The effect of excluding incomplete species lists on trends in species presence was also investigated. Excluding these lists was found to yield a better picture of species decline. Thus, one general conclusion is that excluding incomplete species lists leads to better estimates of presence and changes in presence.

When incomplete lists are to be excluded from analysis, use is generally made of a fixed threshold, i.e. a minimum number of recorded species in a grid cell for it to be included. This threshold is arbitrarily chosen and dispriveleges species-poor areas such as salt-water and brackish ecosystems. A better alternative for assessing whether a grid cell has been sufficiently surveyed would be to estimate the *expected* number of species in the cell in question in the light of the types of habitats involved (e.g. Iverson and Prasad 1998, Wohlgemuth 1998, Heikkinnen 1998). This is an issue that requires further study.

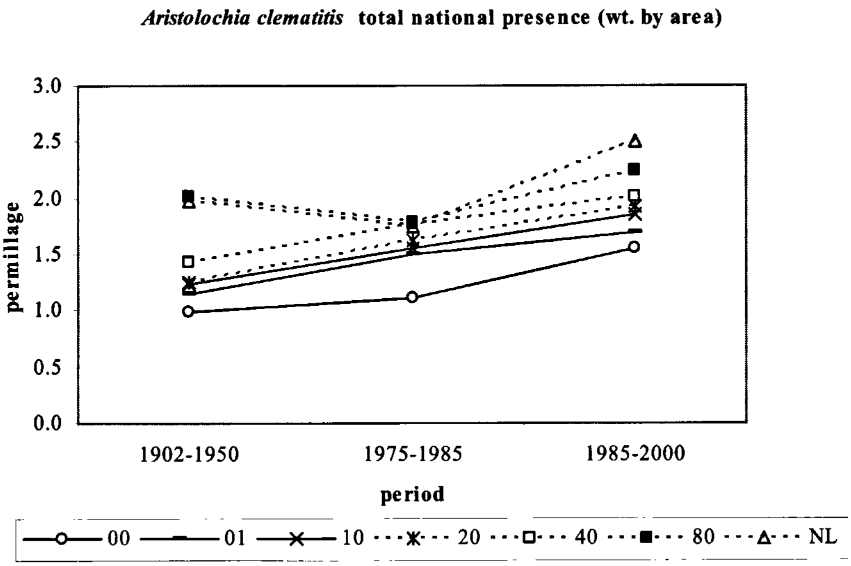
2.6.5. Differences in survey intensity and length of survey periods

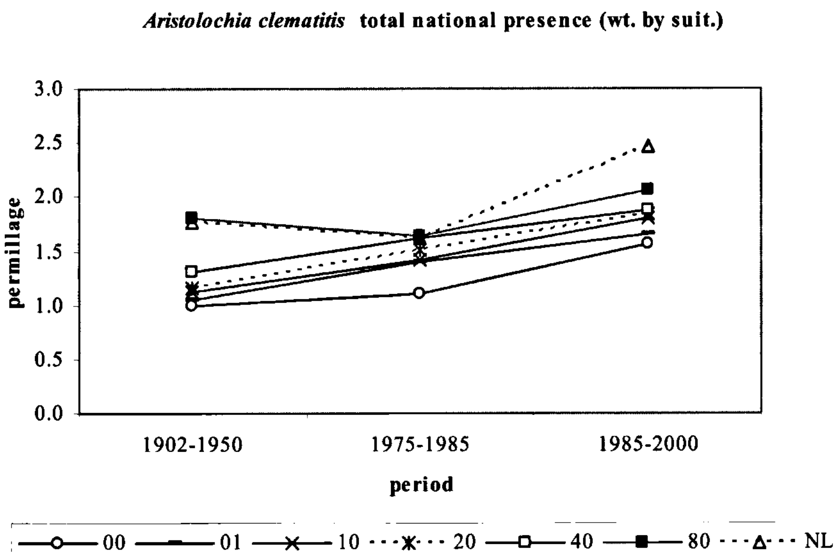
In the Netherlands there has been an increase in the intensity of floristic surveying as well as an improvement in botanical knowledge and in identification skills over the years. For species on the increase, this makes results more difficult to interpret. However, for species in decline – of which there are many – the decline becomes all the more apparent. We used the constant of standard regression techniques to correct for possible diferences in survey intensity, a procedure similar to that employed by Telfer *et al.* (2002).

There are two problematical aspects of survey intensity and species identification that require further study: 'summation effects' of ephemeral species, and the influence of ease of finding and of identification. These issues can be researched by comparing results for different species groups (ephemeral versus non-ephemeral species, for example).

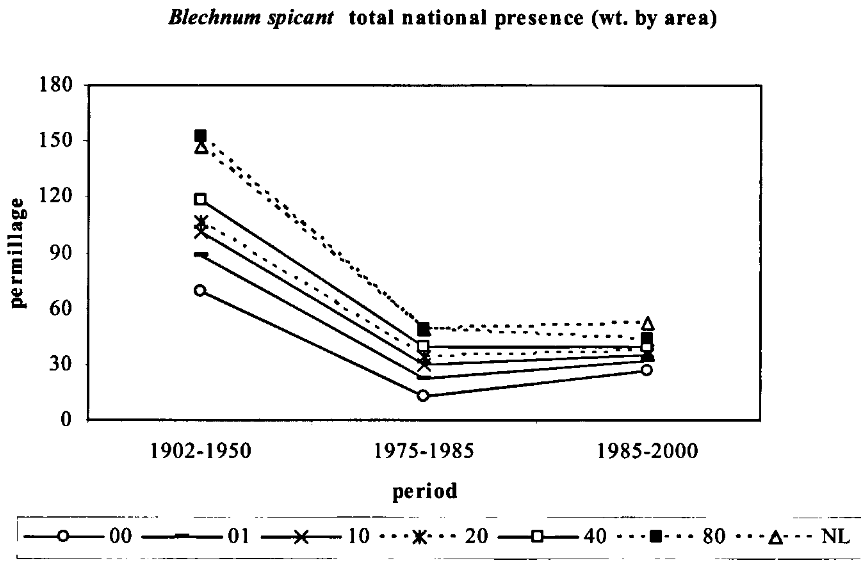
2.7. Acknowledgements

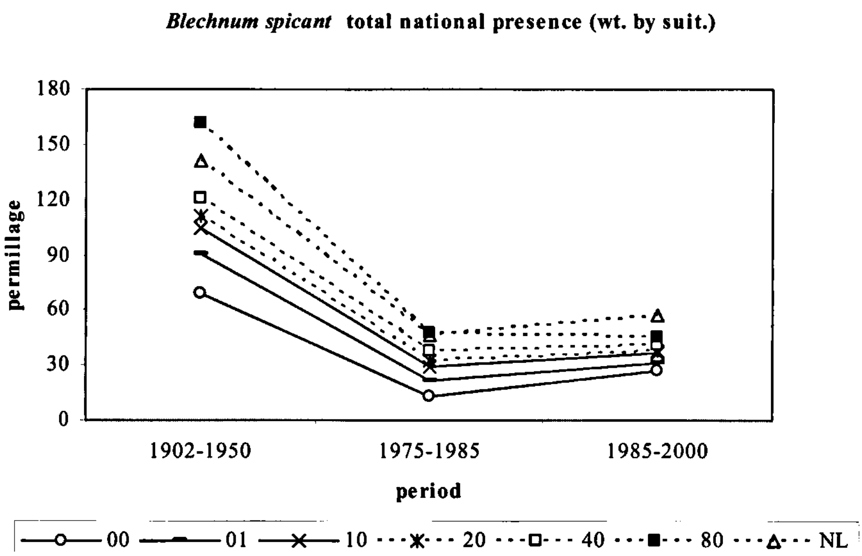
This work was carried out in the framework of the Dutch National Research Programme on Global Air Pollution and Climate Change, second phase (NOP-II) grant no. 95.2275 and in the framework of the Stimulation Programme Biodiversity of the Netherlands Organisation for Scientific Research (NWO) grant no. 014.22.071.





Annex of chapter 2, continuaton Fig. 7. Total national presence (expressed as permillage) of three other plant species after application of regional filling-up method (with various selection thresholds) for three periods. Two variants of this procedure were investigated: weighting (abbreviated: wt.) by area and by site suitability (abbreviated: wt. by suit.). See section 3.3 and Fig. 4 for further explanation





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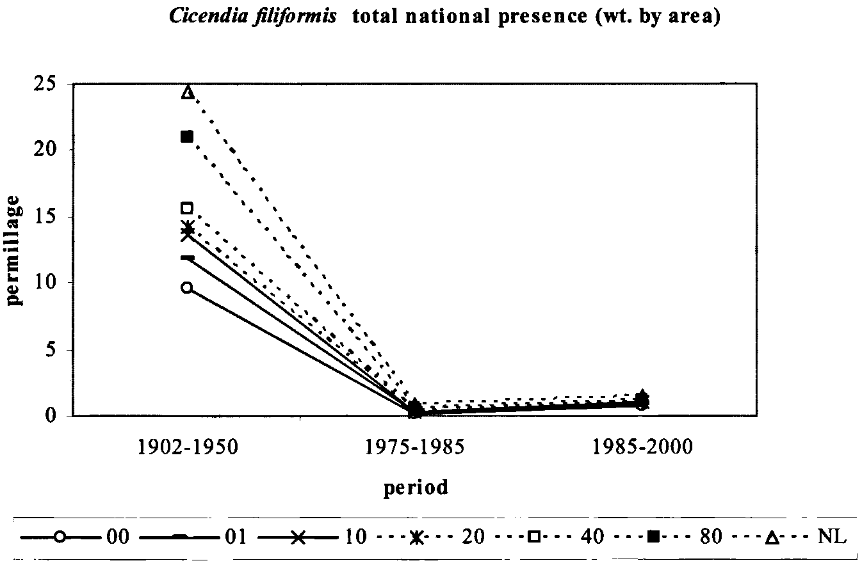

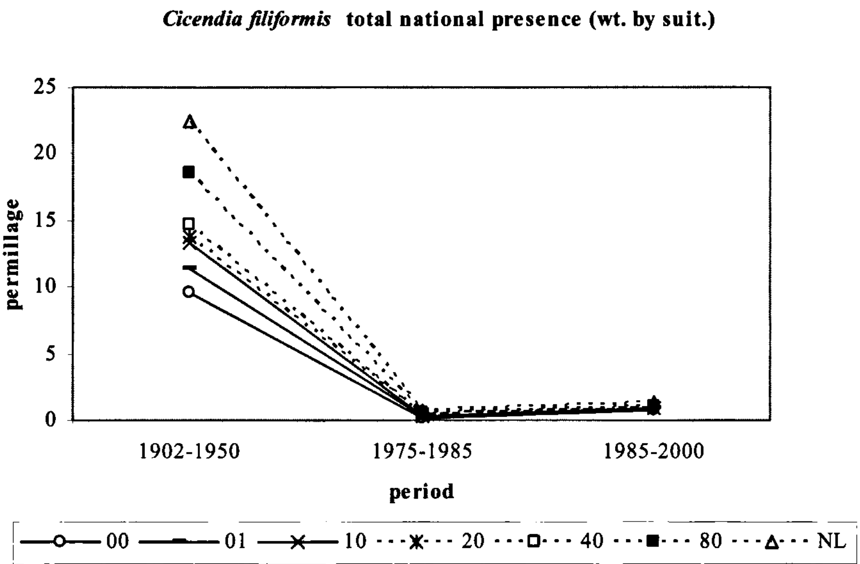

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3. Ecological interpretation of changes in the Dutch flora in the 20^{th} century

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Abstract

This article presents an ecological interpretation of the changes in the vascular flora of the Netherlands during the 20^{th} century, paying attention to survey bias and the impact of environmental and nature conservation policies from 1970 onwards. In the course of the 20^{th} century some 10 million records of 1,500 vascular plant species were sampled on a 1 kilometre grid scale. These data were divided into three periods: 1902–1950, 1975–1988 and 1988–2000, and for each period and species total national presence were calculated. To interpret the ecological significance species were aggregated into 83 'ecological groups' using a classification based on five ecological site factors. The changes of these ecological groups were statistically analysed by RDA. The principal change observed throughout the whole of the 20^{th} century is a marked decline in vegetation types of nutrient-poor sites, particularly those on neutral soils, and at the same time a large increase in those of (moderately) nutrient-rich sites. The second most important change was a decline in saline vegetation types especially between the first and second period. Other important changes were a decline in grassland vegetation types and an increase in tall herbaceous and woodland vegetation types. For certain pioneer vegetation types on nutrient-poor, neutral soils recovery was observed, probably as a consequence of nature restoration projects started in the 1980s. Despite measures to reduce environmental emissions, eutrophication remains a major threat to the flora of the Netherlands.

3.1. Introduction

The loss of biodiversity has become a major issue, notably since the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (e.g. Loh *et al.* 1999, Hilton-Taylor 2000, Groombridge and Jenkins 2000, McNeely 2001, Flavin *et al.* 2002). However important in itself, loss of biodiversity is but one side of the coin. The other is the conversion of key natural habitats to secondary ones or to agricultural or urban land use. However, there is much less information available about the actual sum of loss and gain, than about the loss of important habitats, extinctions and numbers of species threatened. In scientific literature, however, there is only limited information on actual, overall changes in biodiversity (e.g. Riecken *et al.* 1994, Moravec 1995, Loh *et al.* 1999, Preston *et al.* 2002, Robinson and Sutherland 2002). This information is often incomplete, moreover, being merely qualitative, or only averaging losses and gains, or focusing on one type of landscape. A more balanced picture of changes in biodiversity is needed, because areas with man-made and secondary habitats are expanding rapidly as a result of rising human numbers and growing economic welfare (Guruswany and McNeely 1998).

In the Netherlands there is a lot of documentation about the loss of plant species in the 20th century. The second part of the Atlas of the Dutch flora (Mennema *et al.* 1985) provides a list of publications concerning floristic changes up to 1985. Later publications include e.g. Weinreich and Musters 1989, Van der Meijden *et al.* 1991, Groen *et al.* 1997, Van der Meijden *et al.* 2000 and Weeda *et al.* 2000. All these studies drew more or less the same conclusions regarding changes in and threats to the Dutch flora. They reported an enormous loss of characteristic national landscapes and their characteristic plant species, especially coastal habitats, heaths, fens, bogs, marshes and extensively managed arable fields.However, these studies have several methodological shortcomings, which are quite common for spatial data (see e.g. Weeda 1985, Rich and Woodruff 1992, Groen *et al.* 1997, Telfer *et al.* 2002). In particular, no correction was made for several types of survey bias. Besides survey bias, most studies prior to 1985 presented data on a scale of about 5 km grid cells. Numerous studies described changes in the Dutch flora on a regional scale, and often only qualitatively. Other studies were more quantitative, but restricted to specific ecosystems: Claessen *et al.* (1996) and Witte (1998), for example, focused on freshwater, wet and moist ecosystems. In a recent study, we investigated possible climate-related effects on the Dutch flora (see chapter 4), corrections were made for some of the principal types of survey bias and some of the main historical changes in the composition of the vascular flora described. However, this picture is not complete, because coastal areas and certain other ecosystems were largely excluded. In most of the Dutch studies cited above there was no quantitative, ecological interpretation of the results, except for Plate (1990) and Witte (1998) who classified plant species into 'ecological groups'.

In this article we present a comprehensive review of the changes in the vascular flora of the Netherlands during the 20th century. This study seeks to address the issues of correction of survey bias and of quantitative ecological interpretation using the data sampled on a 1 kilometre grid scale. Moreover, we also included new plant distribution data compiled in the past two decades, enabling us to report on developments in the final part of the 20th century. This is especially relevant, because over the past few decades policy measures have been taken to reverse e.g. acidification and eutrophication and a large number of nature restoration projects have been initiated in the Netherlands. We will evaluate botanical change in terms of the impact of success of Dutch environmental and nature conservation policies. We adopted a classification of plant species into ecological groups (Runhaar *et al.* 1987, see Annex). By applying this approach we were able to quantitatively interpret the observed floristic changes in terms of changes in ecological site factors and relate these changes to possible causes.

The main question of this article is the following: From an ecological perspective, what are the most important changes to have occurred in the Dutch flora in the course of the 20th century? This question is broken down further, as follows:

- Which ecological groups of plant species show the greatest increase or decline in presence and with which ecological site factors are these increases and decreases associated?
- How sensitive is the quantitative analysis of these ecological shifts to differences in how the ecological groups are defined or treated?
- Which specific shifts in ecological site factors can best explain observed changes?

3.2. Materials and methods

3.2.1. Species and area selection

The vascular flora of the Netherlands comprises 1490 plant species and subspecies considered original or naturalised (Van der Meijden *et al.* 2000). For 102 of these taxa we judged the distribution data to be unreliable for tracing the changes addressed in this study, predominantly because they were planted by man. Besides these 'unreliable' taxa we also distinguished a second group of 126 'moderately reliable' taxa, most of which belong to so-called difficult species groups. In this latter case we aggregated many species, subspecies and varieties into combined taxa. After exclusion of 'unreliable' taxa and aggregation of the 'difficult' species, a total of 1289 taxa remained for further analysis. For ease of reference these taxa will be referred to simply as species. Our study is almost restricted to 'terrestrial' grid cells only, taken to encompass small bodies of freshwater. Before 1950 these grid cells covered an area of about 35,400 km^2, rising to about 36,800 km^2 following completion of several reclamation projects during the 20^{th} century.

3.2.2. Periodisation of data relative to environmental and conservation policies

The plant distribution data were divided into three periods. For the first period, from 1902 up to 1950, the data of the FLORIVON database were used (Kloosterman and Van der Meijden 1994, Witte *et al.* 2000). No further subdivision of this period was feasible, as the sampling dates of the FLORIVON data have not yet been digitised. For this period there are about 1.7 million records, on a grid scale of 1.042 km × 1.250 km ("quarter cells"). For the period 1950–1974 there was considerably less information available, mainly on a 5 km × 5 km grid scale and only partly digitised. We therefore excluded distribution data of the latter period. The second inventory period starts in 1975 and extends to 1988. For this period data from version 2G of the FLORBASE database were used (Van der Meijden *et al.* 1996, Witte and Van der Meijden 2000), in all about 2.7 million records on a 1 km × 1 km grid scale ("km cells"). For the third period, from 1988 to 2000, data from FLORBASE version 2G were also used and there were about 3.3 million records available. The main reason for taking 1987/1988 as the dividing line between the second and third periods is that it was not until then that nature restoration activities began to be implemented on any scale in the Netherlands.

3.2.3. Correction for differences in grids and incomplete geographical coverage

Prior to 1950, distribution data were recorded in quarter cells and after 1950 in km cells. There was also a difference in map projection of the grids: before 1950 a Bonne projection and after 1950 a stereographic projection (e.g. Snyder 1993). Simple comparison of species presence before and after 1950 on the basis of these different grids would lead to overestimation of presence prior to 1950, especially in the case of more sparsely distributed species. We therefore introduced a correction, using GIS to remap the pre-1950 distribution of each species onto a 1 km × 1 km grid scale (see for details chapter 2).

The principal survey bias is the incomplete geographical coverage in terms of both space and time of the distribution data. From a statistical perspective, however, provided the total number of sampling data is sufficiently large and the data are representative for the Netherlands as a whole, it is still possible to arrive at a reliable estimate of national trends. In each of the three periods analysed 30–50% of the Netherlands was deemed sufficiently surveyed, taken to mean that the grid cells in question have records of at least 80 taxa. This figure accords closely with the criteria of 50 and 100 taxa taken respectively by Witte (1998) and Groen *et al.* (1997). A regional filling up method was applied to obtain an unbiased estimate of the national presence of plant species in all three periods. For this calculation a classification of the Netherlands into twenty-five ecogeographical regions was used (based on Weeda 1996 and Klijn 1997). For each of these ecogeographical regions (E) the fraction of each plant species within the sample of well-surveyed grid cells (F_E) was multiplied by a regional weight, calculated as the ratio between region area and sample area (W_E). This yielded the estimated total presence of the species in each ecogeographical region. For each species these values were then summed. The sum was divided through the total terrestrial area of the Netherlands A_{Neth} and multiplied by 1,000 to get a total national presence expressed as a permillage Pr (a rate or proportion per thousand), as given by Formula 1:

$$\mathrm{Pr} = \frac{1{,}000}{A_{\mathrm{Neth}}} \times \sum_{E=1}^{E=25} F_E \times W_E \qquad \text{(Formula 1).}$$

3.2.4. Ecological species groups and ecological amplitude

The data on individual species presence were aggregated according to the 'ecological groups' to enable shifts in species composition to be ecologically interpreted and related to natural or human causes. These ecological groups of plant species have been developed by Dutch researchers as part of an ecosystem classification (Runhaar *et al.* 1987, Runhaar and Udo de Haes 1994, Runhaar 1999, Van Ek *et al.* 2000, see Annex of this chapter), based on literature and ecological field research. Each ecological group is characterised by at least five key ecological site factors: salinity, vegetation structure, moisture availability, nutrient availability and acidity. The original classification recognises 97 ecological groups. Some of these groups comprise only a very small number of species and for the present study these groups were therefore combined with other, allied groups, yielding a total of 83 ecological groups. These ecological groups and their codes are described in the

Annex to this chapter. Most species occur in more than one ecological group with a few recurring in many groups, up to a maximum of ten for species like Common Bent (*Agrostis stolonifera*). The 'ecological amplitude' of a plant species is the number of ecological groups in which the species occurs. The reciprocal of ecological amplitude we term the 'ecological weight' (*w*) of the species, which is used in our calculations. See Witte and Van der Meijden (2000) and discussion (first paragraph) for differences between ecological groups and plant communities.

3.2.5. Calculation and description of changes in ecological groups between successive periods

For each plant species we calculated the relative increase or decrease in total national presence between the periods 1902–1950 and 1975–1988 and between 1975–1988 and 1988–2000. Thus, two rates of decrease or increase were calculated. For each ecological group the geometric mean decrease or increase was calculated (Sokal and Rohlf 1969), taking into account the ecological weight of each species. We also calculated and present in diagrams the average increase or decrease for each ecological site factor separately. For this presentation we combined the changes between successive periods in one diagram and we used the overall change, an increase of 7%, for the whole 20^{th} century as baseline. The changes occurring between 1902–1950 and 1975–1988 span a larger range than those between 1975–1988 and 1988–2000. So, we also presented a standardized decadal change for the twenty most extreme increasing and decreasing ecological groups between the successive periods, assuming an exponential change in time.

3.2.6. Sensitivity analysis to different definitions of ecological groups.

RDA (for details next section) was used to assess the sensitivity of the analysis of ecological shifts to different options for defining the ecological groups. These options were: 1) further aggregation into larger species groups, 2) including moderately reliable species; 3) including species with a broad ecological amplitude (occurring in more than four ecological groups), and 4) different methods of weighing and statistical transformation. These different options were evaluated in terms of the percentage variation explained by the first two axes of the RDA, *lambda (λ)*. Also the results of a statistical forward selection of best explanatory ecological site factors for all options are reviewed.

3.2.6. Statistical analysis of importance of ecological shifts

The optimal option resulting from the sensitivity analysis is used for the definitive analysis of the ecological shifts with a redundancy analysis (RDA-Canoco 4.0; Jongman *et al.* 1987, Ter Braak and Smilauer 1998). In this multivariate analysis ecological groups were treated as 'samples', ecological site factors as 'environmental variables' and periods as 'species'. Vegetation structure was taken as the nominal explanatory variable and the other site factors as continuous linear variables: salinity: 0 (fresh) – 2 (salt); moisture availability: 0 (water aquatic) – 3 (dry); nutrient availability: 0 (nutrient-poor) – 2 (nutrient-rich); acidity: 0 (acid) – 2

Table 1. Changes in the presence of plant species groups (fully described in the Annex) in the Netherlands between 1902–1950 and 1975–1988. The changes are expressed as ratios of the presence of the former and latter period. The ecological site factors and their codes are given in the vertical and horizontal table headers. The complete code for each ecological group can simply be derived by combining the partial column and row code parts, e.g. .P2. and ...7 becomes P27. * = some small ecological groups combined with allied groups. Results for ecological subgroups not included in the table are appended below it.

		salinity→	fresh	fresh	fresh	fresh	fresh	fresh	fresh	brack.	saline
		nutrient avail→	poor	poor	poor	poor	mod.	mod.	rich	indif.	indif.
vegetation		acidity→	acid	neutr.	alkal.	indif	alkal.	indif.	indif.	indif.	indif.
↓structure	↓moisture avail		...1	...2	...3	...4	...6	...7	...8	b..0	z..0
aquatic	water	.W1.	0.80	0.76	*			1.25	2.13	1.60	0.29
seas. dry	water	.W1.dv		0.54	0.78			1.09			
amphibian	water	.V1.	*	0.35				1.05	1.16	1.70	
pioneer	wet	.P2.	0.32	0.19	0.68			1.16	1.47	1.02	0.25
low herb.	wet	.G2.	0.70	0.30	0.53			0.90	1.29	0.49	0.68
tall herb.	wet	.R2.				1.37		1.25	1.27	0.87	*
woodland	wet	.H2.	1.33	0.59	*			1.71	1.90		
pioneer	moist	.P4.	*	0.17	0.77		0.24	0.84	1.77	1.47	*
low herb.	moist	.G4.	0.53	0.32	0.63		0.97	1.26	1.06	0.62	*
tall herb.	moist	.R4.				1.84	0.95	1.43	3.15	1.06	
woodland	moist	.H4.	0.74	0.95	1.01		1.29	2.05	2.37		
pioneer	dry	.P6.	*	0.35	0.80			0.96	1.62	0.91	
low herb.	dry	.G6.	0.66	0.52	0.76			0.99	1.29		
tall herb.	dry	.R6.				1.37		0.84	0.53	0.84	
woodland	dry	.H6.	0.83	0.56	1.16			1.44$^+$			

Results for subgroups: P63ro: 0.64, P40mu: 1.32, P60mu: 1.50, V18sa: 2.31, P48tr: 2.46, bP60st: 0.80; $^+$ = H69.

(alkaline); indifferent classes were given the intermediate value 1. Scores were standardised, to ensure that average differences between periods (probably due to remaining survey bias errors) had no effect on the analysis. In our analysis set-up the first two ordinate axes represent the variation explained linearly by the ecological site factors and the third and fourth axes the remaining, unexplained variation. The significance of the first axis and of the first and second axes together was tested using a permutation test (200 runs). A stepwise forward variable selection procedure was carried out and *lambda* (λ), the contribution to the explanation, and the significance (permutation test, 200 runs) of each selected variable were determined.

3.3. Results

3.3.1. Greatest declines and increases of ecological groups

The average decline or increase of all ecological species groups represented in the Netherlands between the periods 1902–1950 and 1975–1988 and between 1975–1988 and 1988–2000 are presented in Tables 1 and 2. For the ten ecological groups suffering greatest decline between 1902–1950 and 1975–1988 the decadal rate of change ranges from -20% to -30%. (Table 3) Six of these are ecological groups of nutrient-poor, neutral sites (Table 1, 2nd data col.), while two belong to saline ecological groups (Table 1, 9th data col.). Six out of ten can also be characterised as pioneer vegetation types (Table 1, 4th, 8th and 12th data row) and as aquatic vegetation types or vegetation types of wet soils (Table 1, 1st to 7th data row).

For the ten ecological groups that have been in greatest decline in recent decades the decadal rate of change ranges from -20% to -50% (Table 3). Four out of ten are ecological groups of nutrient-poor, neutral soils (Table 2, 2nd data col.); two are groups of nutrient-poor, acid sites (Table 2, 1st data col.) and two are groups of brackish or saline sites (Table 2, 8th and 9th data col.). Seven can be characterised as aquatic vegetation types or vegetation types of wet soils (Table 2, 1st to 7th data row).

Table 2. Changes in the presence of plant species groups in the Netherlands between 1975–1988 and 1988–2000. For explanation see Table 1.

		salinity→	fresh	fresh	fresh	fresh	fresh	fresh	fresh	brack	saline
		nutrient avail→	poor	poor	poor	poor	mod.	mod.	rich	indif.	indif.
vegetation		acidity→	acid	neutr.	alkal.	indif	alkal.	indif.	indif.	indif.	indif.
↓structure	↓moisture avail		...1	...2	...3	...4	...6	...7	...8	b..0	z..0
aquatic	water	.W1.	0.68	0.45	*			0.90	1.38	0.75	0.49
seas. dry	water	.W1.dv		0.88	0.95			1.10			
amphibian	water	.V1.	*	0.63				0.83	0.92	0.83	
pioneer	wet	.P2.	0.83	1.41	1.35			1.11	2.09	1.18	1.00
low herb.	wet	.G2.	0.62	0.76	0.91			0.73	0.99	1.14	0.89
tall herb.	wet	.R2.				0.87		0.83	1.41	0.81	*
woodland	wet	.H2.	1.89	0.78	*			0.81	1.32		
pioneer	moist	.P4.	*	1.26	0.92		0.96	1.24	1.69	1.21	*
low herb.	moist	.G4.	0.85	0.67	0.85		0.97	1.18	1.24	0.90	*
tall herb.	moist	.R4.				0.91	1.93	1.29	1.81	0.98	
woodland	moist	.H4.	1.41	0.99	0.77		1.40	1.03	1.70		
pioneer	dry	.P6.	*	1.47	1.45			1.68	1.73	1.51	
low herb.	dry	.G6.	0.90	1.37	1.11			1.22	1.03		
tall herb.	dry	.R6.				0.89		1.47	1.25	0.96	
woodland	dry	.H6.	0.96	0.96	1.13			1.30^{+}			

Results for subgroups: P63ro: 2.38, P40mu: 1.63, P60mu: 1.40, V18sa: 2.02, P48tr: 1.43, bP60st: 1.09; $^{+}$= H69.

Table 3. The twenty ecological groups showing the greatest decadal **decrease (in bold)** or *increase* (in italic) between the successive periods. Ecological groups were ordered to their greatest decline or increase; first for the changes between 1902–1950 and 1975–1988 and then for the changes between 1975–1988 and 1988–2000.

Ecological group			successive periods	
		from	1902–1950	1975–1988
		to	1975–1988	1988–2000
code	description		% rate of change in 10 y	
DECREASE				
P42	pioneer vegetation of moist, nutrient-poor, neutral soils		**-30**	+20
P22	pioneer vegetation of wet, nutrient-poor, neutral soils		**-30**	+30
P46	pioneer vegetation of moist, moderate nutrient-rich, alkaline soils		**-25**	-5
zP20	pioneer vegetation of wet, saline soils		**-25**	0
zW10	aquatic vegetation of saline waters		**-20**	**-45**
G22	low herb vegetation of wet, nutrient-poor, neutral soils		**-20**	-20
G42	low herb vegetation of moist, nutrient-poor, neutral soils		**-20**	**-30**
P62	pioneer vegetation of dry, nutrient-poor, neutral soils		**-20**	+35
P21	pioneer vegetation of wet, nutrient-poor, acid soils		**-20**	-10
V12	amphibian vegetation of nutrient-poor, neutral soils		**-20**	**-30**
W12	aquatic vegetation of nutrient-poor, neutral waters		-5	**-50**
G21	low herb vegetation of wet, nutrient-poor, acid soils		-10	**-35**
W11	aquatic vegetation of nutrient-poor, acid waters		-5	**-25**
H22	woodland vegetation of moist, nutrient-poor, neutral soils		-10	**-25**
G47	low herb vegetation of moist, moderately nutrient-rich soils		+5	**-20**
bW10	aquatic vegetation of brackish waters		+10	**-20**
H43	woodland vegetation of moist, nutrient-poor, alkaline soils		0	**-20**
INCREASE				
R48	tall herb vegetation of moist, nutrient-rich soils		*+25*	*+60*
H48	woodland vegetation of moist, nutrient-rich soils		*+20*	*+50*
P48tr	pioneer vegetation of moist, nutrient-rich, heavily trodden soils		*+20*	*+35*
V18sa	amphibian vegetation of extremely nutrient-rich waters		*+20*	*+75*
W18	aquatic vegetation of nutrient-rich waters		*+15*	+30
H47	woodland vegetation of moist, moderately nutrient-rich soils		*+15*	+5
H28	woodland vegetation of wet, nutrient-rich soils		*+10*	+25
P48	pioneer vegetation of moist, nutrient-rich soils		*+10*	*+50*
P68	pioneer vegetation of dry, nutrient-rich soils		*+10*	*+55*
R44	tall herb vegetation of moist, nutrient-poor soils		*+10*	-10
P28	pioneer vegetation of wet, nutrient-rich soils		+10	*+80*
P67	pioneer vegetation of dry, moderately nutrient-rich soils		0	*+50*
P40mu	pioneer vegetation of moist, stony sites		+5	*+50*
bP60	pioneer vegetation of dry, brackish soils		0	*+40*
P62	pioneer vegetation of dry, nutrient-poor, neutral soils		-20	*+35*

(zW10, G42 and V12), there has been little change in the overall picture of ecological groups of wet, nutrient-poor soils and saline waters showing the most pronounced decline. One notable difference is that from 1975–1988 to 1988–2000 there is no longer a downward trend to be observed in the presence of pioneer vegetation types.

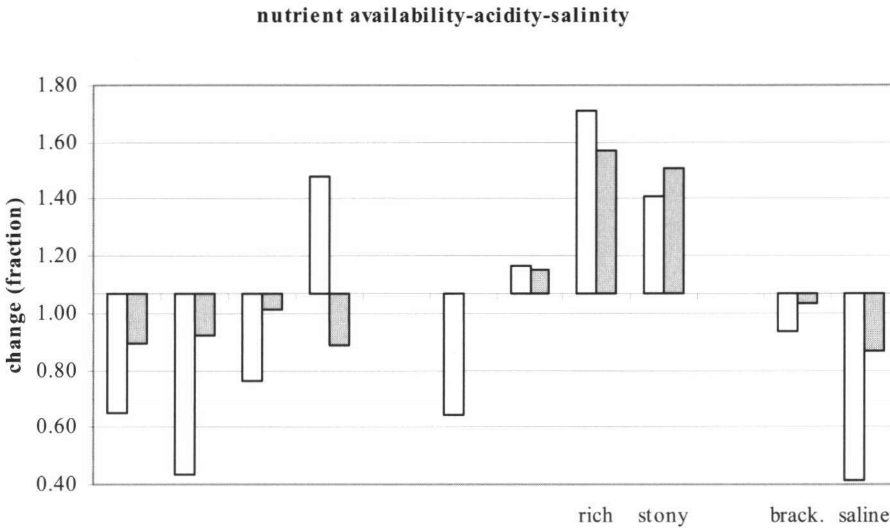
For the ten ecological groups showing the greatest increase in national presence from 1902–1950 to 1975–1988 the decadal rate of change ranges from +10% to +25% (Table 3). Eight of these are vegetation types of nutrient-rich sites (Table 1, 7th data col.) and six are vegetation types of moist soils (Table 1, 8–11th data row).

For the ten ecological groups increasing most from 1975–1988 to 1988–2000 the decadal rate of change varies from +35% to +80% (Table 3). Seven out of ten are again vegetation types of nutrient-rich sites (Table 2, 7th data col.) and seven vegetation types of moist to dry soils (Table 2, 8–15th data row). The ten ecological groups increasing most between the first and second period and the second and third period are fairly similar, having six groups in common.

3.3.2. Declines and increases per ecological factor

In Fig. 1 the non-standardised decreases and increases have been averaged for each ecological site factor, providing a more comprehensive picture than the 'extremes' considered above. Between the periods 1902–1950 and 1975–1988 the national presence of plant species of nutrient-poor and moderately nutrient-rich sites declined markedly, except for those indifferent to acidity, while plant species from nutrient-rich sites showed a strong increase (Fig. 1, top). Within the plant species of nutrient-poor sites, those of weakly acid or neutral soils showed a stronger decrease than those of acid or alkaline sites. Within the plant species of moderately nutrient-rich sites, those on alkaline sites showed a strong decrease, in contrast to those indifferent to acidity. Plant species characteristic of stony sites showed a moderate increase. Plant species of brackish sites suffered some decline, while those of saline sites underwent a marked decline (Fig. 1, top). In terms of moisture availability, species of both wet and dry sites exhibited a moderate decrease (Fig. 1, bottom). Species of low herbaceous vegetation types (i.e. 'grassland') and pioneer species showed a moderate to strong decrease, while species of tall herbaceous vegetation types and woodlands showed a strong increase (Fig. 1, next page).

From 1975–1988 to 1988–2000 almost the same pattern of decrease and increase emerges for the ecological site factors nutrient availability, acidity, 'stoniness' and salinity (Fig. 1, top), although the values are lower because of the shorter time span. One difference is that now plant species of nutrient-poor sites indifferent to acidity show a relatively large decrease, while those of moderately nutrient-rich, alkaline sites are no longer in decline (Fig. 1, top). With respect to moisture availability, plant species of aquatic vegetation types now show a decrease, while species of dry sites show a marked increase (Fig. 1, bottom). Plant species of pioneer vegetation types and tall herbaceous vegetation types show a large increase, while species of aquatic vegetation types and low herbaceous vegetation types are in decline (Fig. 1, next page).



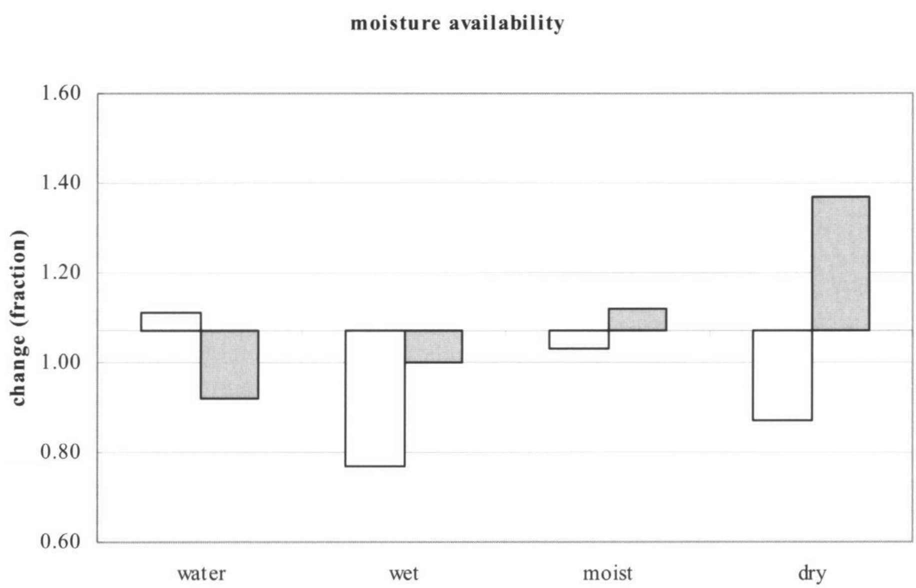


Fig. 1. Geometric mean of changes (expressed as ratio national presences of two periods) of vascular plant species in the Netherlands between 1902–1950 and 1975–1988 (white bar) and between 1975–1988 and 1988–2000 (grey bar), classified according to main ecological site factors. Upper: nutrient availability, acidity and salinity (alkal. = alkaline, indif. = indifferent, brack.. = brackish); bottom: moisture availability; next page: vegetation structure.

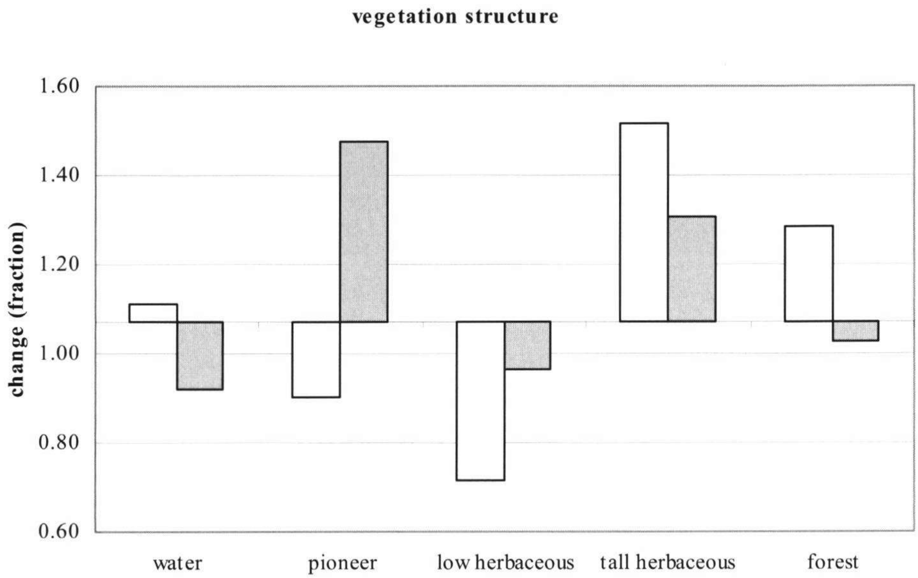


Fig. 1. Continued.

Table 4. Comparison by RDA of different definitions and treatments of ecological groups used for evaluating changes in the Dutch flora during the 20th century; Options comprise: I) ecological group "aggregated" versus "original"; II) data reliability "d"; 1 = only reliable species, 2 = also moderately reliable species; III) ecological amplitude w, w > 0 all species included, w ≥ 1/3 or 1/5 only species with a small ecological amplitude included; IV) statistical transformation and calculation "transf", logarithmic (log) or logistic (logit) transformation of national presence (Pr) and w applied before or after transformation. sum = no. of weighted species present in option. RDA: λ = lambda, % of variance explained by first, second and third ordinate axe or by explanatory variable. Results of forward variable selection and percentage of explained variance of each significant ($p<0.05$) variable after subsequently adding the variable to the analysis; N = nutrient availability, sal = salinity, mst = moisture availability, vegetation structure of P = pioneer vegetation, K = all herbaceous vegetation (aggregated groups), G = low herbaceous vegetation, W = woodlands; x = not relevant, - = not significant.

d	transf	*w*	sum	RDA			Forward variable selection					
				λ1	*λ2*	*λ3*	*λN*	*λsal*	*λmst*	*λP/K*	*λG*	*λW*
ecological groups aggregated (n = 47)												
1	log(∑*w***Pr*)	≥ 1/3	899.7	31	3	62	16	10	-	-	x	-
1	∑*w**log(*Pr*)	> 0	1158	34	3	56	20	12	-	-	x	-
ecological groups original (n = 83)												
2	∑*w**log(*Pr*)	> 0	1283	45	5	44	25	9	3	3	3	6
2	∑*w**log(*Pr*)	≥ 1/5	1226	44	5	45	24	9	3	4	3	5
1	∑*w**log(*Pr*)	> 0	1158	49	5	40	32	8	4	4	4	-
1	∑*w**logit(*Pr*)	> 0	1158	54	5	36	36	7	5	5	4	-

3.3.3. Different definitions of ecological groups: sensitivity analysis

Before the changes in the presence of each ecological group between the successive periods were analysed statistically, a series of different options for defining and treating ecological groups were run as a form of sensitivity analysis, using a multivariate method (RDA) (Table 4). The first option we considered was whether to use the 'ecological groups' as originally defined or aggregate these groups further, as done by Witte (1998). The principal form of aggregation examined was a combination of all herbaceous vegetation types into a single group within each moisture class. As can be seen from Table 4, the original ecological group classification could explain far more (5th data row: 49+5 %) than the aggregated groups (2nd data row: 34+3 %).

A second option was whether or not to include plant distribution data classed as moderately reliable. Excluding these species yielded a better explanation of the data (3rd and 5th data row, Table 4). A third point to consider was whether species with a broad ecological amplitude could be excluded (respectively >0 and >1/5 in 3rd column, Table 4), as done by Witte (1998). Because of their broad ecological amplitude these species may be less indicative. However, inclusion of such species in fact led to a slightly better explanation of the data (3rd and 4th data row, Table 4). The final option concerned the procedures to be adopted for statistically transforming the data and accounting for ecological amplitude. Logistic transformation proved to be better than logarithmic transformation (6th and 5th data row respectively, Table 4) and the ecological amplitude (*w* in Table 4) should be accounted for *after* transformation (1st and 2nd data row, Table 4). Irrespective of the option used, nutrient availability and salinity proved to be the most important explanatory variables (Table 4).

3.3.4. Explanation of changes

The results of the definitive multivariate RDA are shown in Table 4 (last row) and Fig. 2. The first axis in this figure explains 54% of the data ($p<0.005$, permutation test) and the second axis only 5%. The overall diagram explains 59% of all variation ($p<0.005$, permutation test). The first axis can be interpreted as a long-term decrease-increase axis. Ecological groups on the right of the diagram, e.g. R68, R48 and H28, are those exhibiting a strong upward trend in presence during the 20th century; conversely, ecological groups on the left, e.g. G21, G22 and G42, are those that underwent marked decline in the course of the century. The second axis can be interpreted either as recent recovery (upper left of diagram) or recent increase (upper right). The two ecological groups of stony sites (P40mu and P60mu) are examples of groups showing a strong increase in recent decades. The pioneer vegetation types of nutrient-poor, neutral sites (..P.2) are examples of groups exhibiting a recovery following a decline. The main ecological site factors were also employed in the analysis to explain the changes shown in the diagram (Fig. 2). Nutrient availability (*NUTR*) is characterised as a large arrow pointing to the right, indicating that large increases are correlated with nutrient-rich sites and major declines with nutrient-poor sites. Salinity (*SAL*) has an arrow to the left, indicating a decline of saline ecological groups. Also noteworthy are the positions on the right (increase side) of

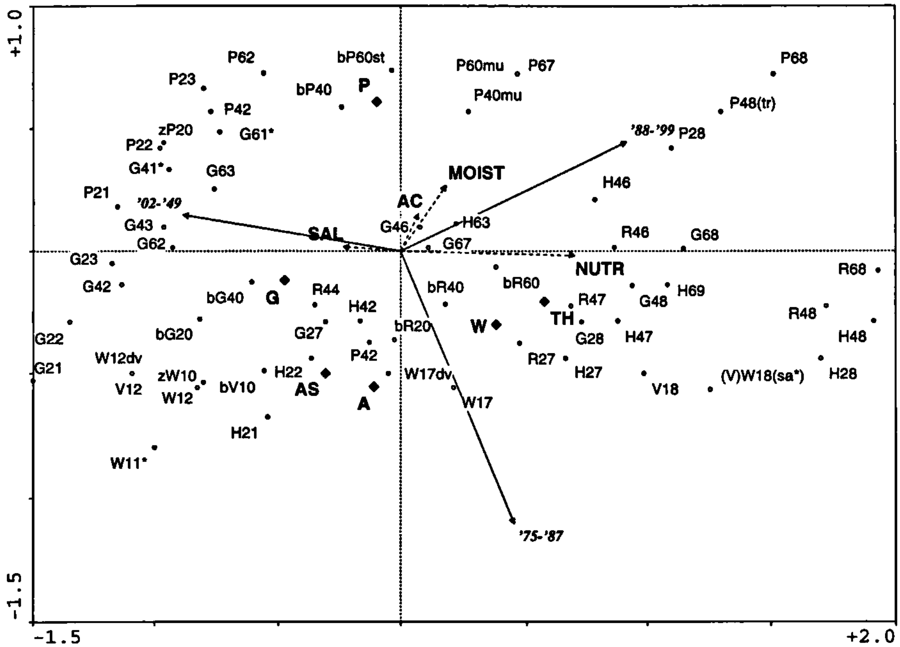


Fig. 2. RDA-triplot of changes in the presence of the Dutch vascular plant flora, aggregated into ecological groups, during the 20th century. See also Table 4 for general description of RDA and Table 1 and Annex for explanation of codes. Explanatory variables are represented by either arrows (quantitative variables) or diamonds (nominal variables); *NUTR* = nutrient availability, *MOIST* = moisture availability, *AC* = acidity, *SAL* = salinity, *A* = aquatic vegetation structure, *AS* = amphibian vegetation structure, *P* = pioneer vegetation structure, *G* = low herbaceous vegetation structure, *TH* = tall herbaceous vegetation structure, *W* = woodland vegetation structure. Overlapping ecological groups are indicated by means of brackets, e.g. P48 and P48tr becomes P48(tr). The figure shows only the 63 ecological groups with a fit of at least 50% along the first two axes.

the diagram centroid for woodland vegetation types (*W*) and tall herbaceous (*TH*) vegetation types and the same for low herbaceous (*G*) vegetation types on the left (decrease side). Also remarkable are the high position (recent recovery or increase) occupied by pioneer (*P*) vegetation types and the low position (recent decrease) for aquatic and partially inundated vegetation types (*A* and *AS*). The arrow for moisture availability and acidity points to the upper right corner, indicating a relative increase in the national presence of dry and more alkaline ecological groups. The relative contribution of nutrient availability to statistical explanation was about 66%, while for salinity this was 12% (bottom row Table 4). Moisture availability, pioneer and low herbaceous vegetation structure were also significant (Table 4). The third axis (not shown here) accounts for about 90% of the remaining, unexplained variation. This element of the diagram can be interpreted as an additional decrease-increase axis: ecological groups of nutrient-poor, neutral sites underwent relatively greater decline than those of other nutrient-poor sites; brackish ecological groups showed a slight increase, in contrast to saline groups, while moist ecological groups exhibited a relatively stronger increase than dry and wet groups. The additional explanatory power of moisture and salinity could not be simply explained by linear multivariate analysis.

3.4. Discussion

3.4.1. Ecological groups versus plant communities

In this study we have assessed trends in the Dutch flora throughout the entire 20[th] century, using the concept of 'ecological groups'. Witte and Van der Meijden (2000) have already demonstrated that classification into ecological groups is more accurate than in terms of plant communities (Weeda *et al.* 2000, Rodwell *et al.* 2002) for species distribution data on a fine grid scale of 1 × 1 km. On a European scale, classification in terms of plant communities was in turn deemed an improvement (Rodwell *et al.* 2002) on both the CORINE biotope classification (Anon 1997) and the EUNIS habitat classification (Davies and Moss 1999). At the very least, these two European classification systems do not allow for even simple quantitative ecological interpretation. Extension of the ecological group concept to the European scale would thus represent an improvement over existing European classifications.

3.4.2. Indicator values of ecological groups versus Ellenberg

In our earlier study of the possible effects of climate change on the Dutch flora (see chapter 4) we employed Ellenberg indicator values (e.g. Ellenberg *et al.* 1992, Hill *et al.* 1999). One major drawback of these indicator values, however, was that values amenable to statistical analysis are available for only 45% of the plant species studied, while a classification in terms of ecological groups is available for all species. Two other advantages of using ecological groups are the possibility of aggregating information from species into a more robust set of ecological groups and the scope for accounting for ecological amplitudes.

3.4.3. Monitoring changes in biodiversity

In the international literature there is only a limited amount of information available on the precise nature of ongoing changes in biodiversity. On a global scale there is a Living Planet Index, which presents trends in the average state of biodiversity for some of the world's major biomes between 1970 and 2000 (Groombridge and Jenkins 1998, Loh *et al.* 1999). However, this Index yields no insight into which elements of the index are increasing or in decline. On a European scale several EU reports have been published on biodiversity status and trends (Delbaere 1998, EEA 1999). This information is based primarily on national Red Lists and assessments of habitat loss and the changes reported are characterised in only very general terms. Another important source of information about changes in biodiversity are the studies concerning the negative effects of agricultural intensification (see e.g. Baldock 1990, Andreasen *et al.* 1996, Robinson and Sutherland 2002). The focus there is solely on agricultural landscapes, however. There are several Red Lists (Riecken *et al.* 1994, Moravec 1995) providing a comprehensive review of the status of threatened and non-threatened habitats and communities. However, these studies lack any quantitative characterisation of the changes observed. Only in Great Britain has there been quantitative, ecological analyses of recent changes in the entire wild British flora (Preston *et al.* 2002a, b, Smart *et al.* 2003).

3.4.4. Comparative analysis of changes in Europe

By far the most important change for the Netherlands in the 20th century is the increased presence of plant species preferring nutrient-rich conditions. Eutrophication may stem from several causes, ranging from agricultural intensification, industrial activity to changes in water management. Today it is generally recognised that eutrophication is one of the major causes of changes in biodiversity in developed temperate countries (Riecken *et al.* 1994, Moravec 1995, Preston *et al.* 2002). The decline of many weed species (Andreasen *et al.* 1996, Robinson and Sutherland 2002) can also be partly explained by eutrophication, because the more valuable weed species often prefer moderately nutrient-rich conditions.

The second most important change to have occurred in the Netherlands is the loss of vegetation types of saline sites This is clearly an effect of several large coastal dams (e.g. Afsluitdijk), dikes and reclamation projects (e.g. Wieringermeer) being implemented in the 20th century. In Europe it is especially shallow, sandy coastlines and dunes that are threatened (Delbaere 1998, EEA 1999), in particular by urban development.

The effects of acidification in the Netherlands have been widely reported, particularly the presumed impact on weakly buffered ecosystems (e.g. Heil and Diemont 1983, Bobbink *et al.* 1998). In our analysis, however, these effects proved to play only a minor role, probably because they are usually confounded with e.g. the effects of eutrophication. In several European countries, studies based on national species distribution data also revealed no effects of acidification (Riecken *et al.* 1994, Moravec 1995, Preston *et al.* 2002). On the contrary, we found that in recent decades there has been an increase in the presence of plant species of more alkaline sites. These changes may be one of the consequences of recent climate change in the Netherlands (see chapter 4), because plants of alkaline sites are known to be more thermophilous.

The effects of changes in water management (e.g. increased drainage and a lowering of water tables), have been recognised as another major environmental problem affecting the Netherlands (Claessen *et al.* 1996, Witte 1998, Van Ek *et al.* 2000). In this study the decline of aquatic and wet vegetation types and the increased presence of dry vegetation types is apparent. On a global scale the Living Planet Index for inland waters decreased by about 50% (Groombridge and Jenkins 1998). In Great Britain no effects were found associated with increased drainage (Preston *et al.* 2002). While a decline of wet habitats has been reported in other European countries, this has been related mainly to conversion of land to agricultural exploitation (Delbaere 1998, EEA 1999). The observed effects of decreased moisture availability thus seem to be typical for the Netherlands.

Two other major features of the ecological changes in the Dutch flora in the 20th century are a decrease of low herbaceous vegetation types ('grassland') and an increase of tall herbaceous vegetation types and herbaceous vegetation types of woodlands. Between 1970 and 1995 the Living Planet Index for northern temperate grasslands declined by about 50% (Loh *et al.* 1999). The increased presence of taller herbaceous vegetation types is also reported from Great Britain (Preston *et al.* 2002, Smart *et al.* 2003).

The Living Planet Index for northern temperate forests showed a small increase of about 20% (Loh *et al.* 1999). For European countries in general a stabilisation of the amount of area forested is reported (Delbaere 1998, EEA 1999), but at the same time also a decline of forest quality due to the planting of monocultures of exotic tree species. In the Netherlands a forestry monitoring programme (Dirkse and Martakis 1998) reported increased herb layer diversity in recent decades. In contrast to the situation in other European countries, then, in the Netherlands there has there been an increase not only in forest area but also in forest quality.

3.4.5. Effectiveness of Dutch environmental and nature conservation policies

What conclusions can be drawn about the effectiveness of the environmental policies implemented in the Netherlands and of nature restoration projects since about 1970? The most relevant environmental measures post-1970 have been those to reduce emissions causing acidification and eutrophication of soils and waters (e.g. VROM 1993). As the results make clear, eutrophication is still an ongoing problem. Between 1902–1950 and 1975–1988 there was a pronounced decline in the presence of alkaline ecological groups and while this trend was no longer observed between 1975–1988 and 1988–2000 for the moderately nutrient-rich ecological groups this was not the case for the nutrient-poor groups. This difference is probably the result of effective protection from further agricultural impacts and restoration of alkaline sites. It is clear that reduction of nutrient emissions continues to be an environmental issue of major concern.

The major changes in the distribution of Dutch vascular plants in the first half of the 20th century was one of the main factors triggering development of nature conservation policy (e.g. LNV 1990). From about 1987 onwards a large number of restoration projects were initiated (Aerts *et al.* 1995, Roelofs *et al.* 1996, Bootsma *et al.* 1999, *Hydrobiologia* 2002 Vol. 478, Wolters *et al.* 2005), directed mainly towards weakly buffered or neutral ecosystems like fens and dune lakes.. From the results it is apparent that the pioneer vegetation types of wet, moist and dry, neutral, nutrient-poor sites, in particular, showed a remarkable change from a strong decline to a strong increase. However, this is not yet the case for other threatened types of vegetation. One explanation for this phenomenon is that a key element of most restoration projects is removal of nutrient-rich top-soils, resulting in bare soils favoured by pioneer plant species.

3.4.6. Changes of biodiversity at different scales

On balance, what is the significance of all these changes in the vascular flora for biodiversity in the Netherlands? That balance depends on the scale considered (e.g. Sax and Gaines 2003). On a national and regional scale the decline of highly valued plant species of nutrient-poor or saline sites is outweighed by the increase of the less valued common species of nutrient-rich sites. On lower spatial scales of vegetation and land use units, diversity decreases because of a quantitative and qualitative decline of valuable ecosystems. However, the recovery of valuable pioneer vegetation types, probably as a result of nature restoration projects, and the increase of woodland herb diversity, are encouraging signs that national environmental and nature conservation policies may be yielding results, which are quantitatively measurable using available national plant distribution records.

3.5. Acknowledgements

This work was carried out in the framework of the Stimulation Pogramme Biodiversity of the Netherlands Organisation for Scientific Research (NWO) grant no. 014.22.071. Prof. Dr. P. Baas (NHN) is greatly acknowledged for his comments. We are also grateful to Nigel Harle for his critical reading and editing of the English.

Annex of chapter 3. Description of ecological groups

The table below provides a full description of the ecological groups of vascular plant species in alphabetical order of their code. The number of species in each group is shown in brackets. Because some species occur in several groups the sum total of these numbers exceeds the actual total number of species covered by the analysis. See for species composition of the groups: http://www.synbiosys.alterra.nl/ecotopen or Annex of this study.

code	description (number of species)
bG20	low herbaceous vegetation of wet, brackish soils (28)
bG40	low herbaceous vegetation on moist, brackish soils (33)
bP20	pioneer vegetation of wet, brackish soils (14)
bP40	pioneer vegetation of moist, brackish soils (30)
bP60	pioneer vegetation of dry, brackish soils (6)
bP60st	pioneer vegetation of dry, brackish soils, regularly covered by wind-blown sand (18)
bR20	tall herbaceous vegetation of wet, brackish soils (10)
bR40	tall herbaceous vegetation of moist, brackish soils (10)
bR60	tall herbaceous vegetation of dry, brackish soils (5)
bV10	amphibian vegetation of brackish waters (7)
bW10	aquatic vegetation of brackish waters (10)
G21	low herbaceous vegetation of wet, nutrient-poor, acid soils (20)
G22	low herbaceous vegetation of wet, nutrient-poor, neutral soils (69)
G23	low herbaceous vegetation of wet, nutrient-poor, alkaline soils (33)
G27	low herbaceous vegetation of wet, moderately nutrient-rich soils (79)
G28	low herbaceous vegetation of wet, nutrient-rich soils (33)
G41	pioneer and low herbaceous vegetation of moist, nutrient-poor, acid soils (28)
G42	low herbaceous vegetation of moist, nutrient-poor, neutral soils (59)
G43	low herbaceous vegetation of moist, nutrient-poor, alkaline soils (73)
G46	low herbaceous vegetation of moist, moderately nutrient-rich, alkaline soils (66)
G47	low herbaceous vegetation of moist, moderately nutrient-rich soils (111)
G48	low herbaceous vegetation of moist, nutrient-rich soils (48)
G61	pioneer and low herbaceous vegetation of dry, acid soils (21)
G62	low herbacous vegetation of dry, neutral soils (58)
G63	low herbaceous vegetation of dry, alkaline soils (79)
G67	low herbaceous vegetation of dry, moderately nutrient-rich soils (78)
G68	low herbaceous vegetation of dry, nutrient-rich soils (8)
H21	woodland vegetation of wet, nutrient-poor, acid soils (8)
H22	woodland vegetation of wet, nutrient-poor, neutral or alkaline soils (15)
H27	woodland vegetation of wet, moderately nutrient-rich soils (48)
H28	woodland vegetation of wet, nutrient-rich soils (28)
H41	woodland vegetation of moist, acid soils (18)
H42	woodland vegetation of moist, neutral soils (63)
H43	woodland vegetation of moist, alkaline soils (69)
H46	woodland vegetation of moist, moderately nutrient-rich, alkaline soils (32)
H47	woodland vegetation of moist, moderately nutrient-rich soils (120)
H48	woodland vegetation of moist, nutrient-rich soils (33)
H61	woodland vegetation of dry, acid soils (24)
H62	woodland vegetation of dry, neutral soils (35)
H63	woodland vegetation of dry, alkaline soils (40)
H69	woodland vegetation of dry, moderately nutrient-rich and nutrient-rich soils (32)

P21	pioneer vegetation of wet, nutrient-poor, acid soils (6)
P22	pioneer vegetation of wet, nutrient-poor, neutral soils (19)
P23	pioneer vegetation of wet, nutrient-poor, alkaline soils (12)
P27	pioneer vegetation of wet, moderately nutrient-rich soils (25)
P28	pioneer vegetation of wet, nutrient-rich soils (44)
P40mu	pioneer vegetation of moist, stony sites (20)
P42	pioneer vegetation of moist, nutrient-poor, neutral soils (8)
P43	pioneer vegetation of moist, nutrient-poor, alkaline soils (10)
P46	pioneer vegetation of moist, moderately nutrient-rich, alkaline soils (39)
P47	pioneer vegetation of moist, moderately nutrient-rich soils (83)
P48	pioneer vegetation of moist, nutrient-rich soils (105)
P48tr	pioneer vegetation of moist, nutrient-rich, heavily trodden soils (13)
P60mu	pioneer vegetation of dry, stony sites (28)
P62	pioneer vegetation of dry, nutrient-poor, neutral soils (23)
P63	pioneer vegetation of dry, nutrient-poor, alkaline soils (26)
P63ro	pioneer vegetation of dry, nutrient-poor, alkaline soils, regularly mixed by wind/animals (17)
P67	pioneer vegetation of dry, moderately nutrient-rich soils (123)
P68	pioneer vegetation of dry, nutrient-rich soils (49)
R24	tall herbaceous vegetation of wet, nutrient-poor soils (7)
R27	tall herbaceous vegetation of wet, moderately nutrient-rich soils (42)
R28	tall herbaceous vegetation of wet, nutrient-rich soils (40)
R44	tall herbaceous vegetation of moist, nutrient-poor soils (7)
R46	tall herbaceous vegetation of moist, moderately nutrient-rich, alkaline soils (7)
R47	tall herbaceous vegetation of moist, moderately nutrient- rich soils (38)
R48	tall herbaceous vegetation of moist, nutrient-rich soils (51)
R64	tall herbaceous vegetation of dry, nutrient-poor soils (8)
R67	tall herbaceous vegetation of dry, moderately nutrient-rich soils (17)
R68	tall herbaceous vegetation of dry, nutrient-rich soils (5)
V12	amphibian vegetation of nutrient-poor, neutral waters (14)
V17	amphibian vegetation of moderately nutrient-rich waters (44)
V18	amphibian vegetation of nutrient-rich waters (30)
V18sa	aquatic and amphibian vegetation of extremely nutrient-rich waters (12)
W11	aquatic and amphibian vegetation of nutrient-poor, acid waters (9)
W12	aquatic vegetation of nutrient-poor, neutral waters (13)
W12dv	aquatic vegetation of nutrient-poor, neutral seasonally dry waters (14)
W13dv	aquatic vegetation of nutrient-poor, alkaline waters and seasonally dry waters (6)
W17	aquatic vegetation of moderately nutrient-rich waters (33)
W17dv	aquatic vegetation of moderately nutrient-rich seasonally dry waters (7)
W18	aquatic vegetation of nutrient-rich waters (25)
zG20	pioneer, low and tall herbaceous vegetation on wet and moist saline soils (16)
zP20	pioneer vegetation of wet, saline soils (8)
zW10	aquatic vegetation of saline waters (2)

4. Changes in vascular plant biodiversity in the Netherlands in the 20th century explained by their climatic and other environmental characteristics

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Abstract

In the Netherlands nation-wide databases are available with about 10 million records of occurrences of vascular plant species in the 20th century on a scale of approximately 1 square km. These data were analysed with a view to identifying relationships between changes in botanical biodiversity and climatic and other environmental factors. Prior to analysis the data were corrected for several major forms of survey bias. The records were broken down into three periods: 1902–1950, 1975–1985 and 1985–2000. Using multiple regression analysis, differences between successive periods were related to plant functional characteristics as explanatory variables. Between the periods 1902–1950 and 1975–1985 there were small but significant increases in the presence of both thermophilic ('warm') and psychrophilic ('cold') species. However, in the final decades of the 20th century there was a marked increase in thermophilic species only, coinciding with the marked increase in ambient temperature observed during this period, evidence at least of a rapid response of Dutch flora to climate change. Urbanisation was also examined as an alternative explanation for the increase in thermophilic plant species and was found to explain only 50% of the increased presence of such species in the final decades of the 20th century. Besides temperature-related effects, the most important change during the 20th century was a strong decline in oligotrophic and a marked increase in eutrophic plant species.

4.1. Introduction

According to a number of recent meta-studies ecological effects of recent climate change are already visible all over the world (e.g. IPCC 2001, Gitay *et al.* 2002, Walther *et al.* 2002, Root *et al.*, 2003). Studies on the effects of climate change on vascular plants have been concerned predominantly with phenology. Only a limited number of studies report on shifts in vascular plant ranges or communities in relation to climate change, and these studies are confined mainly to mountainous (e.g. Grabherr *et al.* 1994) or arctic regions. In the Netherlands studies on the effects of climate change on plants have recently been published on lichens (Van Herk *et al.* 2002), vascular plant phenology (Van Vliet and De Groot 2001, Van Vliet *et al.*, 2002) and morphology of birch leaf stomata (Wagner *et al.* 1996). The possible effects of climate change on Dutch botanical diversity have thus attracted scant scientific attention, being implicitly regarded as marginal compared with the impacts of other environmental problems. Because of the growing acreage and age of Dutch forests, an increase in the number of 'cold', or psychrophilic, boreal species was in fact predicted (Mennema *et al.* 1985). Van der Meijden (1993, 1998) was the only one to note an increased presence of thermophilic plant species, but he pointed out that urbanisation might be an important alternative explanation for this phenomenon. Among other things, urban ecosystems are characterised by markedly higher temperatures than rural ecosystems (e.g. Gomez *et al.* 1998). Given the strong increase in the urbanised area in the Netherlands in the 20th century (from 6.4% in 1950 to 13.3% in 1990, cf. Van der Meij and Van Duuren 2000), an increase in thermophilic, urban plant species might certainly be expected.

The changes in the Dutch flora over the past century have been relatively well documented (e.g. Mennema *et al.* 1980, 1985, Van der Meijden *et al.* 1989, 2000, Plate 1990, Groen *et al.* 1997, Van Strien *et al.* 1997, Witte 1998, Van Duuren and Schaminée 1999, Weeda *et al.* 1990, 2000). All these publications point to a major loss of botanical diversity, especially of valuable plant species of nutrient-poor and wet, acidic or alkaline sites (e.g. hay meadows, fens, bogs, heaths, etc.) between the first half of the 20th century and the period 1950–1980. In the cited literature, the possible causes of the observed changes in the Dutch flora and vegetation are analysed exclusively in qualitative terms. The main cause mentioned in this literature is change in land use, especially conversion of natural areas to arable farmland and forestry. Other important causes cited are agricultural intensification, especially the massive increase in fertiliser use (e.g. on pastureland from about 50 to about 400 kg N/ha), changes in water management (e.g. lowering of the water table) and emissions, contributing especially to acidification and eutrophication (e.g. Heij and Erisman 1997).

Only during the last few decades has climate change come to be recognised as an important environmental problem in the Netherlands. The most recent major 'natural' climate change occurred at the end of the so-called Little Ice Age, in the 19th century (Grove 1988, Damon *et al.* 1998). From then on the average ambient temperature increased to a more or less constant level in the first half of the 20th century. The temperature subsequently began to slowly rise again and since about 1980 a pronounced increase in temperature has been observed. In the final two decades of the 20th century the average ambient temperature was between 9.5 and 10°C, which is 0.7°C higher than in first two decades (Können, 1999). Although natural changes in the North Atlantic Oscillation may have contributed to the recent warming in the Netherlands, human activity is an important cause of the overall temperature rise during the 20th century (Van Dorland 1999, IPCC 2001). In the Netherlands there was also a well-documented increase in winter rains (Können 1999, Van Boxel and Cammeraat 1999) by about 7% over the last 30 years to approx. 800 mm annual precipitation at the end of the 20th century.

Among the potential effects on vascular plants of increased temperature, precipitation and atmospheric CO_2 concentration might be an increase in thermophilic species (e.g. C4- and CAM-species, Ehrlicher 1978, Pynakov and Mokronosov 1993) and hydrophilic species.

The Netherlands has two extensive nation-wide databases with information on the distribution of vascular plants in the 20th century, both with a grid size of about 1 sq. km. The historical FLORIVON database has some 1.7 million records covering the period from 1902 to 1950 (Kloosterman and Van der Meijden 1994), while the more recent FLORBASE database has about 8 million records for the period from 1975 until the end of the last century (Witte and Van der Meijden 1995, Van der Meijden *et al.* 1996). Both these sets of records report only on species presence in a given grid cell. The records have, moreover, been sampled by different institutional groups and volunteer botanists, often using a variety of methods. Unless this survey bias is properly accounted for, there may be serious misinterpretation of data.

Against this background the present article focuses on the following key questions:

- Is it possible to detect any quantitative relationship between climate change, in particular increased temperature, precipitation and CO_2 concentration, and changes in botanical biodiversity in the Netherlands in the 20^{th} century?
- Is it possible to quantitatively disentangle climate-related effects from apparently strong effects of other environmental problems?
- Is it possible, if climate-related changes are detected, to discriminate between changes due to climate change per se and changes due to urbanisation?

4.2. Materials and methods

A total of 1490 vascular plant taxa were initially considered (Van der Meijden *et al.* 2000). For the sake of convenience, instead of the correct term 'taxon' the term 'species' will subsequently be used in this article. Two groups of species were omitted from the analysis from the onset. Firstly, the majority of trees and shrubs were excluded, because most woody species have been planted intentionally Secondly, species were excluded for which records are known to be unreliable because of serious identification problems, e.g. most hybrids. A number of other species were combined, in particular because certain groups of species are very difficult to identify.

After this process of exclusion and combination, 1292 species remained for study. Within this total group a subgroup of 134 species were recognised as 'problematic': the recorded data on these species should be used with great caution, because of improved identification in the second half of the 20^{th} century, for example. These 'problematic' species were excluded from the analysis of changes between the periods 1902–1950 and 1975–1985, but included in that of changes between 1975–1985 and 1985–2000, methodological differences between the latter two periods being only negligible.

During pre-analysis of the data it turned out that the amount of unexplained variation was high, especially for the very rare species (less than 1 per mille in every period). These very rare species – accounting for about 20% of the species – were therefore excluded from further analysis. Finally, an additional 35% of the species had to be excluded because there was no information available on at least one of the explanatory variables used in the statistical analysis.

Distributional data on the Dutch flora were taken from the FLORIVON and FLORBASE databases (see Introduction) and divided into three periods, viz. 1902–

1950, 1975–1985 and 1985–2000. Further subdivision of the records prior to 1950 was not possible, because information on the year of sampling had not yet been digitised. The period 1950–1975 was not included in the analysis because of a relative paucity of data and other scale of the data. Records from 1975 onwards were divided into two periods because of the marked increase in temperature after about 1980. For each of the plant species covered by this study, data were thus aggregated into three periods.

Only data from grid cells that had been sufficiently surveyed were selected for further analysis, cf. Groen *et al.* (1997) and Witte (1998). Thus, only grid cells with at least 80 species were used. For the periods before and after 1950, respectively, this requirement is fulfilled by about 40% and 60% of the grid cells with floristic information.

Consideration was given only to the terrestrial portion of the Netherlands' territory, including small surface waters like ditches, but excluding all large waters (e.g. IJsselmeer). Also excluded were 1,419 kilometre grid cells ('km-squares') in which the terrestrial component had risen substantially since 1930, mainly as a consequence of land reclamation (e.g. Flevoland). The resulting number of terrestrial km-squares included in this study was 35,374.

Before 1950 the quarter hour square grid was used with dimensions of 1023 × 1250 m (approx. 130 ha) and based on a poly-standard conic projection. After 1950 this was replaced by the kilometre square grid, with a grid size of 1000 m × 1000 m (i.e. 100 ha) and a stereographic projection according to the National Trangular System (Mennema *et al.* 1980, Van der Linden 1981, Snyder 1987, Kloosterman and Van der Meijden 1994). Because of the differences in grid size, national presences of rare and diffusely distributed plant species prior to 1950 would be overestimated, and therefore presences in the quarter hour squares were converted to km squares using a GIS (ARC-INFO). As a result, the number of records for this earlier period rose from 1.7 million to 2.1 million.

The most important survey bias was incomplete coverage in space and time: for example, before 1950 agricultural areas were not often visited. A regional filling up method was therefore applied to gain an unbiased estimate of the national presence of plant species in all three periods. For this calculation a classification of the Netherlands into ecogeographical regions was used (Weeda 1996, Klijn 1997). For each of the twenty-five ecogeographical regions (E) the fraction of each species within the sample of sufficiently surveyed grid cells (F_E) was multiplied by the ratio between region area and sample area (W_E). The result is an estimated total presence of the species per ecogeographical region. For each species these regional values were then summed for the whole of the Netherlands and presented finally as permillages:

$$\mathrm{Pr} = \frac{1{,}000}{A_{\mathrm{Neth}}} \times \sum_{E=1}^{E=25} F_E \times W_E \qquad \text{(Formula 1).}$$

The total permillage of each plant species, Pr, was logistically transformed (see statistical textbooks, e.g. Cox and Snell 1989) so that the data fulfilled the statistical assumption of homogeneity of variance:

$$\text{logit}(\text{Pr}) = \ln\left(\frac{\text{Pr}+0.0283}{1000.0283-\text{Pr}}\right) \quad \text{(Formula 2).}$$

Addition of 0.0283 per mille, equivalent to a presence in just one 1 km square, was carried out to avoid calculation problems with zeros.

Next, the differences in (logistic) values between consecutive periods were calculated; these differences will be referred to in the text as changes in frequencies of plant species. In the subsequent tests the transitions from the period 1902–1950 to 1975–1985 and from 1975–1985 to 1985–2000 will be referred to, respectively, as first transition: 1930–>1980, and second transition: 1980–>2000.

To analyse the observed changes in species frequency, plant functional characteristics were taken as explanatory variables, for the principal reason that sufficiently detailed nation-wide information on, especially, ecological site factors (e.g. nutrient availability) are lacking for the 20^{th} century and for the Netherlands as a whole.

In relation to climate, the Temperature (T) and Continentality (K) indicator values of Ellenberg *et al.* (1992) were used. Information on type of photosynthetic pathway per plant species was taken from Szarek and Ting (1977), Szarek (1979), Andrés (1993) and Van Voorst (2001). Plants with a C4 or CAM type of photosynthesis are subsequently referred to as C4–plants.

Ellenberg indicator values were also used as explanatory variables for several other environmental characteristics, viz. Nutrient availability (N), Moisture availability (F), Salinity (S) and Acidity (R) (Ellenberg *et al.* 1992, Wiertz 1992, Hill *et al.* 1999). In addition, the 'Urbanity' classification of Denters (1999) was used as an explanatory variable to test the hypothesis that urbanisation might be an alternative explanation for the observed increase in thermophilic plant species.

An important aspect of statistical analysis is the scale on which the different variables are set out. Scales may be quantitative (continuous or discrete) or qualitative (ordinal or nominal). Ellenberg indicator values are ordinal, but in many studies they are simply treated as if they were continuous (see Discussion). The approach adopted in this study was to treat Ellenberg indicator values in a pre-analysis both as factors (qualitative) and as variates (quantitative), comparing the respective results. In the significant variables selected, no differences were found between these two approaches and therefore analysis was completed using Ellenberg indicator values as variates. Photosynthetic type and Urbanity were used as factors with two and four levels respectively. Ellenberg's 'indifferent' values (X) for plant species responding indifferently to a given site factor were treated as missing values. All variates V were transformed according to:

$$V_i' = \frac{V_i - \text{mean}(V)}{\text{standard deviation}(V)} \quad \text{(Formula 3).}$$

For the purpose of the present study multivariate statistical methods (e.g. Hengeveld 1985) were judged less appropriate, because there were only three basic sampling periods and because multivariate analysis is used primarily in research of an exploratory character (e.g. Jongman *et al.* 1987). Univariate multiple regression analysis was used instead, because more detailed models and test options are available. More specifically, the software package GenStat (VSN 2000) was used for the statistical analysis.

For each of the plant species selected for analysis the changes in frequencies occurring in the first and second transitions were used as records in the statistical analysis. The changes in frequencies associated with the first and second transitions were analysed separately. These were related to the climatic and other environmental characteristics (either as factors or as variates) of each species by multiple regression analysis (Montgomery and Peck 1992).

A major problem in identifying the best explanatory variables was possible correlation (collinearity) among them. This was tackled in two ways: by calculating Pearson correlations between the main climatic and other environmental variables, and by applying the technique of best subset regression (e.g. Miller 1990). This latter method produces a best subset of equations by comparing all possible regression equations, permitting conclusions on whether effects of variables are 'interchangeable'.

The analysis was performed in several steps. First, the significance of climatic and other environmental characteristics was tested using best subset regression. Once the most significant effects had been established, possible effects of interactions and quadratic terms were analysed. This constituted the bulk of the analysis. Second, after the main explanatory climatic and environmental variables had been established, the significance of photosynthetic type was established by adding this variable to the model with all the significant climatic and environmental variables already present. Third, to test the alternative hypothesis the interchangeability of the variables Urbanity U and temperature T was tested by conditional (U or T added to the model with other significant variables) and marginal tests (U or T added to the model with other significant variables *and* the competing variable).

Fourth, the contribution of the significant variables to explaining the data was calculated. In a completely balanced study, the contribution of a variable can be directly determined as its sum of squares relative to the total sum of squares. Obviously, we do not have a balanced design, so that the contribution of a variable is dependent on the order of the variables in the regression equation. However, it is still possible to estimate the contribution using a combination of marginal and conditional tests (e.g. McCullagh and Nelder 1989). With conditional testing, the variable is added to the simplest regression model, in this case the constant. With marginal testing, the variable is added to the most complex regression model, i.e. the constant and all the other explanatory variables. If the contributions of the variable of interest are similar in both tests, we have a fairly reliable estimate.

In this type of research using statistical models, the effects of significant variables are generally illustrated using the mean values predicted by the models. In this study, effects are presented as bar diagrams, using the average relative change of *all* originally selected species, not only those used in the statistical analysis, to obtain more reliable figures that can be more readily interpreted. The most important motive here is that model predictions are expressed as differences in logistic values, which cannot be interpreted in a meaningful way. Also, given our very strict selection of species for statistical analysis, the representativeness of that selection will always be queried. The mean predicted changes in the selected species and the mean measured changes in all species were very similar, however.

The diagrams show the mean relative change. First the ratio was determined for each species between the total permillages (Formula 1) of two consecutive periods. Then the average overall ratio, R_o was calculated as the geometric mean (Sokal and Rohlf 1969) of all ratios. Also the average class ratios R_c were calculated as geometric means for the different classes of the different explanatory variables. Finally the mean relative change (MRC) was calculated as a percentage:

$MRC = (R_c/R_o - 1) \times 100$ (Formula 4).

4.3. Results

4.3.1. General: average decrease and increase per transition

The analysis of each of the two transitions was based on only 45% of the total number of originally selected species (Table 1). However, a comparison of the average changes in the frequencies of these species with the average changes for all species examined in this study showed any differences to be small and, where present, only strengthened the expectations. The species selected for the main statistical analysis can therefore be said to be representative. This conclusion is also supported by the close resemblance in correlations between climatic and other environmental characteristics for these species with respect to the two separate transitions and the correlations for all species (Table 2).

Table 1. Best regression models for explaining changes in plant species frequencies in the Netherlands by climatic and environmental characteristics for two transitions in the 20th century.

		first transition: 1930-> 1980	second transition: 1980->2000
degrees of freedom		514	546
% explained variation (R^2)		44.8	17.4
significant regression coefficients			
T: Temperature	linear term	-0.065	0.200
	quadratic term	0.089	0.065
N: Nutrient availability		0.319	0.159
F: Moisture availability		-0.118	-0.143
R: Acidity		0.115	-0.078

During the first transition there was a strong mean decrease in particular of rare species of highly valued original ecosystem types, which is larger than the mean increase, in particular of common species. The overall mean change in species frequencies was about 0.85, an overall decline in presence per sq. km, probably reflecting the loss of many valuable types of vegetation. For the second transition the reverse is the case, but increase and decrease are far less strong than for the first transition. The overall mean change in species frequencies was 1.35, an overall increase, which is generally recognised by Dutch botanists to be due to an expansion of urban habitats (road verges, roads, buildings, etc.), leading to a more 'mosaic'-type landscape comprising elements of both rural and urban landscapes.

4.3.2. Best selection models

Table 1 summarises the results of the best subset regression models. For both transitions, analysis resulted in one best model with Nitrogen availability (N), Temperature (T), Moisture availability (F) and Acidity (R). Only in the case of Temperature were there significant quadratic terms. There were thus no serious problems with collinearity. This is also supported by the low correlation values between climatic and other environmental characteristics (Table 2). The percentage of variance explained by the two models was about 45% for the first transition and about 18% for the second. For further interpretation of the amount of variance explained, see section 3.6.

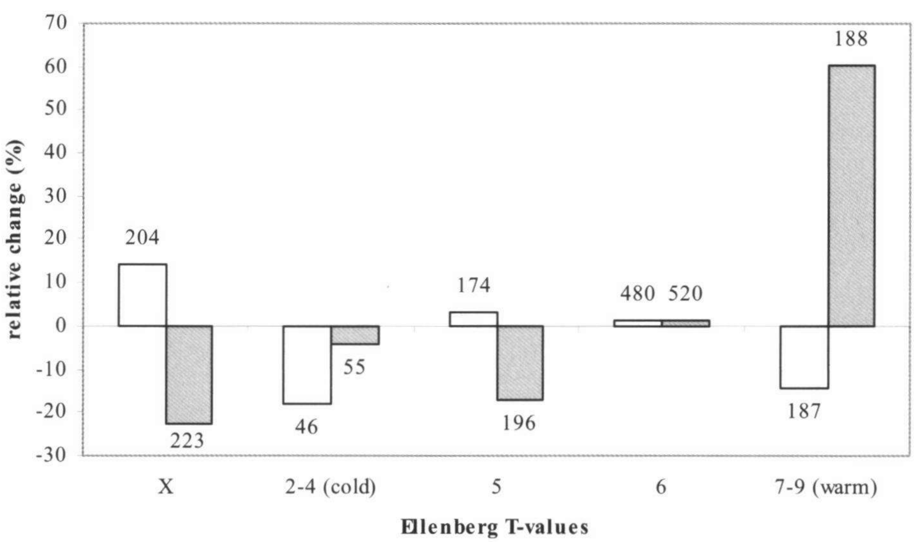

Fig. 1. Average relative change of plant species in relation to Ellenberg Temperature classes for the first transition: 1930–>1980 (white bars) and second transition: 1980–>2000 (grey bars); X = 'indifferent' value; bars are labelled with number of species used for calculation.

Table 2. Correlations between climatic and environmental characteristics and changes in plant species frequencies in the Netherlands in the 20th century; avail. = availability.

correlations for first transition: 1930–>1980 (514 taxa)

Temperature	T	1.000						
Continentality	K	0.051	1.000					
Nutrient avail.	N	0.127	0.184	1.000				
Moisture avail.	F	-0.158	-0.066	0.217	1.000			
Acidity	R	0.281	0.373	0.429	-0.066	1.000		
Salinity	S	0.077	-0.028	0.106	0.220	0.130	1.000	
Change frequency	d12	-0.123	0.083	0.343	0.040	0.126	-0.026	1.000
		T	K	N	F	R	S	d12

correlations for second transition: 1980–>2000 (553 taxa)

T	1.000						
K	0.066	1.000					
N	0.129	0.161	1.000				
F	-0.165	-0.035	0.230	1.000			
R	0.270	0.354	0.430	-0.043	1.000		
S	0.080	-0.009	0.099	0.200	0.135	1.000	
d23	0.252	0.047	0.152	-0.190	0.048	-0.047	1.000
	T	K	N	F	R	S	d23

correlations based on maximum number per pair of variables (837–1189 taxa)

T	1.000					
K	0.056	1.000				
N	0.088	0.125	1.000			
F	-0.212	-0.095	0.188	1.000		
R	0.255	0.295	0.382	-0.079	1.000	
S	0.059	0.012	0.129	0.178	0.148	1.000
	T	K	N	F	R	S

4.3.3. *Effects of climatic characteristics*

Temperature was found to be a significant explanatory characteristic in both transitions (Table 1). In the first transition statistical analysis showed a small increase in both psychrophilic species (Ellenberg T-values 2–4) and thermophilic species (Ellenberg-values 7–9), an effect not visible in the measured values (Fig. 1), which showed only small decreases for both groups of species. In the second transition thermophilic species increased far more markedly than other species (Ellenberg T-values < 7) (Table 1, Fig. 1). In the first transition there thus appears to be a small temperature effect, which is not observable in the measured values

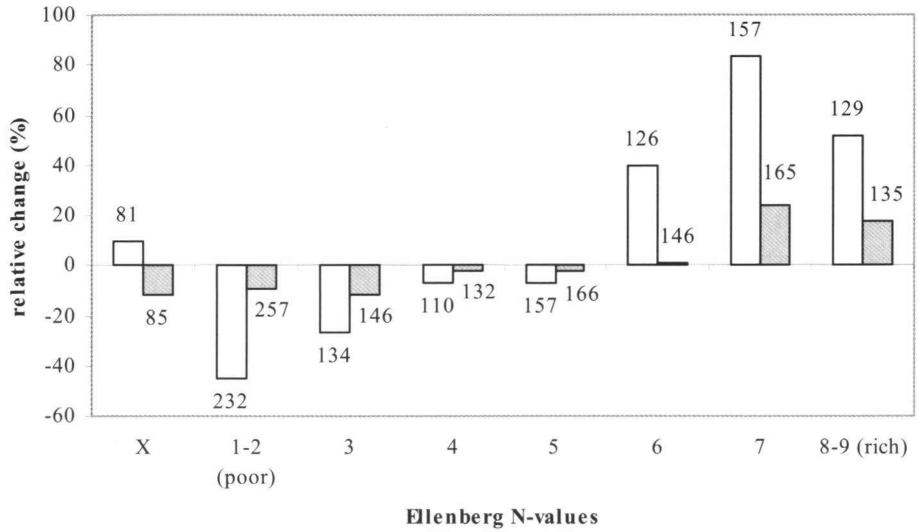

Fig. 2. Average relative change (%) in measured frequency of plant species in relation to Ellenberg's Nutrient availability classes for the first transition: 1930–>1980 (white bars) and the second transition: 1980–>2000 (grey bars); for explanation see Fig. 1.

because it is obscured by the stronger effects of the other variables, while in the second transition the temperature effect is pronounced.

The climatic characteristic Continentality (K) was not significant in either transition. In other words the increase of winter rains in the Netherlands is not mirrored in the observed floristic changes. (On this point, see also the results on the environmental variable moisture (F) in section 3.3, however.)

Plant species with C4- or CAM-photosynthesis are adapted to warmer and drier climates. The number of C4-species included in the analysis is about 2.5% of all species. Photosynthesis type was also only significant in the second transition: a threefold increase of C4-species relative to the average increase of the C3-group. The effect of photosynthesis type is additional to the effect of temperature, i.e. the observed increase in C4-species cannot be explained by temperature changes alone.

4.3.4. Effects of other environmental characteristics

In both transitions the environmental characteristic Nutrient availability (N) was significant (Table 1). In general terms the results can be interpreted as an increase in eutrophic plant species and a decline in oligotrophic species. As can be seen in Fig. 2, in the first transition there was a marked decline in oligotrophic species (Ellenberg N-values 1–3), by about 50%, and an increase in eutrophic species (Ellenberg N-values >6). Mesotrophic (Ellenberg N-value 4–6) and indifferent (Ellenberg X-value) plant species showed an average change or an increase. For the second transition a similar conclusion can be drawn, but in this case the increases

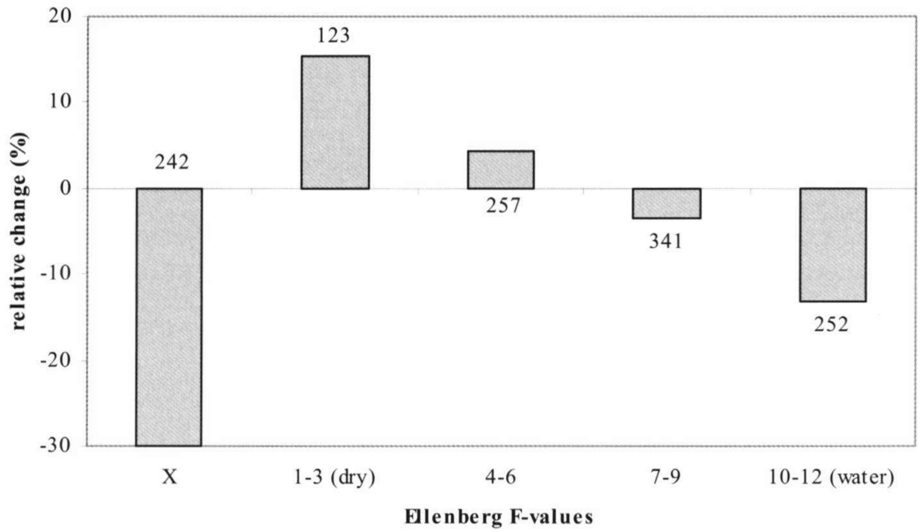

Fig. 3. Average relative change (%) in measured frequency of plant species in relation to Ellenberg's Moisture availability classes for the second transition: 1980–>2000; for explanation see Fig. 1.

and decreases were much smaller, while mesotrophic and indifferent plant species showed an average change or minor decrease (Fig. 2).

The environmental characteristic Moisture availability (F) was likewise significant in both transitions (Table 1) and can be interpreted, in general terms, as an increase in xerophilic species and a decrease in hydrophilic species. This is demonstrated for the second transition in Figure 3: a decrease in hydrophilic species (Ellenberg F-values 10–12), an increase in xerophilic species (Ellenberg F values 1–3), average changes for species of moist sites (Ellenberg F-values 4–9) and a strong decline in indifferent species. Why species indifferent to moisture availability should show such a marked decrease remains obscure. The environmental characteristic Acidity (R) was also significant, but will not be further treated here.

4.3.5. Interaction between climatic and other environmental variables

Best subset regression analysis revealed two cases of interchangeability between significant positive characteristics, both in the second transition: between moisture and nutrient availability (F × N) and between moisture availability and temperature (F × T). The additional explanatory power of these interactions was only minor (approx. 1 %), with the interaction F × N having slightly more influence than F × T. From Table 3 it is apparent that there is a positive interaction between moisture availability and nutrient availability. Plant species that are both xerophilic and eutrophic, in particular, show a larger increase than other combinations. These results are consistent with the absence of an effect of climatic characteristic continentality (K), i.e. no effect of increased precipitation.

Table 3. Average measured change in plant species frequencies (expressed as the geometric mean of the ratios of total permillages in latter and former period) in the Netherlands for the second transition: 1980–>2000; positive interaction of Moisture (F) and Nutrient availability (N) (upper part) and competitive interaction of Moisture availability (F) and Temperature (T). In parentheses: number of records per class combination of the characteristics. n.a. = not available.

second transition: 1980–>2000			moisture	
		dry	moist	wet
nutrient avail.	(N)	(F) <5	5–8	>8
oligotrophic	1–3	1.24 (194)	1.34 (107)	1.02 (79)
	4–6	1.59 (134)	1.23 (228)	1.17 (68)
eutrophic	7–9	2.42 (45)	1.59 (187)	1.32 (58)
temperature	(T)			
psychrophilic	2–4	n.a. (2)	1.44 (31)	1.05 (32)
	5–6	1.22 (221)	1.35 (341)	1.06 (134)
thermophilic	7–9	2.07 (120)	2.32 (50)	1.50 (15)

4.3.6. Urbanisation: an alternative explanation for the increase in thermophilic species

Given that urban areas generally have a warmer microclimate, urbanisation may provide an alternative explanation for the observed increase in thermophilic species in the Netherlands (see Introduction). If the entire increase in thermophilic species were indeed due to urbanisation, then in statistical terms the effect of Temperature (T) and Urbanity (U) would be completely interchangeable. Urbanity was found to be significant in the second transition only, with a 50 % to 150 % increase being observed in typically urban species (Fig. 4). Non-urban species and surprisingly cosmopolitan species (like *Plantago major* and *Capsella bursa-pastoris*) showed an average decrease. The effect of Urbanity was not completely interchangeable with that of climatic variables. Its effect was thus partly additive. After addition of the factor Urbanity to the best regression model for the second transition (Table 1) the percentage variation explained increased from 17% to 26%. (Table 4). Of the variation explained by temperature in the second transition, 50% could be explained by Urbanity.

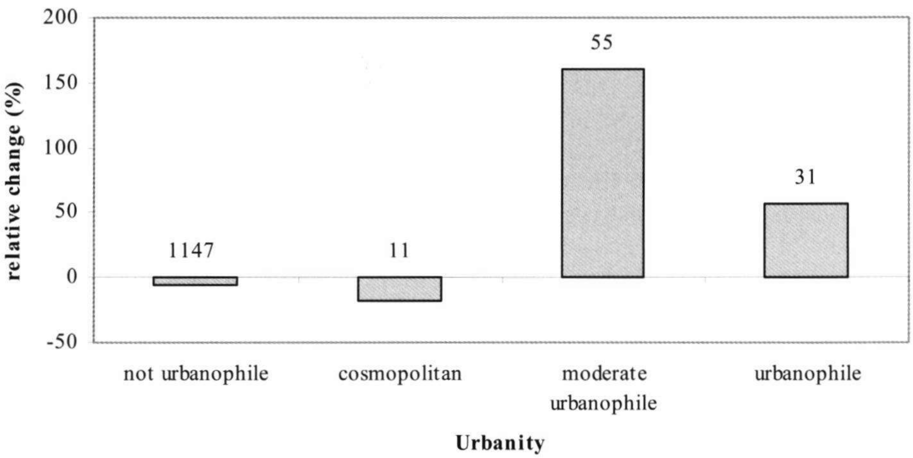

Fig. 4. Average relative change (%) in measured frequency of plant species in the Netherlands for the second transition: 1980–>2000 in relation to different classes of Urbanity; for explanation see Fig. 1.

Table 4. Contribution of climatic and environmental variables to explaining changes in plant species frequencies in the Netherlands; SS = sum of squares; total = sum of contributions of individual variables; T+F+N+R = contribution of combination of variables; avail. = availability; - = not significant.

	first transition: 1930–>1980				second transition: 1980–>2000			
	marginal		conditional		marginal		conditional	
	SS	%	SS	%	SS	%	SS	%
T: Temperature	4.7	(6)	13.4	(22)	21.9	(59)	17.1	(45)
N: Nutrient avail.	49.7	(61)	35.7	(60)	5.7	(15)	9.2	(24)
F: Moisture avail.	1.2	(1)	6.1	(10)	9.2	(25)	9.5	(25)
R: Acidity	25.9	(32)	4.8	(8)	0.4	(1)	2.3	(6)
subtotal	81.5	(100)	60.0	(100)	37.2	(100)	38.1	(100)
T+F+N+R			71.8				36.9	
total model			362.4				49.3	
total model + Urbanity			-				71.0	
total SS			808.5				282.4	

4.3.7. *Contribution of climatic and other environmental variables to explanation of changes*

Table 4 shows the sum of the squares of the climatic variables, the other environmental variables and Urbanity as calculated by the models. The contribution of each significant environmental variable to the overall variation explained by all variables can be calculated, as in a balanced experiment, if the results of marginal and conditional testing are in general agreement. In the first transition nutrient availability alone explains a constant 60% of the variation explained by the environmental variables. The contributions of the other environmental variables calculated by marginal and conditional testing were not in sufficient agreement. In the case of the second transition there was much better agreement between the marginal and conditional sum of the squares of the climatic and other environmental variables. Temperature (T) explained approx. 50% of the variation explained by these variables taken together, with nutrient and moisture availability explaining virtually the remainder. In the second transition Urbanity proved to be the main explanatory variable (Table 4 and section 3.6).

4.4. Discussion

This article describes some effects of climate change on vascular plant distribution in the Netherlands during the 20th century and makes a significant contribution to the body of evidence on modern climate change, for five reasons: 1) The results are from a temperate lowland region of considerable size (in comparison to mountain tops). 2) The full range of natural, semi-natural and urban ecosystems has been examined, so that results are not biased towards pristine and very sensitive ecosystems (Parmesan and Yohe 2003, Root *et al.* 2003). 3) By applying appropriate statistical analysis, possible confounding effects (e.g. urbanisation) could be properly accounted for and disentangled. 4) More generally, changes in flora appear to correlate very closely with changes in climate, small changes in flora coinciding with small temperature changes and large changes in flora with large temperature changes. 5) We studied species frequencies instead of phenology or range boundary shifts.

The observed changes in vascular plant presence and distribution in the Netherlands in the 20th century were found to be significantly related to the temperature characteristics of the plants in question. In the last few decades of the 20th century, particularly, the marked increase in thermophilic species corresponds closely with the similarly marked increase in temperature recorded in the Netherlands. The timing of the response of thermophilic vascular plant species was almost identical to that observed for lichens in the Netherlands (Van Herk *et al.* 2002). The marked increase in the presence of thermophilic plant species in the final decades of the 20th century was not counterbalanced by a decrease in psychrophilic species. This asymmetric response is recognised as a general phenomenon in most of the main reviews of the biological effects of climate change (IPCC 2001, Walther *et al.* 2002, Gitay *et al.* 2002, Parmesan and Yohe 2003, Root *et al.* 2003). In the first transition, between 1902–1950 and 1975–1985, there was a small increase in thermophilic plant species, to be expected as a result of the ending of the Little Ice Age in the 19th century. However, the analysis of this transition also showed a small increase in psychrophilic species. The most likely explanation for this latter increase is the marked increase in the age and area of Dutch forest in the 20th century. The group of herbaceous woodland species contains more psychrophilic species; the average Ellenberg Temperature indicator for woodland species is about 5, as against about 6 for the remainder of the species.

The second article of the United Nations Framework Convention on Climate Change (UNFCCC) states, amongst other things, that ecosystems should be allowed to adapt naturally to climate change. In general it is assumed that plants and animals cannot adapt their ranges fast enough, given the very high rates of climate change anticipated (e.g. Huntley 1991, Grabherr *et al.* 1994, IPCC 2001, Walther *et al.* 2002, Gitay *et al.* 2002, Parmesan and Yohe 2003, Root *et al.* 2003). Unfortunately, apart from the marked increase in thermophilic plant species in the final decades of the 20th century, no conclusions can yet be drawn as to whether today's assemblage of plant species in the Netherlands is in line with changed climatic conditions. Runhaar *et al.* (2002) have compared plant community assemblages in wet brook valleys in the Netherlands and in north-west France, a situation expected to reflect the Dutch climate and vegetation in about a hundred years' time. They concluded that certain minor changes were to be expected and that such changes had not been observed in the recent past. It would be very useful to conduct a similar study on moist and dry ecosystems in the Netherlands, to assess their adaptability to climate change.

There was no evidence for changes in plant frequencies being due to the increase of winter rains in the Netherlands. This may have several explanations, e.g. that the additional winter precipitation does not contribute significantly to higher water levels in summer and higher moisture availability but only to increased pumping. This is supported by the results, which show a strong increase in xerophilic plant species. These results are not consistent with the north-east shift of plant species and vegetations in Europe predicted by a number of authors (Alkemade *et al.* 1999, Ihle *et al.* 1999, Bakkenes *et al.* 2002). Consequently, processes other than climate change are probably masking or counteracting any increase in more western species. The increase in C4-plants could not be completely explained by temperature, so other factors such as herbicide use in arable fields are probably favouring C4-plants.

Despite our focus on the effects of climate change, other environmental variables prove to be far more important as causal factors explaining observed changes in the Dutch vascular plant flora in the course of the 20^{th} century. The results of our statistical analyses are in general agreement with earlier, more qualitative research into the causes of historical changes in the Dutch flora (see Introduction). By far the most important change was found to be the marked decline in oligotrophic plant species and the marked increase in eutrophic species.

As the information in the databases employed had not been collected systematically, great caution had to be exercised in its usage and interpretation (e.g. Rich and Woodruff 1992). Even after making extensive corrections for survey bias in this study, we cannot entirely rule out the presence of artefacts in the data and analysis. The representativeness of the results might be improved in the future by developing methods to add records of the very rare species and species responding 'indifferently' (Ellenberg) to one or more environmental factors. Further research is also needed on the use of survey periods of differing lengths and differing survey intensities.

Plant functional characteristics were used as explanatory variables for the changes observed in the Dutch flora in the 20^{th} century, the most important of which were Ellenberg's indicator values (Ellenberg *et al.* 1992). However, it should be pointed out that these are based on operational ecological site factors like nutrient availability. These operational site factors are not equivalent to conditional or causal factors: for example, nutrient-related effects may have a number of different causes, in particular agricultural intensification, changes in land use, lowering of the water table and nitrogen deposition.

Despite the fact that Elleberg indicator values are defined on an ordinal rather than continuous scale, they have been consistently regarded and used as if they were continuous, even by the creator himself (Ellenberg *et al.* 1992, also e.g. Ter Braak and Barendregt 1986, Jongman *et al.* 1987, Schaffers and Sýkora 2000, Wamelink *et* *al.* 2002). Using field data, Ellenberg *et al.* (1992), Schaffers and Sýkora (2000) and Wamelink *et al.* (2002) also demonstrated that differences between indicator values were relatively constant, as with a continuous scale. In a pre-analysis for this study Ellenberg's indicator values were treated as both continuous and qualitative. However, these divergent approaches did not yield essentially different results. In this case, then, it seemed justified to treat Ellenberg's indicator values as being continuous.

Over the last decade the protection of biodiversity has become an important political issue (UNCED 1992). While reliable distributional data on flora and fauna are a key prerequisite for developing effective and efficient conservation policies, such data are often unavailable, thus creating a bottleneck for project realisation. In the Netherlands, however, there are two nation-wide databases containing millions of historical records of vascular plants occurrence. Despite the inherent survey bias of these kind of surveys, the results obtained using these atlas data hold major relevance for nature conservation and environmental policy.

4.5. Acknowledgements

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5. History of non-native vascular plant species in the Netherlands

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Submitted.

Abstract

Non-native, or alien, species are held to be a major threat to biodiversity worldwide. This article presents a quantitative analysis of the history and dynamics of non-native vascular plant species in the Netherlands and assesses the ecological threat they might pose. The total number of non-native plant species growing outdoors in the Netherlands was estimated, using a variety of sources and distinguishing between archeophytes (species introduced prior to 1500) and neophytes (introduced thereafter), the latter grouped according to century of introduction. The chief focus of this article is on the naturalised non-natives, which are compared and contrasted with Dutch native species. The stock of non-natives is characterised in terms of species numbers, date of naturalisation, region of origin, ecology and family affiliation and trends in species occurrence are analysed as a function of naturalisation date. The results are used to test several hypotheses regarding the success of non-native species. Finally, the fate of these species and their impact on the Dutch wild flora are assessed. In the Netherlands naturalised non-natives account for approximately 25% of all vascular plant species occurring in the wild (9 p.p. archeophytes, 16 p.p. neophytes). Almost all the archeophytes are of European origin, while neophytes are from several continents (63% Europe, 25% North America, 9% Asia). The archeophytes are from a narrower spectrum of ecological groups than the neophytes, though both can be characterised as predominantly pioneers and ruderals of (moderately) nutrient-rich soils. The profile of common versus rare species is very similar for archeophytes and natives. Neophytes are far less common than either, becoming commoner the earlier the date of naturalisation. In terms of change in occurrence, too, archeophytes also show a similar pattern to natives, with a modest increase in common species and a decline in rare species that is more pronounced for the archeophytes. The neophytes show increases that become greater the more recent the date of naturalisation and the commoner the species. Commonness and rate of increase are higher for non-native species of more distant geographic provenance, supporting the 'escape from the antagonist complex' hypothesis. The results also support the hypothesis that non-natives occur predominantly in man-made habitats, that are subject to frequent disturbance. No support could be found for the hypothesis that ecosystems with a large number of native species are less susceptible to colonisation by new species, i.e. that their 'invasibility' is lower. The percentage of archeophytes on the Dutch 'Red List' of threatened species is similar to the figure for native species. The percentage of neophytes listed is far lower, but there are a few. As to the percentage of extinct species, there was no significant difference between natives, archeophytes and neophytes. No relation was found between the number of non-native species in a particular ecological group and the percentages of Red List or extinct species in that group. Based on our data, there appears to be no evidence that non-native vascular plant species have had any significant effect on plant biodiversity in the Netherlands.

5.1. Introduction

Colonisation is one of the fundamental ecological processes determining biodiversity (MacArthur and Wilson 1967, Hubbell 2001). It may be either spontaneous, the result of changing ecological conditions and natural processes of transport and dispersal, or anthropogenically induced. In the latter case it may either be deliberate, as when new agricultural or forestry species are introduced, or accidental, as with the escape of garden ornamentals. Regional patterns of colonisation by new plant and animal species are of interest to both scientists and society at large. The scientific interest lies in understanding the environmental factors and species characteristics that determine the success of introduced species within an evolutionary context. Several hypotheses have been proposed to explain rapid expansions of species range, focusing in particular on the role of the native antagonist complex (diseases, pests, predators, etc.), co-occurrence with increasing anthropogenic disturbance (incl. open space) and the presumed greater 'invasibility' of species-poor communities (Elton 1958, Lodge 1993, Cronk and Fuller 2001, Slobodkin 2001, Turlings 2001 etc.). For society at large, non-native and especially invasive species are of interest because of their potential to damage ecologies as well as impact on economic activities. Examples of such damage include competition with native flora and fauna and impacts on a variety of ecological processes (Elton 1958, Mooney and Drake 1989, Williamson 1996, Delbaere 1998, EEA 1999, Groombridge and Jenkins 2000, Cronk and Fuller 2001 etc.). In this connection IUCN regards introduced or alien species as the second largest cause of biodiversity loss worldwide (IUCN 2000). Examples of economic damage include impacts on agricultural crops and forestry (e.g. Pimentel *et al.* 2000, Van den Tweel and Eysackers 1987) and on water management (e.g. Van der Velde 1987, Pot 2002). Some authors also cite benefits to ecologies and society, including protection of soils and coasts (planting of Townsend's Cord-grass, *Spartina anglica* in coastal waters, for example, or Sea wormwood, *Artemisia campestris* subsp. *maritima* in dry dunes) and, depending on conservation attitudes, even speak of 'ecological enrichment' (e.g. Weeda 1987: "examples ... of neophytes which complete vegetation types in a "harmonious" way ", see also Shapiro 2002).

In the literature a variety of terms (exotic, alien, invasive, invading, aggressive, etc.) and classifications are used in connection with non-native species, often inconsistently and with the same terms sometimes even meaning different things owing to different criteria being employed (compare, for example, Sukopp 1998, IUCN 2000, Cronk and Fuller 2001, Williamson 1996, Di Castri 1989, Heywood 1989, Richardson *et al.* 2000). In this article we have opted to use the neutral, dichotomous terms 'non-native' versus 'native'. In characterising non-natives in terms of date of naturalisation, geographic provenance, commonness, rate of change and so on, we have endeavoured to account unambiguously for all relevant aspects of the other terms employed in the literature.

The present article focuses on the history and dynamics of non-native vascular plant species in the Netherlands. We consider this analysis particularly valuable, because of the large number of well-documented databases of species occurrence maintained in the Netherlands that until now have been scarcely employed in this context. Despite considerable public and political interest in the issue of non-native plant species, it has been the subject of only a limited number of scientific papers in the Netherlands (Weeda 1987, Van den Tweel and Eijsackers 1987, Den Hartog and Van der Velde 1987, Ernst 1998, Pot, 2002, and, in part, Thompson *et al.* 1995). A quantitative analysis of the introduction, development and impacts of non-native plant species in the Netherlands is entirely lacking. We have chosen here to adopt a historical approach, putting present developments into a long-term context and investigating the fate of non-native species over an extensive period. Two groups of non-native species are distinguished: archeophytes, introduced from the advent of our era up to 1500 AD, and neophytes, introduced since. Trends in species occurrence are compared with those of Dutch natives, i.e. species presumed to have been growing in the Netherlands before our era. All species were classified into one of these three groups using various data sources, including archeobotanic databases, written and electronic sources, herbarium records and databases of species distribution.

In this paper we pursue four research themes in tandem. First we characterise the stock of non-native species in terms of species numbers, date of naturalisation, region of origin, ecological characteristics and family affiliation. We next analyse trends in species occurrence as a function of naturalisation date. We then discuss the results in the light of several hypotheses regarding the success of non-native species. Finally, we examine the fate of these species and their impact on the wild flora of the Netherlands, assessing the extent to which non-native species might pose an ecological threat.

5.2. Methods and sources

In presenting the methods employed in this study we follow the sequence of research themes cited at the end of the last section.

The first goal was to analyse several key characteristics of non-native Dutch vascular plant species and compare them with those of native species. A note on terminology is in order here: for the sake of convenience in this article we shall generally use the term 'species' rather than 'taxon', which also includes subspecies, varieties and hybrids. Only in establishing total species numbers has the strict definition of the term species been used, by aggregating subspecies, varieties and hybrids to the species level.

The first phase of characterisation was a species count. To this end we first distinguished between native and non-native vascular plant species, dividing the latter into species found in (semi-)natural and other habitats. The non-natives encountered in (semi-)natural habitats were further subdivided into non-naturalised and naturalised species. The main criterion for naturalisation was that a new plant species must have had at least three generations at three different sites (Van der Meijden *et al.* 1991). The number of non-natives not found in (semi-)natural habitats, all of them agricultural and horticultural plants commonly sold in the

Netherlands, was derived from Wortelboer (2000); see Table 1 for further details. The number of non-naturalised non-natives found in (semi-)natural habitats was derived from the Dutch distribution databases FLORIVON and FLORBASE (Mennema *et al.* 1980, Kloosterman and Van der Meijden 1994, Groen *et al.* 1999, Van der Meijden *et al.* 1996) and the botanical register BIOBASE (CBS 1997). Numbers of native and naturalised non-natives were derived from the 'Standard List' and the 'Red List' of the Dutch flora (Van der Meijden *et al.* 1991; Van der Meijden *et al.* 1996; Van der Meijden *et al.* 2000); together, these latter species will be referred to subsequently as the Dutch wild flora, or wild species.

Further characterisation of non-natives was restricted to naturalised species, as it is only for this group that reliable Dutch distribution data are available for the 20th century. These non-natives were broken down into archeophytes and neophytes, as defined in the Introduction, employing a variety of sources (including Haasteren and Brinkkemper 1995, Van der Meijden 1996, Kooistra 2001, see for further details Annex of this study). Using the same sources, the neophytes were then classified according to date (century) of naturalisation: 16th, 17th, 18th and 19th and two equal periods for the 20th (1900–1950 and 1950–2000), combined as necessary for calculations. From the same sources, both the archeophytes and neophytes were classified, by date of naturalisation, according to region of origin: the five continents, and within Europe six regions, again combined into groups as necessary for calculations.

For ecological characterisation of the naturalised non-natives and natives a classification of vascular plant species into 84 ecological groups was used (Runhaar *et al.* 1987, Plate 1990, Witte and Van der Meijden 2000, Runhaar *et al.* 2003). In this classification each ecological group is characterised in terms of five operational site factors: salinity, vegetation structure, moisture availability, nutrient availability and acidity.

Finally, the plant family affiliation of natives, archeophytes and neophytes was determined using the most recent edition of the standard Dutch flora (Van der Meijden 1996).

The second research focus was an analysis of trends in occurrence of non-native species compared with natives. For this purpose we made use of two large plant distribution databases, FLORIVON and FLORBASE (see above), the former containing about 1.7 million records for the years 1902–1950, the latter some 8.0 million records for 1975–2000; both map vascular plant species distribution for the whole of the Netherlands on grid squares of (approx.) 1 sq. km. As these data have been sampled over a long period in a variety of projects by people with varying botanical skills, they were thoroughly corrected for survey bias errors.

Trends in occurrence were assessed in terms of two yardsticks: commonness and rate of change in presence. The commonness of each native and naturalised non-native in the final decade of the 20th century was determined using a simplified, logarithmic classification (KFK: Dutch acronym for Kilometre Frequency Classes; Tamis and Van 't Zelfde 2003) to establish total national presence: KFK 0: 0 km squares, KFK 1: 1–3 km sq., KFK 2: 4–10 km sq., KFK 3: 11–30 km sq., KFK 4: 31–100 km sq., etc. to KFK 9: over 10,000 km sq.

The rate of change (increase or decrease) of each native and naturalised non-native was determined as the ratio between calculated total national presence in the final decade and the first half of the 20th century.

For a full description of the databases FLORIVON and FLORBASE, correction methods and calculation of total national presence we refer the reader to chapters 1 and 2.

The third research theme was concerned with testing several key hypotheses, alluded to briefly in the Introduction, that seek to explain the success of (some) non-native vascular plant species in competition with the native flora. The first hypothesis we examined with our results posits the native antagonist complex, i.e. diseases, pests, predators, etc. as determining the success of non-native species. As a proxy for the 'relatedness' of non-natives to the native antagonist complex we used distance of region of origin from the Netherlands. We then tested for correlation between commonness and rate of change on the one hand and distance of region of origin on the other.

The second hypothesis tested posits frequent disturbance as a key factor influencing non-native success. Man-made habitats are characterised by frequent disturbance of soil and water and removal of natural vegetation, leading, among other things, to open spaces and in the case of farmland to nutrient enrichment of soils and water. According to this hypothesis, non-natives are likely to be more successful at nutrient-rich sites and in dynamic situations. This can be measured as the percentage and mean commonness (KFK) of the ecological groups characteristic of these conditions, viz. pioneer and tall herbaceous ('ruderal') vegetation structure on the one hand and nutrient-rich and, to a lesser extent, moderately nutrient-rich conditions on the other. Particular attention was paid to pioneer vegetations of moist, nutrient-rich soils, generally synonymous with the weed flora of intensively farmed arable land.

The third hypothesis, neophyte success as a function of ecosystem 'invasibility', was tested by establishing, for each ecological group, the percentage of non-native species relative to total number of natives. If ecological groups comprising more species are more resistant to colonisation by neophytes, then a negative relationship should be found.

The fourth research theme addressed the fate and impact of non-native species. Fate was investigated by testing whether the percentages of 'Red List' and extinct species are the same for the various classes of non-natives as for the native flora. The impact of non-natives was assessed by investigating, for each ecological group, the relationship between the percentage of Red List or extinct species in that group and the number of non-natives it comprises. If groups with more non-natives have higher percentages of Red List or extinct species, then non-natives can be posited as having a (negative) impact. Information on extinction and threatened status was taken from the Red List for vascular plants in the Netherlands, in which species are classified according to IUCN categories (IUCN 2001) using guidelines and criteria drawn up by the Dutch Ministry of Agriculture, Nature Conservation and Fisheries (Van der Meijden *et al.* 2000, Tamis *et al.* 2003a). In this study we distinguished three basic categories: (1) Red List, threatened (present in fewer than 551 kilometre grid cells and in decline of over 25%, (2) Red List, non-threatened (either present in fewer than 36 km grid cells - including extinct species - and in decline of less than 25%, or present in over 551 km grid cells and in decline of over 50%) and (3) non-Red List.

Standard statistical methods were implemented with the software package SPSS 11.0. Log-linear analysis was used for the basic analysis of frequencies. In case of the family composition, the distribution of natives, archeophytes and neophytes each plant family was tested against that in the families excluded from analysis. For all bivariate analysis, power regression was used. To avoid problems with zeroes in calculating logarithms, zeroes were replaced by 0.1. The mean rate of change in occurrence was calculated as a geometric mean (Sokal and Rohlf 1969). Mean commonness was calculated as the arithmetic mean of KFK values (see above).

Table 1. Number of vascular plant species in the Netherlands (without subspecies, varieties or hybrids) in the 20th century in relation to nativeness, occurrence in (semi-)natural habitats and naturalisation. Estimated numbers are presented as ranges, rounded to the nearest 500.

category	number	
total	11,000 – 12,500	
non-natives	10,000 – 11,500	
not in (semi-)natural habitats	8,500 – 10,000 [a)]	
in (semi-)natural habitats	1,340	
non-naturalised	985	
naturalised	358 [b)]	1,448 (wild flora)
natives	1,090 [b)]	

a) Number of vascular plants commonly cultivated in Dutch outdoor horticulture and agriculture, corrected for 50% of commercially available natives, naturalised non-natives and non-naturalised non-natives found in (semi-)natural habitats. The first figure was estimated by counting the number of species on one-third of the total list (Wortelboer 2000), extrapolating and calculating the 95% confidence interval for limited populations: 3 * mean ± f * 1.96 * standard error; f = correction factor for limited sampling and here taken to be 2 (rather than 3 for unlimited sampling).
b) These two categories, which together constitute the 'Standard list' of the Dutch vascular flora, include three species of which the nativeness could not be determined

5.3. Results

5.3.1. Characterisation

The total number of vascular plant species growing outdoors in the Netherlands is estimated to be between about ten thousand and twelve thousand five hundred. Of these, some 89–91% are non-native. About 12–13% of these non-natives are found in (semi-)natural habitats, with about 27% of these (358 species) naturalised. The Netherlands has 1,090 native vascular plant species, and naturalised non-natives therefore now make up around 25% of the country's wild flora (Table 1). It is on this quarter of the flora that this article focuses.

Of the 358 naturalised non-native vascular plant species found in the Netherlands, 131 became naturalised prior to 1500 AD (archeophytes) and 227 at a later date (neophytes). From the 16th century onwards the number of naturalised neophytes has grown progressively, with the greatest increases occurring in the 19th (85) and 20th (114) centuries (Table 2).

All the archeophytes found in the Netherlands have their origins in Europe, except for *Lolium remotum*, which is probably of Asian provenance. In contrast, the neophytes originate from several different continents: 63% from Europe, 25% from North America and 9% from Asia (Table 3). The difference in continental provenance between archeophytes and neophytes is significant (χ^2=81.9, d.f.=1, P<0.001).

Of the European archeophytes, 83% originate from western and central Europe and the other 17% from southern or south-east Europe. Of the European neophytes, 61% originate from western and central Europe, 33% from southern or south-east Europe and the remaining 7% from other regions of Europe (Table 3). The difference in regional provenance within Europe between archeophytes and neophytes is significant (χ^2=17.8. d.f.=1, P<0.001).

Table 2. Period of naturalisation of the non-native vascular plant species of the Netherlands.

period	no. of species		(% of all wild species)	
archeophytes				
before 1500	131		(8.8)	
neophytes				
16th and 17th century	14		(0.9)	
18th century	14		(0.9)	
19th century	85		(5.7)	
20th century	114		(7.7)	
1901–1950		70		(4.7)
1951–2000		44		(3.0)
subtotal, neophytes	227		(15.3)	
total non-natives, naturalised	358		(24.4)	

Table 3. Region of origin of the naturalised non-native vascular plant species of the Netherlands.

region of origin		archeophytes n	archeophytes %	neophytes n	neophytes %
Europe	total	130	99.2	142	62.8
	west	2	1.5	14	6.2
	central	13	9.9	39	17.3
	west/central	93	71.0	32	14.2
	north	0	0.0	5	2.2
	east	0	0.0	6	2.7
	south	20	15.3	36	15.9
	south-east	2	1.5	10	4.4
Africa		0	0.0	2	0.9
Asia		1	0.8	20	8.8
North America		0	0.0	56	24.8
South America		0	0.0	5	2.2
Australia		0	0.0	1	0.4
non-traceable		0	-	1	-
total		131	100.0	227	100.0

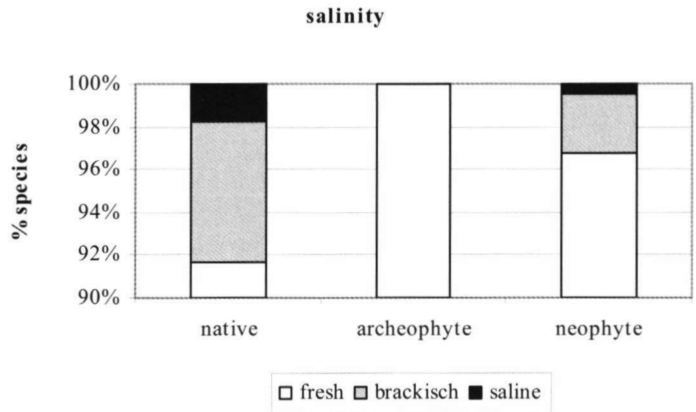
Given historic growth in transportation volume, intensity and distance, we expected an increase in the relative number of neophytes of distant provenance over time. However, the fraction of non-European neophytes is in fact lowest in the 20th century (data not shown). The differences in distance of provenance among the different periods distinguished for the neophytes were not significant (χ^2=12.9, d.f.=8, P=0.11).

We turn now to the ecology of the naturalised non-native species, reporting first on the distribution of archeophytes and neophytes over the various ecological groups and which are best represented. We then look in more detail at the ecological differences between native, archeophyte and neophyte species for each of the five ecological site factors cited earlier: salinity, structure, moisture availability, nutrient availability and acidity.

The archeophytes belong to 32 of the 84 ecological groups distinguished for the Dutch flora. In three of these groups they are especially well represented (>40% of species): (1) pioneer vegetations of moist, moderately nutrient-rich, alkaline soils, e.g. weeds of low-input arable fields; (2) pioneer vegetations of moist soils, and (3) pioneer vegetations of dry, nutrient-rich soils, e.g. weeds of common arable fields

The neophytes belong to 56 of the 84 ecological groups and are particularly well represented (>40% of species) in three: (1) pioneer vegetations of dry, nutrient-poor, alkaline soils regularly disturbed by wind and animals, e.g. pioneers of dry dunes; (2) pioneer vegetations of dry, moderately nutrient-rich soils, e.g. urban and agricultural soils; and (3) tall herbaceous vegetations of moist, nutrient-rich soils, e.g. common ruderal sites.

(A)



(B)

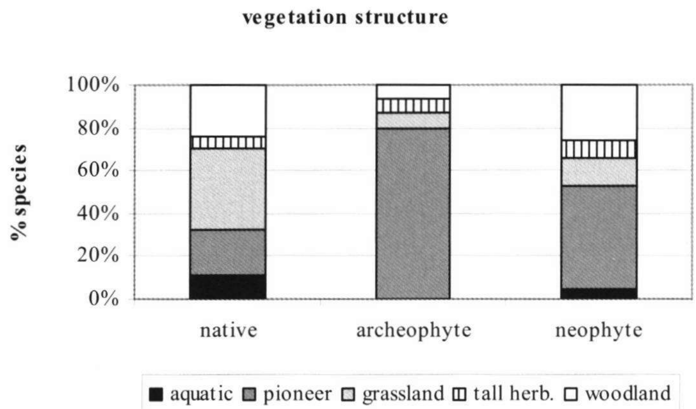


Fig. 1. Ecological characteristics of native, archeophyte and neophyte vascular plant species of the Netherlands in terms of salinity (this page A), vegetation structure (this page B), moisture availability (next page C), nutrient availability (next page D) and acidity (next page E).

With respect to the five ecological site factors cited (see Methods), a number of differences can be identified between archeophytes and neophytes on the one hand and native species on the other. In the first place, the archeophytes and neophytes have virtually no brackish or saline representatives, or at any rate a far lower percentage compared with native species, 8% of which are brackish and saline species (Fig. 1A).

The archeophytes and neophytes have much higher percentages of pioneer and tall herbaceous species and much lower percentages of grassland species than natives, which have about 20% pioneer and 40% grassland species. The archeophytes include no aquatic species and very few woodland species, while the neophytes have similar percentages to natives, about 10% of which are aquatic and 25% woodland species (Fig. 1B)..

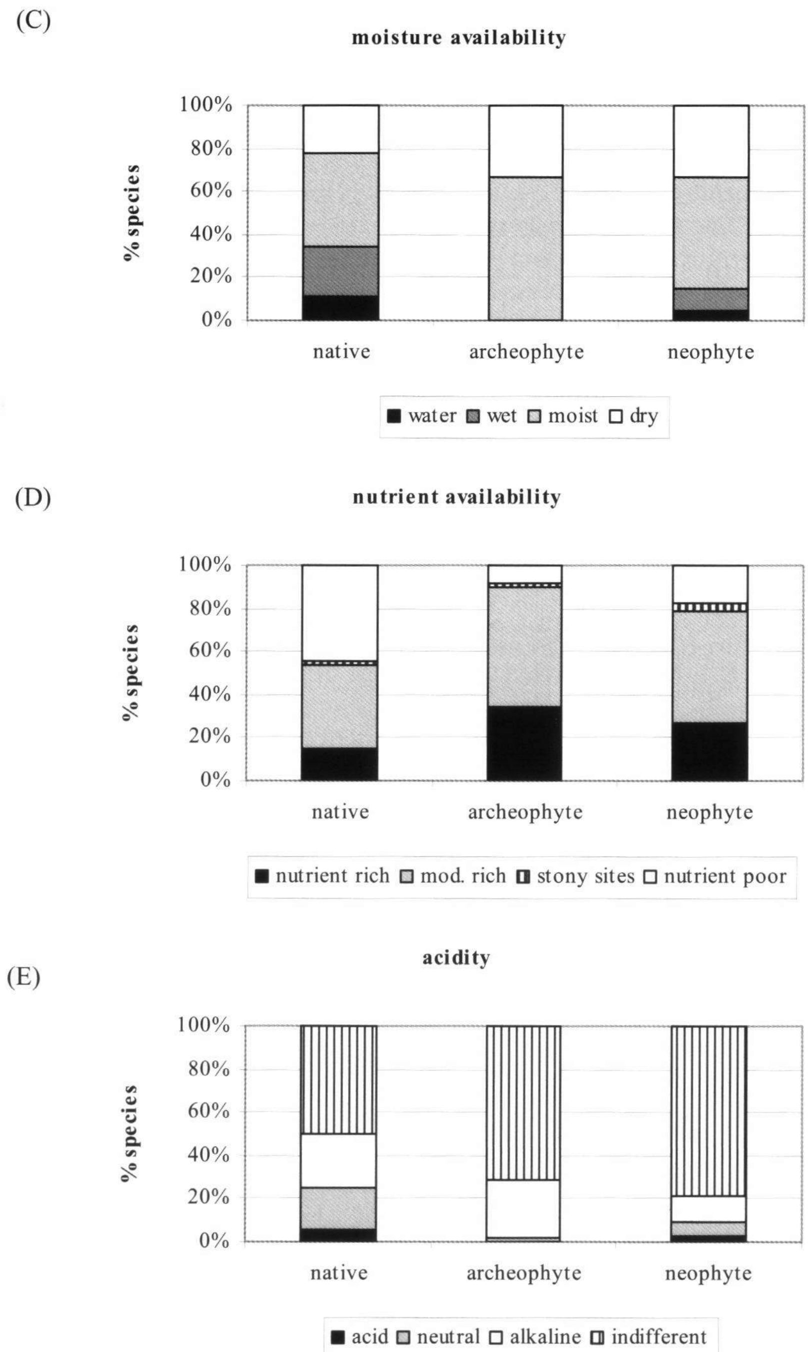


Fig. 1 Continued.

Table 4. Family affiliation of the naturalised non-native vascular plant species of the Netherlands; n.s.= not significant, * = 0.01<P<0.05, ** =0.001<P<0.01, *** = P<0.001, - = not relevant or numbers too small.

family	natives	archeo-phytes	neo-phytes	total	sign.	high % of
18 large families (> 19 species per family), representing 69% of all native and naturalised species in the Netherlands; both significant and non-significant results.						
Asteraceae	97	16	28	141	n.s.	-
Poaceae	98	11	21	130	n.s.	-
Cyperaceae	82	0	3	85	***	natives
Brassicaceae	37	14	21	72	***	archeo- and neophytes
Fabaceae	49	3	13	65	n.s.	-
Caryophyllaceae	50	7	3	60	*	archeophytes
Rosaceae	45	2	11	58	n.s.	-
Scrophulariaceae	40	9	8	57	n.s.	-
Lamiaceae	42	7	5	54	n.s.	-
Apiaceae	39	4	8	51	n.s.	-
Ranunculaceae	34	4	3	41	n.s.	-
Orchidaceae	38	0	0	38	***	natives
Liliaceae	23	2	12	37	*	neophytes
Chenopodiaceae	16	8	6	30	**	archeo- and neophytes
Juncaceae	25	0	3	28	*	natives
Polygonaceae	22	1	5	28	n.s.	-
Potamogetonaceae	23	0	0	23	**	natives
Boraginaceae	11	6	3	20	*	archeophytes
37 intermediate families (5-19 species per family), representing 21% of all native and naturalised species in the Netherlands; significant results only.						
Euphorbiaceae	8	5	0	13	**	archeophytes
Equisetaceae	11	0	0	11	*	natives
Solanaceae	2	2	5	9	**	neophytes
Malvaceae	2	3	1	6	*	archeophytes
Amaranthaceae	0	1	4	5	**	neophytes
Papaveraceae	2	3	0	5	*	archeophytes
70 small families (<5 species per family) combined, representing 10% of all native and naturalised species in the Netherlands.						
60 families	113	3	19	135	-	-
10 non-native fam.	0	5	8	13	-	-
All 125 families	1128	131	227	1486	-	-

The archeophytes and neophytes include more species of dry sites than natives, of which about 20% are 'dry' species. The archeophytes include virtually no aquatic or 'wet' species, in contrast to the neophytes, for which the share is about 15% (Fig. 1C).

The archeophytes and neophytes both have far higher percentages of species of (moderately) nutrient-rich sites than the natives: 80–90% versus 55%. The archeophytes have more species of (moderately) nutrient-rich than the neophytes and fewer species of stony sites (Fig. 1D).

The archeophytes and neophytes have a higher percentage of species indifferent to acidity than the natives, for which the figure is about 50%. The archeophytes have a higher percentage of species of alkaline sites and fewer species of neutral and acid sites compared with the neophytes (Fig. 1E).

The differences in ecological preference between natives, archeophytes and neophytes were tested for each site factor and proved to be significant ($P<0.05$) in all cases.

In summary, archeophytes belong to a narrower spectrum of ecological groups than neophytes. Ecologically, there are greater differences between archeophytes and native species than between neophytes and natives. In comparison with native species, archeophytes and neophytes can both be ecologically characterised as predominantly pioneers (and ruderals) of (moderately) nutrient-rich, moist and dry soils.

The Dutch wild flora comprises 125 families: 56 with only native species, 58 with natives and non-natives and 11 with only non-natives. In terms of family affiliation the archeophytes and neophytes differ from the native flora as well as from one another (Table 4). Archeophytes are better represented in the following families: Papaveraceae (60%), Malvaceae (50%), Euphorbiaceae (39%), Boraginaceae (30%), Chenopodiaceae (27%) and Brassicaceae (19%) and neophytes in the Amaranthaceae (80%), Solanaceae (56%), Liliaceae (32%), Brassicaceae (29%) and Chenopodiaceae (20%). In contrast, the native flora accounts for a high percentage of the Orchidaceae, Potamogetonaceae and Equisetaceae (all 100%), Cyperaceae (96%) and Juncaceae (89%)

5.3.2. Commonness and rate of change

In terms of commonness and rarity, archeophytes (Fig. 2, dashed line) have a very similar profile to native species (solid line), with neophytes (dotted lines) substantially less common. The frequency distributions for archeophytes and natives are broadly similar, with a maximum at KFK 7–8 and a long left 'tail' down to zero, although natives have a higher percentage of very common species (KFK 9). Within the neophytes, those naturalised in the periods 1500–1900 and 1900–1950 have a very similar frequency distribution, with a maximum at KFK 5–6 and a long left tail. These are far more common than neophytes naturalised in the period 1950–2000, which have a log-normal distribution with a maximum at KFK 3–4. The differences in commonness between natives, archeophytes and the different classes of neophytes are significant ($F=9.9$, d.f.=4, $P<0.001$). If we sum up the occurrences for all native, archeophyte and neophyte species, the contribution of these groups to the Dutch flora is respectively 86.3%, 7.6% and 6.1% (1500–1900: 3.9%, 1900–1950: 2.0% and 1950–2000: 0.1%). In summary, the longer ago naturalisation took place, the commoner the non-native species tend to become. The rate of change in species occurrence is very similar for archeophytes and native species but substantially

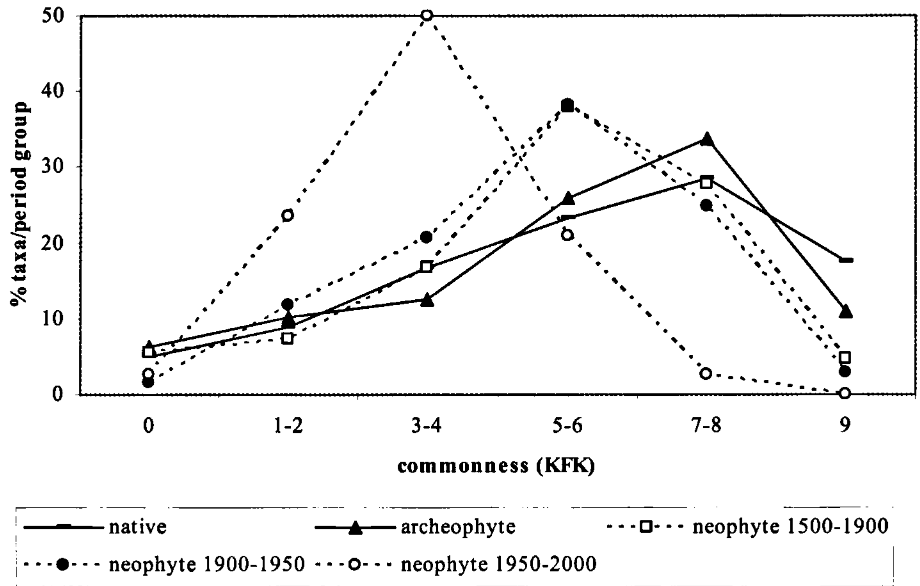


Fig. 2. Mean commonness (KFK) of native, archeophyte and neophyte vascular plant species of the Netherlands at the end of the 20th century. KFK classes: 0 = absent; 1–2 = 1–10 km squares, 3–4 = 10–100 km sq., 5–6 = 100–1000 km sq., 7–8 = 1000–10,000 km sq. and 9 >10,000 km sq.

higher for neophytes (Fig. 3)..Archeophytes and natives show a very similar increase (positive change), from zero to threefold, for the more common species (KFK>3–4). However, for the less common species (KFK 3–4 and less) archeophytes and natives show a decrease (negative change), which is stronger for the archeophytes. Almost all the neophytes show an increase, which is greater the more recent the naturalisation and the more common the species, with the exception of the rarest class of neophytes naturalised between 1500 and 1900, which show a small decrease. The differences between the rates of change of natives, archeophytes and the various classes of neophytes are significant (F= 116.9, d.f.=4, P<0.001). In summary, archeophytes show a similar pattern of change in occurrence to native species, with small increases in common species and a decline in rare species that is more pronounced for the archeophytes. Almost all the neophytes show an increase, which is greater the more recent the naturalisation and the more common the species.

5.3.3. Hypotheses for the success for non-native species

A variety of hypotheses have been proposed to explain the success, or otherwise, of non-native species and several of these were tested using the results of this study. The first hypothesis centres on the role of the native antagonist complex, as outlined in the Methods section. We started out from two contrasting expectations, of greater

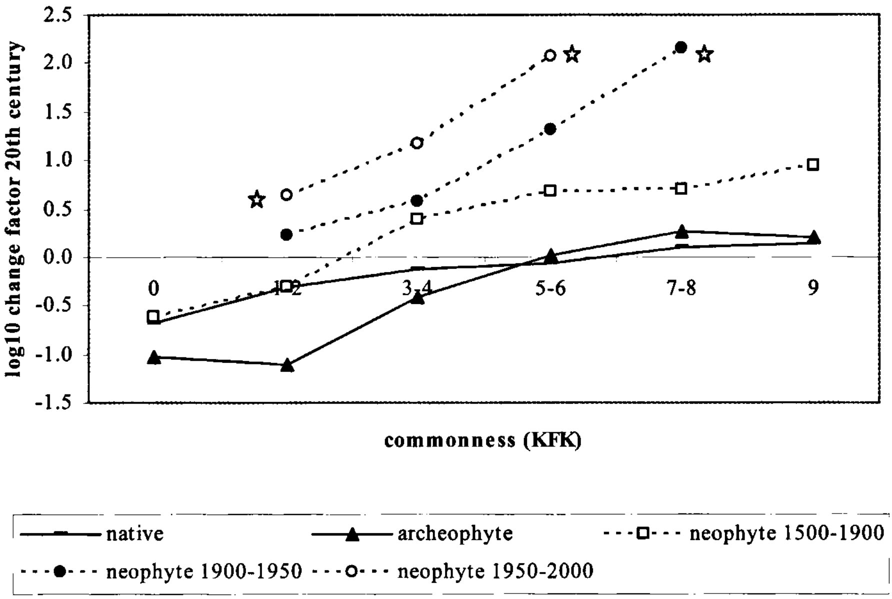


Fig. 3. Mean rate of change in abundance of native, archeophyte and neophyte plant species of the Netherlands during the 20th century, expressed as the ^{10}log of the ratio between commonness in the periods 1988–2000 and 1900–1950. Little stars: for several combinations of commonness and naturalisation date, data were sparse and were therefore aggregated: neophytes (1900–1950) with KFK 0 and 9 were combined, respectively, with species with KFK 1–2 and 7–8 and neophytes (1950–2000) with KFK 7–8 with species with KFK 5–6. For explanation KFK-classes, see Fig. 2.

commonness and a greater increase in occurrence of (1) non-native species of relatively nearby origin and (2) species of more distant provenance. In the first case, the non-natives from nearby are deemed to be better adapted to the antagonist complex and thus at an advantage over the non-natives from further afield. In the second case, species from further away are held to be freed of their original antagonist complex and thus have an edge over species of nearby provenance. Neophytes from other continents indeed appear to have a higher mean commonness than those from Europe. Within Europe, the neophytes from the more 'remote' southern and eastern region have a higher mean commonness than those from the nearby western and central region (Fig. 4). These differences in commonness between neophytes of different provenance are significant (F=7.3, d.f.=4, P<0.001). Neophytes from other continents also exhibit a higher mean rate of change than those from Europe. Within Europe, neophytes have fairly similar rates of change across the various regions (Fig. 5). These differences in the rates of change among neophytes of different provenance are again significant (F=4.1, d.f.=4, P=0.001). In summary, it can be concluded that commonness and rate of increase of abundance are higher for species from other continents or from more distant European regions, which supports the 'escape from native antagonist complex' hypothesis.

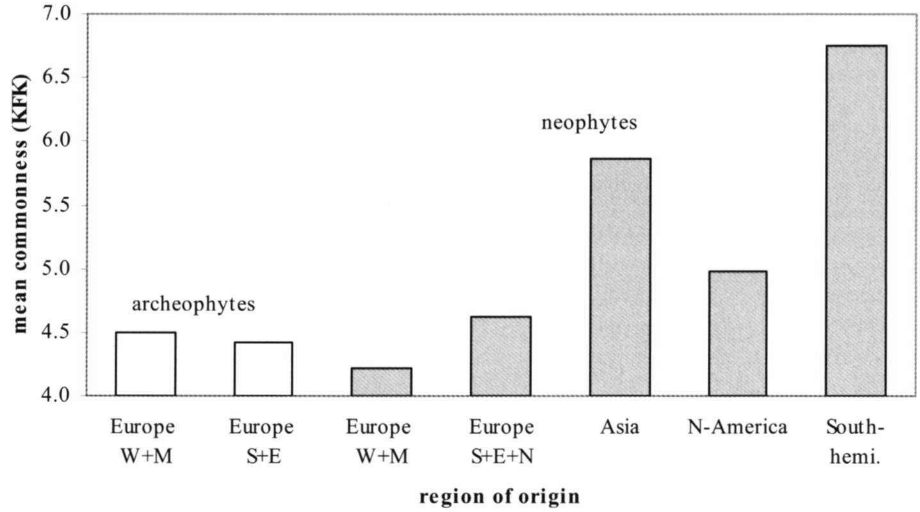


Fig. 4. Mean commonness (KFK) of archeophyte (open bar) and neophyte (filled bar) vascular plant species of the Netherlands by region of origin. W = western, M = central, S or South = southern, E = eastern, N = northern, hemi. = hemisphere.

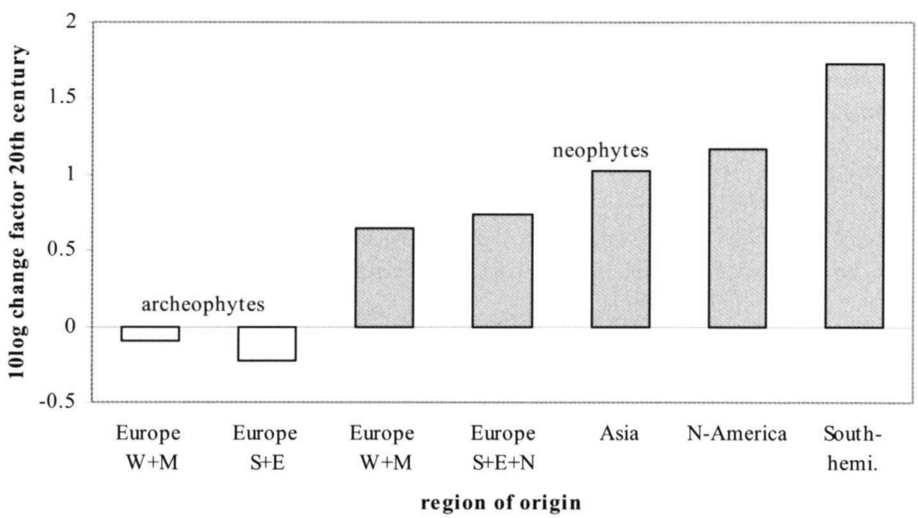


Fig. 5. Mean rate of change in abundance of archeophyte (open bar) and neophyte (filled bar) vascular plant species of the Netherlands by region of origin. See also Fig. 4.

Table 5. Mean commonness of the native and naturalised non-native plant species of the Netherlands as a function of habitat disturbance. Nutrient-rich (and to a lesser extent moderately nutrient-rich) conditions and pioneer and tall herbaceous (ruderal) vegetations have been taken as representing frequently disturbed habitats (due mainly to human activity), while pioneer vegetations of moist, nutrient-rich soils (mainly intensively farmed arable fields) have been separately distinguished as arable fields.

	native KFK	archeophyte KFK	neophyte KFK	archeo/neophyte KFK
- vegetation structure				
pioneer	5.6	5.6	5.0	5.3
arable fields	8.0	6.8	6.1	6.5
tall herbaceous	7.0	6.1	4.9	5.3
other	5.7	6.4	5.0	5.3
- nutrient availability				
nutrient-rich	7.5	6.9	5.5	6.1
moderately nutrient-rich	6.2	5.2	5.0	5.0
nutrient-poor	4.9	4.6	4.3	4.4

The second hypothesis is that non-native species occur predominantly in man-made habitats that are frequently disturbed. This should then be reflected in high percentages of non-native species in ecological groups with pioneer or tall herbaceous vegetation structure, especially on (moderately) nutrient-rich soils. Ecological characterisation has already shown that in comparison with native species, archeophytes and neophytes have significantly higher percentages of pioneer and tall herbaceous species (Fig. 1B) and species characteristic of nutrient-rich sites (Fig. 1D). These categories are not only better represented within the archeophytes and neophytes, but also have higher abundances than the other, more natural categories within the archeophytes and neophytes (Table 5). In summary, it can be concluded that the lion's share of non-native species occur in frequently disturbed man-made habitats.

The third hypothesis posits the 'invasibility' of ecosystems as a determining factor, i.e. ecosystems comprising a large number of native species are deemed less sensitive to invasion by neophytes. This would mean that the greater the number of native species in a particular ecological group, the fewer non-natives it should comprise. We found no evidence of this, but instead a small, non-significant ($F=0.35$, d.f.=1, $P=0.55$) increase in the percentage of non-natives as the number of native species rose (Fig. 6). It was surmised, however, that a correlation might still be revealed if the ecology of the respective groups were taken into account. In Fig. 6 three clusters of data points can be distinguished: (1) 6 ecological groups with about 60% or more non-native species, predominantly pioneer and tall herbaceous vegetations of nutrient-rich sites; (2) a line of points with no non-native species, most of them ecological groups of nutrient-poor, brackish or saline sites; and (3) a group intermediate between the two. A multiple regression was conducted with the

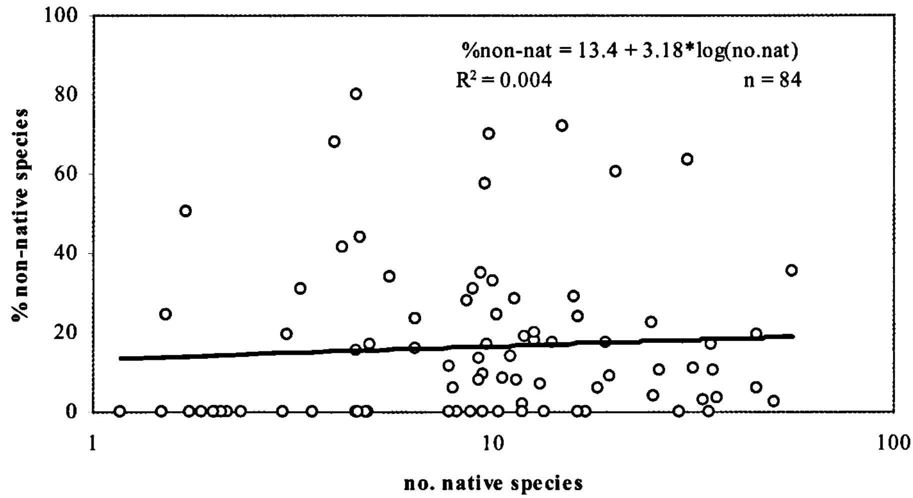


Fig. 6. Percentage of non-native species versus number of native species per ecological group of vascular plants in the Netherlands (log scale).

percentage of non-native species as the dependent variable and the ecological site factors and number of native species as independent variables. We did now find a small decrease in the percentage of non-native species with increasing number of native species, but this was even less significant (F=0.05, d.f.=1, P=0.826) than in first analysis. In summary, the invasibility hypothesis is not supported by our data.

5.3.4. Fate and impact of non-native vascular plant species

The fate of non-native species was characterised as the percentage of non-native species on the Dutch 'Red List' and, more specifically, by the percentage now extinct. We expected lower percentages of non-natives than natives in the categories threatened and/or extinct. The percentages of archeophytes and native species on the Red List are approximately the same (40%; see Fig. 7), with the difference not statistically significant (χ^2=3.30, d.f.=2, P=0.19). The percentage of neophytes on the Red List is markedly lower (5–15%), particularly for species of threatened status. The differences between neophytes and natives was significant (χ^2= 101, d.f.=2, P<0.001).

The Dutch 'Standard List' reports a total of 48 vascular plant species extinct, 8 of them archeophytes (6.1% of all archeophyte species), 5 neophytes (2.2% of all neophyte species) and 35 natives (3.1% of all native species). Compared with native species, then, there are twice as many archeophytes extinct and slightly fewer neophytes. The combined extinction rate for the non-native species, 3.6%, is roughly the same as for the natives. The differences in the extinction rates of archeophytes, neophytes and natives are not statistically significant (χ^2=3.69, d.f.=2, P=0.16).

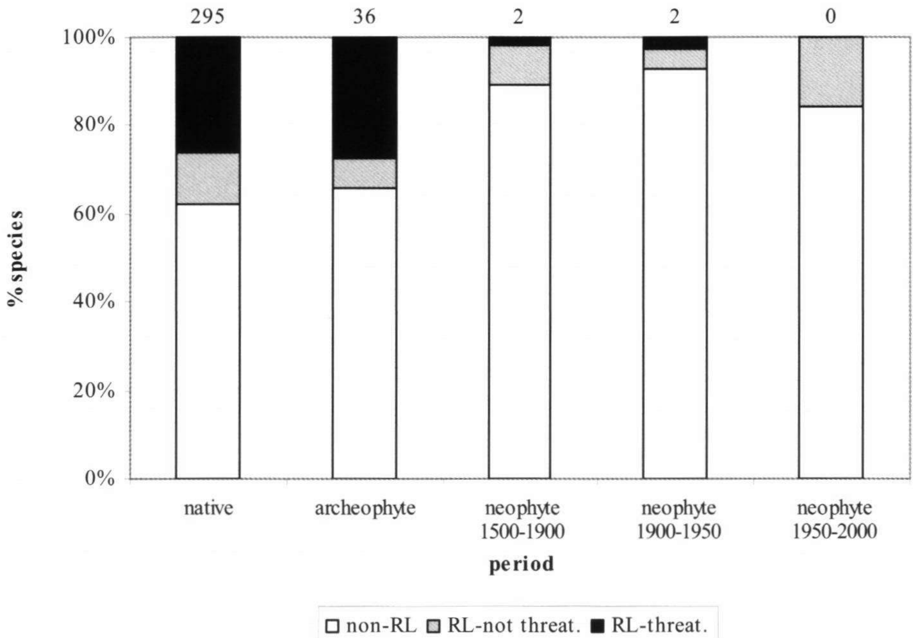


Fig. 7. Percentages of native, archeophyte and neophyte vascular plant species of the Netherlands designated as threatened and not threatened on the Red List (RL) and non-RL species; above each bar, absolute number of RL-species threatened.

Summarising, it can be concluded that similar percentages of natives and archeophytes are on the Dutch Red List of threatened species, but a far lower percentage of neophytes. No significant differences could be detected between the percentage extinctions of native, archeophyte and neophyte species.

We had expected that the more non-native species an ecosystem comprised, the greater the percentage of Red List species and/or extinctions would be. However, we found a small but significant (F=9.13, d.f.=1, P=0.003) decrease in the percentage of Red List species per ecological group as the number of non-native species rose (Fig. 8). Again, though, we surmised that the anticipated relationship might still be uncovered if the ecologies of the different groups were taken into account. A multiple regression analysis was again performed, with the percentage of Red List species as the dependent variable and the ecological site factors and number of non-native species as independent variables. Again, we found a small, but this time non-significant (F=1.05, d.f.=1, P=0.31) decrease in the percentage of Red List species per ecological group as the number of non-native species rose.

A small, but non-significant (F=2.28, d.f.=1, P=0.13) increase was found in the percentage of species extinct per ecological group with rising number of non-native species (Fig. 9). In this case, too, the ecology of the different groups was brought into the equation using multiple regression analysis. We then found an even smaller and less significant (F=1.91, d.f.=1, P=0.19) increase in extinction percentage per ecological group as the number of non-native species rose. In summary, it can be concluded that no significant relationship seems to exist between the number of non-native species per ecological group and the percentage of Red List or extinct species in that group.

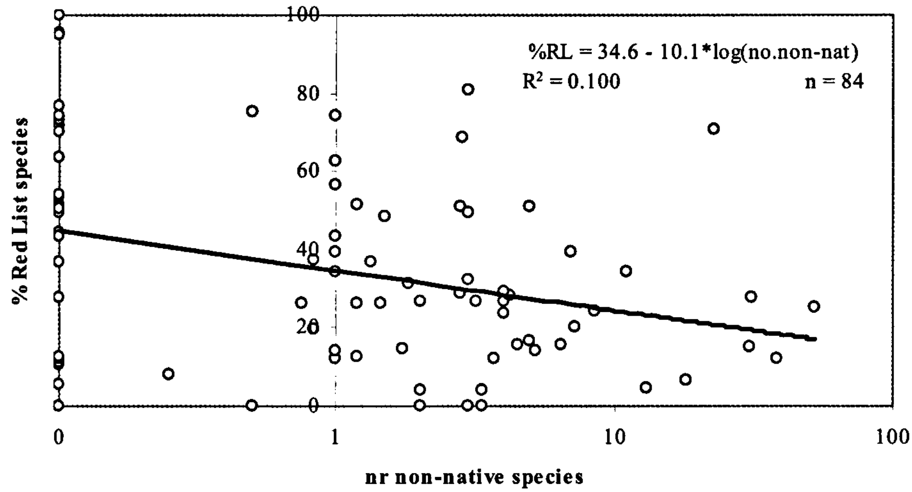


Fig. 8. Percentage of Red List species versus number of non-native species per ecological group of vascular plants in the Netherlands (log scale).

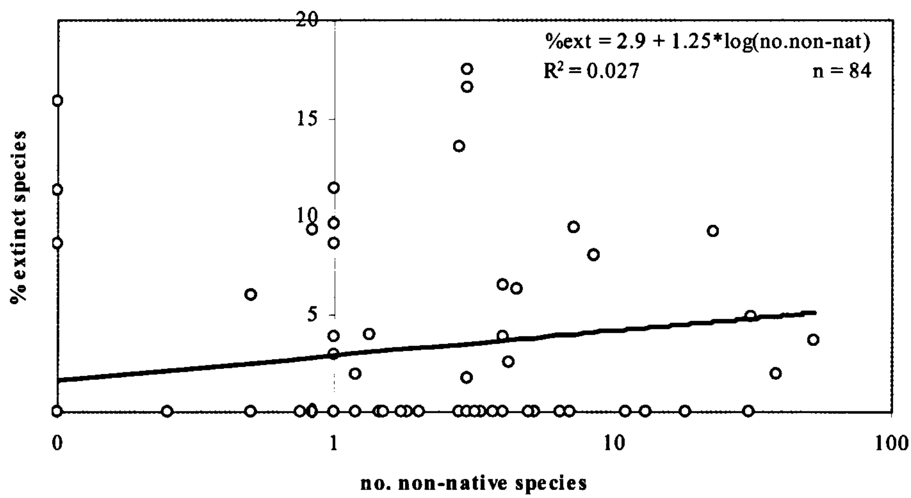


Fig.9. Percentage of extinct species versus number of non-native species per ecological group of vascular plants in the Netherlands (log scale).

5.4. Discussion

A substantial fraction of all the vascular plant species found in the wild in the Netherlands – 25% – is non-native to the country (9 p.p. archeophytes, 16 p.p. neophytes). Being part of the Old World, where man and plants have co-evolved for longer, the Netherlands might be expected to have a lower percentage of non-native species than the New World. This might have resulted in more competitive native plant species which are better adapted to frequent (anthropogenic) disturbance (e.g. Di Castri 1989). Despite all the methodological differences among the respective studies, the percentage of naturalised non-native species appears to be fairly uniform across Europe: around 25% in Flanders (North-Belgium) (Biesbrouck *et al.* 2001; Verloove 2002) and 11% in Switzerland (Weber 1999) and the Czech Republic (Pysek *et al.* 2002), for example. In the United Kingdom figures of 12% and 44% for naturalised non-natives are reported for exactly the same flora, reflecting the use of different criteria (Williamson 1996 and Crawley *et al.* 1996, respectively). On other continents, percentages of non-natives are reported which, in contrast to the higher percentages anticipated, are in roughly the same range as for Europe: 22% in the USA (Kurdila 1988), and about 10% in Australia, 36% in South Africa, 40% in India and 21% in Brazil (Pimentel 2001). Given all the methodological differences, however, the various published percentages are difficult to interpret.

According to the 'tens' rule of thumb posited by Williamson (1996), 10% of non-native species escape to (semi-)natural habitats, 10% of these become naturalised and 10% of the latter become a pest. In the case of the Netherlands this does not appear to hold. According to the present study 12% of all non-native species have escaped to (semi-)natural habitats, with 27% of these appearing to have become naturalised. However, this latter figure may in fact be an overestimate because of our rather conservative estimate of the number of non-native species in (semi-)natural habitats (see below). As the Netherlands has no official 'black list' of pest species we endeavoured to draw one up, based solely on subjective criteria, sparse literature and unsupported by systematic scientific studies. Weeda (1987) mentions only *Aronia x prunifolia* and *Spartina anglica* as "invaders spreading aggressively, independent of human interference". In Cronk and Fuller (2001) fifteen invasive species are cited, that also occur in the Netherlands, with four of them specifically mentioned in relation to this country (*Aronia x prunifolia*, *Prunus serotina*, *Robinia pseudoacacia* and *Spartina anglica*). Pot (2002) mentions *Hydrocotyle ranunculoides* as a recent example of an invasive aquatic species in the Netherlands, and Turlings (2001) and Pot (2002) cite *Ludwigia grandiflora* as another potentially invasive aquatic species. All in all, then, we identified six vascular plant species as being problematical in the Netherlands, which is 1.5% of all naturalised non-native species, far fewer than predicted by the 'tens' rule.

Over 15 years ago Weeda (1987) estimated the total number of non-native species in the Netherlands at about six thousand, but by the time our study had been completed this figure had risen to some ten thousand. This latter estimate is closer to the numbers cited for the UK: between about thirteen and seventeen thousand (botanical gardens excluded; respectively Williamson 1996, Crawley *et al.* 1996) and is almost the same as the total number of wild native European species (12,500: Sukopp 1976, 1980). However, even this most recent estimate of the total number of non-native vascular species in the Netherlands is rather conservative. In particular, the numbers of non-naturalised non-natives found in (semi-)natural habitats and in other habitats are both underestimates, for two reasons: we did not exhaustively pursue all reports of non-naturalised non-natives in the wild, and we based ourselves only on very recent trade lists of agricultural and horticultural species.

From 1500 onwards there has been a clear, progressive rise in the number of neophytes introduced to the Netherlands, probably coincident with growing volume, distance and speed of transportation. Our results show, however, that the number of neophytes introduced in the 20th century – *the* century of globalisation and transport expansion – is only slightly higher than for the 19th century and that there has furthermore been no rise, historically, in the percentage of taxa of more distant provenance. Pysek *et al.* (2003) also found a progressive increase over time (based on year of introduction) in the number of all non-native species occurring in the wild in the Czech Republic: a slow increase up to 1840 and a rapid and almost linear increase thereafter. They also found a significant positive correlation between continent of origin and year of introduction, although the relative shares of the continents through time remained much the same.

When it comes to the ecology and family affiliation of the non-native plant taxa of the Netherlands, it is weeds and ornamentals of arable and urban habitats that make up the lion's share. The Asteraceae, Poaceae and Fabaceae are frequently cited worldwide as being the families supplying the most non-native species (Heywood 1989, Weber 1999, Pysek *et al.* 2002). While this is also true for the Netherlands in terms of absolute numbers, the percentages of non-natives from these particular families is no different from the average across families, so in this country these families cannot be said to be typically 'non-native'.

Despite biogeographical differences across European countries as well as methodological differences across studies, a similar situation is reported Europe-wide with respect to the plant families that are over- or under-represented in terms of non-natives. Thus, the Chenopodiaceae, Caryophylaceae, Solanaceae, Amaranthaceae and Brassicacea are also frequently cited as families with high percentages of non-natives and the Cyperaceae, Orchidaceae, Potamogetonaceae and Juncaceae as families with high percentages of natives (Crawley *et al.* 1996, Weber 1999, Pysek *et al.* 2002).

This study has provided clear evidence, for the Netherlands, that the longer ago non-native plant species became naturalised, the higher their mean score today on a scale of commonness. Archeophytes naturalised prior to 1500 as well as the older neophytes even have a broadly similar distribution profile with respect to species commonness and rarity as the native species. In all three cases the profile resembles a log-normal curve with a long 'tail' of rare species. In his 'neutral theory' Hubble (2002) describes this as a zero-sum multinomial distribution, the stochastic result of demographic processes of birth, death and dispersal within a given functional group. A possible interpretation of our results is that the commonness of non-native plant species, almost all of which belong to the group of nutrient-rich pioneer or ruderal vegetations, is determined more by chance processes and less by biological and ecological factors than is generally acknowledged.

In this study we analysed the rates of change in the abundance of native and naturalised non-native vascular plant species as a function of date of naturalisation and commonness. The most striking result was the marked increase in the presence of recently arrived neophytes, an increase that gradually declined as the neophytes dated back further. The increase was greater for the more common neophytes. The oldest non-native species, the archeophytes, showed approximately the same pattern of 'rise and fall' as the native species, with common species becoming more common and rare species becoming rarer. A similar difference in the pattern for neophytes and archeophytes has been reported for the British Isles (Preston *et al.* 2002). Pysek *et al.* (2002) have proposed using the term "post-invasive" for non-native species that eventually decline following an initial increase; for the Czech flora they classified 64% of archeophytes and 2% of neophytes thus. The marked decline in the Netherlands of a number of archeophytes, many of them weeds of low-input arable fields, is also reflected in other European countries (Svensson and Wigren 1986, Andreasen *et al.* 1996, Pysek *et al.* 2002). Naturally, the different chronological groups (i.e. archeophytes, various classes of neophytes) differ in species composition and ecological characteristics, so future developments will not be necessarily the same. However, this rise and fall pattern can also be observed with individual species such as Canadian pondweed (*Elodea canadensis*), which in the Netherlands escaped in the 19th century, became a very common species causing major problems for water managers (hence its Dutch common name 'waterpest') before going into decline and eventually ending up on the Red List (Van der Meijden *et al.* 1989, Van der Meijden *et al.* 2000). For this particular species a similar pattern has also been observed in Britain and New Zealand (Cronk and Fuller 2001).

With our results we tested several hypotheses for the success of non-native species. The first hypothesis identifies the 'native antagonist complex' as playing a key role in this respect. As a proxy for taxonomical relatedness of non-native to native species, in this study we used distance of geographic provenance; however, a better parameter is still required. Nonetheless, our results support the 'escape form predator-pathogen hypothesis', as have a series of recent experiments with *Prunus serotina* (Reinhart *et al.* 2003).

The second hypothesis explains the success of non-natives as being a consequence of a massive expansion of dynamic, nutrient-rich man-made habitats. We indeed found much higher percentages of pioneers and tall herbaceous (ruderal) plant species on (moderately) nutrient-rich sites, deemed equivalent to the cited anthropogenic habitats. There are relatively few non-native taxa (about 10% of archeophytes and 20% of neophytes) found in more natural ecosystems, and even then it has been suggested that successful species like *Prunus serotina* only thrive because the ecosystems in question are disturbed (Van den Tweel and Eijsackers 1987). Despite our use of different methods and a different ecosystem classification, our results are very similar to those found in earlier studies for other European countries (e.g. Weeda 1987, Crawley *et al.* 1996, Weber 1999, Verloove 2002,

Pysek *et al.* 2002). Our results are also in broad agreement with those of Thompson, Hodgson and Rich (1995), who concluded for the Netherlands, England, Scotland and Ireland that "invasive" (defined by them as "increasing") "alien" plant species have almost the same ecological properties, in particular a preference for nutrient-rich sites, as those referred to as "invasive native" species.
The third hypothesis explored predicts higher percentages of non-native species in plant communities comprising few species, i.e. greater 'invasibility' of such communities. In this study we found no evidence of invasibility declining as the number of natives rose, in contrast to several experimental studies on a smaller spatial scale (Lavorel *et al.* 1999; Kennedy *et al.* 2002; Van Ruijven *et al.* 2003), where some such effects have been found

We had expected non-native species to have fewer Red List and extinct taxa than native species. The percentage of neophyte species on the Red List is indeed low, although there are several listed. When it came to the archeophytes, however, we found no significant difference in the percentage of Red List species compared with natives. In terms of the percentage of species extinct, there is no significant difference between the native, archeophyte and neophyte flora.

As reported in the Introduction, the IUCN has cited introduction of 'alien' species as being the second largest cause of current worldwide loss of biodiversity and we therefore expected the percentage of Red List or extinct species in a particular plant community to increase in step with the number of non-natives it comprised. In the Netherlands, however, no such effects were observed (i.e. the differences were not statistically significant), confirming earlier Dutch studies as well as Red Lists (Weeda 1987; Joenje 1987; Weeda *et al.* 1990; Van der Meijden *et al.* 2000).

According to this study, the longer non-native species have been naturalised, the more they come to resemble native species with respect to commonness, rate of change of occurrence and fate. Rather than being a threat to biodiversity, in the Netherlands the introduction of new plant species and their successful naturalisation seem to be increasing biodiversity.

5.5. Acknowledgements

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6. General discussion, conclusions and recommendations

6.1. Introduction

Nowhere in the world has such a wealth of distribution data been amassed on a country's wild flora over such a long period as in the Netherlands. In the course of the 20^{th} century a grand total of some 10 million distribution data were collected on the country's approx. 1450 wild vascular plant species and filed in two large databases: FLORIVON in the period 1902–1950 on a 'quarter cell' grid (1.250 x 1.042 km) and FLORBASE in the period 1975–2000 on a km cell grid (1 x 1 km). In this dissertation these distribution data have been corrected for recording bias, to enable more accurate comparison. The corrected data were then used to describe and quantitatively analyse the floristic changes that have occurred in the course of the 20^{th} century, thereby using the functional characteristics of species and species groups as a proxy for relevant causative factors. This final chapter begins with a general discussion first of methodological issues (section 6.2), then of the results (sections 6.3 up to and including 6.5). It concludes with some overall conclusions (section 6.6) and recommendations (section 6.7).

6.2. Methodological aspects

6.2.1. Towards a new data correction strategy

The first main methodological issue concerns the corrections made for recording bias, discussed at length in chapter 2. The aim of the principal body of corrections was to render the data for the various periods of the 20^{th} century comparable by standardising spatial formats and geographical coverage.

Reviewing all the many possible corrections, though, it becomes apparent that there is a major need for a more coherent new design for future floristic surveys. One important motive is the lack of any independent yardstick against which to calibrate the corrected data. Another key reason is that, however valuable the support of many hundred amateur Dutch volunteer botanists, efforts still fall short of what is required to survey the whole of the Netherlands within a reasonable period of time. This is all the more pressing, because regular and detailed information is required on the status of the country's flora for the purposes of national environmental and conservation policy, among other things for the Red List, which policy-makers would like to see updated every ten years (e.g. LNV 2004).

One possible alternative strategy for building up a geographically comprehensive picture of the national flora is to gather and present the data on a coarser grid scale[1], as was indeed formerly the case. The major drawback of this option is that changes in abundance are harder to establish on a coarser scale, species taking longer to vanish altogether from a wider geographical area. A second alternative strategy,

[1] The coarser the grid scale, the lower the resolution of the data, and vice versa.

described by Thomas and Abery (1995), is to survey rarer species on a finer, i.e. more detailed grid scale and common species on a coarser scale. This approach is similar to that adopted for the latest Atlas of Dutch Breeding Birds (SOVON Vogelonderzoek 2002), where all rare species were recorded on a 1 km^2 grid (or even finer), with common species being sampled in 'atlas cells' measuring 5 x 5 km according to a standardised procedure in terms of number of visits and time expended per visit. Given current Dutch botanising capacity, a similar strategy might also be used for flowering (vascular) plants to obtain a good idea of the abundance and changes therein of all rare species (i.e. approx. 40% of the Dutch flora present in fewer than 300 kilometre grid cells, equivalent to about 1% of the national territory). By using suitable extrapolation methods (e.g. Pebesma 2000, Tamis *et al.* 2000, Pebesma and Bio 2002) a good impression could thus also be obtained of the commoner species without every grid cell having to be physically surveyed.

A key issue with regard to the proposed survey strategy for the vascular flora is how data collection is to be standardised, particularly with respect to frequency and duration of individual survey visits and the expertise of surveyors. According to Rich (1978, 1998), volunteer expertise is the greatest single source of variance in field observations, but he also demonstrated that using a standardised protocol can yield very satisfactory results. One of the crucial elements of any standardised procedure is survey duration. Peter and Slade (2002) have compared the reliability of various surveying methods for assessing diversity within a given grid cell. They concluded that using 'stop rules' works better than curtailing surveys after a fixed length of time (*cf.* Bremer 1997). With a stop rule, a cell survey is discontinued when the rate of *increase* in information falls below a certain minimum level. One possible way to elaborate a stop rule for inventorying the Dutch flora is with reference to expected species count per km cell.

By adopting a new data collection strategy – detailed surveys of all rare species but representative sampling and extrapolation for the commoner ones, under a standardised protocol in which survey duration is dictated by a stop rule – is will be possible with current efforts to obtain a geographically comprehensive and regularly updated picture of the Netherlands' flora.

6.2.2. Use of functional characteristics

A second key methodological issue is the use of functional characteristics. At a recent workshop organised by the Netherlands Organisation for Scientific Research NWO (NWO 2004) on future needs for Dutch biodiversity research, 'eco-informatics', and in particular collation of plant and animal distribution data with datasets of their ecological and biological (i.e. functional) characteristics, was identified as one of the key priority areas. Functional characteristics are plant species traits that provide information on the type and quality of habitat in which they grow (e.g. Tüxen 1954, Ellenberg *et al.* 1996, Smith *et al.* 1997) and are also referred to as 'indicator values'. When data on site factors are incomplete or lacking altogether, functional characteristics provide a means of filling in the gaps.

Such is the case with nutrient availability, for example, a complex notion referring to the availability to plants of a variety of nutrients (N, P, K, micronutrients), often in many different forms (organic, inorganic, etc.). In the field, the availability of all these nutrients is governed by a vast array of factors (including soil type, water table, management regime and temperature) and varies with the season (*cf.* manuals by De Molenaar 1980, Eijsackers *et al.* 1985, Rijtema and De Haan 1987). Availability is also determined in part by the weather, soil NO_3^- content decreasing by a factor 100 after a rain shower, for example (Meyer 1957). Given all these dependencies, nutrient availability is very difficult to characterise and measure directly. A second example arises from the incompleteness of current data sets for other site factors that in themselves are straightforward to characterise and measure. Thus salinity, though easy to measure (as mg Cl^-/litre), has been monitored at only a limited number of sites, and when data are available, they are often from a previous era and not in electronic format. In each of these cases, now, the functional characteristics or indicator values of the plant species or species groups growing at the sites concerned (e.g. Ellenberg *et al.* 1992, Runhaar *et al.* 1987 or the appendix to the present study) can be used to make a reasonable estimate of nutrient availability or salinity.

While functional characteristics have major benefits, they also have their limitations. The first of these is the fact that description and explanation of site factor changes are confounded. A second drawback is that for many of the rarer plant species growing no indicator values are currently available. On the other hand, a considerable amount of research has already been devoted to validating indicator value-based predictions against independently measured site factors (e.g. Ellenberg *et al.* 1996, Runhaar 1999, Schaffers 2000). Much recent and current research is also geared specifically to comprehensive collection, and collation for open access, of functional characteristic data on as many species as possible (e.g. LEDA: Life history traits of the North West European Flora: a **D**atabase: Kühn *et al.* 2004, Ozinga *et al.* 2005). For all their limitations, functional characteristics are still certainly the best line of approach for undertaking a truly nationwide analysis of the role played by site factors in changes in the Dutch flora during the 20th century as a whole.

6.2.3. Ecological species groups versus individual species

The third key methodological issue concerns the distinction between two basic methods for establishing site factors, *viz.* based on national distribution of ecological species groups versus national distribution of individual species. The first method was adopted in chapter 3, the second in chapters 4 and 5. Both have their advantages as well as limitations.

Using ecological species groups rather than individual species has the following main advantages: 1) the potential for pronouncing on changes at the ecosystem level, of particular relevance for conservation policy, 2) the fact that virtually all Dutch species have been assigned to such groups, enabling almost full analytical species coverage, and 3) the robustness of the yardstick, values being based on broad clusters of species. The main drawbacks of using species groups are: 1) the relatively coarse classification of site factors, and 2) the fewer degrees of analytical freedom resulting from species amalgamation. Another downside is that an ecological species classification scheme is currently lacking at the European level, a *conditio sine qua non* if the method is to be adopted at the European level, too.

The main benefits of using individual species rather than ecological species groups are: 1) the greater number of degrees of freedom, 2) the finer-grained classification, 3) the larger number of functional characteristics, and, as an added benefit, 4) the validity of Ellenberg's indicator values in the Central European setting. The main drawbacks of the individual species approach are: 1) the lack of a classification scheme for one or more functional characteristics for a large number of species, and 2) the greater uncertainty with respect to abundance values.

To the extent that the two methods were used to investigate the same factors in the present study, the conclusions obtained ran largely parallel. Nonetheless, the two methods proved to complement one another well, together contributing to the robustness of the conclusions and allowing a broader range of issues to be resolved.

6.3. Effects of eutrophication, acidification, desiccation and loss of saline habitats

This section is concerned specifically with the classic environmental policy themes of eutrophication, acidification, desiccation and loss of saline and brackish habitats. The respective impacts of climate change and non-native plant species are considered in two subsequent sections.

For the 20th century as a whole, eutrophication was found to be far the most important explanatory factor for the changes observed in the Dutch flora, followed at a distance by loss of saline and brackish habitats, acidification and desiccation (chapter 3). Looking closer at the three eras distinguished (1902–1950, 1975–1988, 1988–2000; see chapter 4), eutrophication is still the main factor up to 1988. Behind eutrophication, however, acidification emerges as relatively important in the first half of the 20th century and desiccation in the era post-1975.

So does this research yield a different picture from earlier studies on changes in the Dutch flora, and in particular the studies cited in chapter 3? Despite various shortcomings in terms of data and methodology, these studies report broadly similar trends, in all likelihood because of the severity of the changes in question. Nevertheless, the present study has allowed more detailed as well as more robust conclusions to be drawn, because of the now improved compatibility among the various sets of distribution data and because the relative importance of the cited policy themes has now been assessed quantitatively. In addition, the changes that have occurred in the final decades of the 20th century have been described for the first time and put in their historical context.

The information yielded by this study also permits evaluation of the effectiveness of government conservation and environmental policy. While several types of ecosystems underwent a degree of recovery in the late 20th century (in particular, fens and dune slacks), this was not the case for others. This is probably related to the fact that pioneer vegetations can recover fairly rapidly, in contrast to grassland and forest vegetations, and that a relatively large proportion of regeneration projects (e.g.

Nuis and Rossenaar 1999, Bekker 2000, Nuis 2001) are concerned with pioneer vegetations of nutrient-poor habitats. There has also been a discernible improvement in the general quality of forest vegetations, related to an increase in area, stand age and possibly also the emergence of ecological forest management in the course of the 20th century. Compared with other European countries (Delbaere 1998, EEA 1999), this is an anomalous trend. There is also evidence that policies to address acidification, in particular, have yielded clear results. As yet, however, policies to control eutrophication have had only limited success in reducing nutrient levels in the field.

What, then, is the overall balance of all the changes observed in the Dutch flora? When it comes to the total number of species growing in the Netherlands, the balance depends on the scale level examined (*cf.* Sax and Gaines 2003). At the national level, we see an increase in the total number of species, due mainly to an increasing number of neophytes gaining a foothold. On a regional scale, we also see an increase in total species number, probably associated with the increasingly 'park-like' landscape of the Netherlands, i.e. the fact that today's landscapes generally embrace a broader mosaic of elements than they used to. On a local scale, however, no such increase in numbers is generally visible, and there has in fact been an overall decline in the country's most valuable ecosystems.

6.4. Effects of climate change

The last quarter of the 20th century saw a marked increase in the abundance of thermophilic ('warmth-loving') plants, as described in chapter 4. The effects of climate change on birds and lichens have already been well established (*cf.* references, chapter 4). For vascular plants, the only effects reported to date were phenological and this is the first study to have charted changes in species distribution related to climate change.

Although the changes in the Dutch flora over the last few decades have been very rapid, it is unclear whether this process of floristic adaptation is indeed keeping up with the pace of climate change (Huntley 1991, Grabherr *et al.* 1994, Walther *et al.* 2002, Gitay *et al.* 2002, Parmesan and Yohe 2003, Root *et al.* 2003). One way to investigate this would be to establish the proportion of thermophilic species as a function of measured temperature along a west European climate gradient running from the Netherlands to western France. It could then be assessed whether the current proportion of thermophilic species in the Netherlands, following the temperature rise recorded in the last quarter of the century, matches the number predicted by such a curve. In doing so, a distinction would have to be made between various types of habitat, as the main differences are to be expected in dry habitats (e.g. Runhaar *et al.* 2002).

General expectations are that rising temperatures will be reflected in an increased abundance of thermophilic species as well as a decline in psychrophilic ('cold-loving') species. Although this research presents evidence for an increase in thermophilic species in the Netherlands, as yet no decline in psychrophilic species has been observed. This phenomenon is cited in the literature as an 'asynchronic' effect of climate change, cold-loving species responding more slowly than thermophiles (Walther *et al.* 2002, Gitay *et al.* 2002, Parmesan and Yohe 2003, Root *et al.* 2003). An additional possible explanation is that any decline in (some fraction of) psychrophiles is being masked by the increased acreage and improved quality of Dutch woodland, where cold-loving species make up a relatively large proportion of species. The overall consequence is that the increase in the total number of plant species we are now seeing in the Netherlands is most likely *temporary*.

In all probability, rising temperatures are due not only to global climate change but also to other factors, in particular urbanisation. We were therefore faced with an entanglement of potential causative factors, the increase in thermophiles being possibly due to either or both factors. By applying indicator values for both urbanisation level and temperature, however, and because there was sufficient spread in the available datasets (for both 'warm' and 'cold' urban and non-urban species), the effects of these two processes could be disentangled. We were thus able to conclude that in the last quarter of the 20th century, urbanisation and climate change both had a greater floristic impact than eutrophication. It should be borne in mind, however, that urbanisation is an 'umbrella concept' embracing multiple changes in abiotic factors, including such influences as the increase of stony areas.

There is also a second form of entanglement involved: between climate change and the spread of non-native species. It may therefore be justifiably queried whether the increase in thermophilic species reported here is not an artefact of the increase in non-natives, most of which originate in warmer regions. In the context of the present study this is very unlikely, however, because the analysis focused mainly on indigenous species, for which climate indicators are indeed available. Even where thermophilic non-natives were concerned, though, an independent climate impact is still discernible. There may even be a degree of positive interaction between climate change and of non-native species (*cf.* MacDonals 1992, Beerling 1994, Walther 2002 and others). The following section examines the position of non-natives in the Dutch flora more closely.

6.5. Non-native plant species in the Netherlands

Chapter 5 dealt in detail with characterising the non-native moiety of the Dutch flora. In doing so, one of the handles that might be used to categorise exotic species was not employed: the extent to which they have arrived here through human activity rather than spontaneous colonisation. This question is generally seen as being of key importance (e.g. Weeda 1987), being a clear marker of whether we are concerned with an anthropogenic environmental problem (Udo de Haes 1991). The reason this issue has been left aside in the present study is that even if initial introduction of a species is due to human activity, its further naturalisation will depend above all on natural processes, and it is these that will determine whether it will eventually be designated as belonging to the wild flora (according to Standard List criteria; see Appendix). In addition, this issue is by no means easy to research, as introductions and colonisations are generally poorly documented and often based on circumstantial evidence. An additional problem is that definition of 'spontaneous colonisation' is problematical in western Europe: how, for example, is a non-native species to be classified that has been introduced to another European country and subsequently extended its range spontaneously to the Netherlands?

One surprising result concerns relative species abundance within the archeophytes (ancient introductions) and various groups of neophytes (recent to longer-standing), as set out in chapter 5. In this respect most of the groups exhibited a log-normal distribution in abundances which is skewed to the left. This is the kind of distribution predicted by the 'unified neutral theory for biodiversity and biogeography' presented by Hubble (2001), a theory grounded purely in the stochastic processes of birth, death, migration and speciation. This might be an indication that, alongside more familiar adaptive ecological theories, neutral theories may also have a role to play in explaining and predicting the numbers of successful and unsuccessful non-native species.

Two main hypotheses emerged as possible explanations for the success of new species: availability of disturbed, nutrient-rich habitats, and escape from the 'predator-pathogen complex'. Under the first hypothesis there appeared to be good evidence that non-natives have benefited from the large-scale anthropogenic changes to the Dutch historical landscape. The second hypothesis was tested by assuming that the more unrelated neophytes are to indigenous species, the less they will be prey to indigenous herbivores and pathogens. In doing so, the distance of the region of provenance of the non-native species from the Netherlands was here adopted as a proxy for relatedness. This hypothesis should be tested further, however, using a more robust measure of relatedness based on phylogenetic affinity (o.a. Felsenstein 1985, Harvey and Pagel 1991, APG 1998).

Finally, the impact of non-native species on the Dutch indigenous flora was also assessed. The question addressed was whether there are indigenous species that have declined in abundance or become extinct as a result of being ousted by neophytes. It is widely held (*cf.* references in introduction to chapter 5) that non-native species pose a major threat to indigenous floras. In this study, however, no evidence was found at either the national or kilometre-cell level for any relationship at present between the number of non-natives and any decline in indigenous species, despite the proven sensitivity of the km-scale level to floristic change. At least for the time being, then, any impact appears to be minimal and there is no good reason for conservationists to adopt a 'zero tolerance' policy on this issue. Nonetheless, a degree of caution is advisable because at the micro-level of individual sites and vegetations there may well be some species displacement. This is an issue that needs researching at more refined scale levels. On the basis of the research reported here, however, it seems likely that even if there is some degree of micro-scale displacement, this will still not be a dominant process meriting any great concern.

6.6. General conclusions

Having been corrected for various categories of recording bias, Dutch floristic distribution data on a scale of approx. 1 x 1 km, deriving mainly from the efforts of amateur botanists throughout the 20th century using a variety of survey methods, proved amenable to an encompassing quantitative analysis.

From this study, based on the functional characteristics of the approximately 1450 species of the Dutch vascular plant flora, the following general conclusions can be drawn. First, that for the 20th century as a whole eutrophication is the single most important cause of the changes observed in the Dutch flora, followed at a distance by loss of saline and brackish habitats, acidification and desiccation. Second, that in the last quarter century the floristic changes have been due mainly to urbanisation and climate change. And, finally, that new (non-native) plant species now make up a substantial proportion of the Dutch flora and in the Netherlands are found above all in anthropogenically disturbed environments.

Given these results, several conclusions can be drawn of particular relevance for national environment and conservation policy. This research shows in the first place that Dutch environmental policy has failed to adequately address the issue of eutrophication, i.e. nutrient enrichment of natural habitats although it has perhaps been more successful in combating acidification. The research also shows that for certain valuable categories of vegetation, in particular pioneer vegetations of wet, nutrient-poor soils (fens, dune slacks and so on), the major decline observed in the first half of the 20th century is now being gradually reversed, probably as a result of specific regeneration projects. The final major conclusion of the study is that, in the Netherlands at any rate, non-native species do not as yet pose a threat to the diversity of the indigenous flora, at least not at the national or regional level.

Overall, the following balance can be drawn up with respect to the changes that have occurred in the Dutch flora. At the national level the number of species is increasing, with common species becoming commoner and rarer species rarer; there is a quantitative shift towards common as well as new species, particularly those of relatively nutrient-rich, urban, dry, warm, pioneer and ruderal habitats, at the expense of less common species of nutrient-poor, neutral, wet grasslands.

6.7. General recommendations

It is recommended that a new national strategy be adopted for surveying the Dutch vascular flora, comprising the following main elements: comprehensive nationwide surveying of rare species, with systematic sampling of all other species, i.e. including common species, using a protocol that clearly signals when an area has been adequately surveyed. This would provide a relatively straightforward yet reliable means of collecting Dutch floristic distribution data on a 1 km^2 grid scale for the purposes of both research and policy-making. If functional characteristics are indeed to be used for academic and policy purposes, it is also recommended that research on these characteristics be pursued with vigour, particularly for rarer, and generally more valuable, species.

It is further recommended to further improve understanding of the processes driving the observed changes in the Dutch flora, studying these at different scale levels, to establish the potential impact of non-native species at the micro-level, among other things.

In the Netherlands there is evidence that climate change is one of the principal causes of the floristic changes observed in recent decades. In this connection it is recommended that two specific lines of research be pursued: to assess the capacity of the Dutch flora to keep abreast of the pace of climate change and, in particular, whether the Ecological Main Structure is sufficiently robust for that challenge; and to assess the interplay between climate change and increasing colonisation by non-native species: is climate change accelerating the pace at which such species are establishing themselves?

Further research is also recommended to assess the scope for employing Hubble's 'unified neutral theory of biodiversity and biogeography', in academic as well as policy circles. Among the issues to be addressed are the extent to which this theory, developed for individual organisms, also holds for species distribution, and the value of the Fundamental Biodiversity number θ for the Dutch flora and how this may have changed with time.

Finally, it is recommended that conservation and environmental policy-makers make due use of plant distribution data in evaluating their plans and programmes; devote more concerted efforts to combating eutrophication; continue to implement ecological regeneration projects, given the initial successes, but now for other valuable categories of ecosystem, too, particularly grasslands; and be more pro-active in anticipating emergent as well as ongoing changes in species numbers and composition.

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Annex: Standaardlijst van de Nederlandse flora 2003

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Summary: Standard List of the Flora of the Netherlands 2003

The present Standard List is the updated sixth edition in the series Standard List of the Flora of the Netherlands. Standard Lists have regularly been published since 1971 with intervals of 4 to 8 years and give an up-to-date survey of the vascular plant species occurring in the Netherlands. The present Standard List gives for each species: (1) the taxon code number, (2) the scientific name, (3) the vernacular name in Dutch, (4) the rarity for three periods in the 20^{th} century according to the KFK-scale, (5) the Red List category to which it belongs, (6, 7) the origin and relevant for non-indigenous species the period of naturalization, (8, 9) the dispersal and seed bank categories to which it belongs, and (10, 11) the ecological species groups to which it belongs according to two classification systems. The species are arranged in alphabetical order of scientific names. The incorporation of vernacular names, origins and periods of naturalization, and dispersal and seed bank categories is new in this edition of the Standard List. The present Standard List includes 1536 taxa mainly species and only few subspecies and cultivars, which is 59 taxa more than the previous Standard List of 1996.

1. Inleiding

Deze standaardlijst is de zesde editie van een reeks waarmee in 1971 werd begonnen. De vorige Standaardlijst verscheen in 1996 en bevatte alleen een opsomming van veranderingen ten opzichte van de vierde Standaardlijst van 1990.[1] De Standaardlijst geeft weer welke plantensoorten tot de wilde flora gerekend worden volgens een aantal uniforme criteria. Daarnaast is zij de standaard voor de wetenschappelijke namen en hun coderingen. Evenals de vierde en vijfde Standaardlijst bevat deze Standaardlijst naast de wetenschappelijke naam en unieke, soortgebonden taxoncode (paragraaf 3) ook belangrijke informatie over zeldzaamheid (paragraaf 5), over de mate van bedreiging (paragraaf 6) en ecologische karakteristieken van de soorten (paragraaf 9). Nieuw in deze Standaardlijst zijn de vermelding van de Nederlandse naam (paragraaf 4), ecologische informatie over de indigeniteit en herkomst (paragraaf 7) en de karakteristieken van dispersie en zaadvoorraad (paragraaf 8) van de soorten.

In 2003 is de tweede elektronische versie van het Botanisch basisregister, als onderdeel van het programma BioBase, verschenen.[2] Het Botanisch basisregister omvat alle gegevens van de Standaardlijst en tevens alle gegevens van de in Heukels flora opgenomen niet-wilde plantensoorten. Bovendien bevat het Botanisch basisregister informatie over tal van andere biologische en ecologische kenmerken. De Standaardlijst van de Nederlandse flora 2003 verschilt met BioBase 2003 doordat de lijst met soorten en de naamgeving is bijgewerkt en tevens nieuwe en bijgewerkte biologische en ecologische informatie omvat; de wetenschappelijke verantwoordelijkheid voor de inhoud van de Standaardlijst 2003 berust bij de auteurs, het Nationaal Herbarium Nederland en FLORON. Naast de gedrukte versie is het voorjaar van 2005 ook een elektronische versie van de Standaardlijst op het internet beschikbaar gekomen.

2. Criteria voor het opnemen van taxa

De huidige Standaardlijst telt 1536 taxa (de vierde en vijfde Standaardlijst tellen respectievelijk 1448 en 1477 taxa). Er zijn ruim 70 nieuwe soorten aan de nieuwe Standaardlijst toegevoegd, maar er zijn ook een vijftiental soorten van de Standaardlijst afgevoerd, meestal als gevolg van veranderingen in de gehanteerde criteria.

De criteria voor het opnemen van taxa op de Standaardlijst, uitvoerig toegelicht in de vierde Standaardlijst van 1991, zijn aangepast om aan te sluiten bij de gehanteerde criteria over de indigeniteit van soorten (paragraaf 7.1).[1 3] Het eerste criterium, A. *De taxa zijn herkenbaar*, is ongewijzigd gelaten. Van het tweede criterium, B. *De soorten komen in het wild voor*, zijn de subcriteria B.a en B.b aangepast. Subcriterium B.a luidde tot nog toe: "Alle soorten (of ondersoorten, respectievelijk variëteiten) die inheems zijn worden opgenomen". Inheemse soorten werden gedefinieerd als "*in het wild levende soorten die omstreeks 1825 voor Nederland bekend waren*". Het jaar 1825 was gekozen vanwege de publicatie van de eerste min of meer complete flora van Nederland van Van Hall.[4] In de voorliggende Standaardlijst wordt een uitwerking gegeven van een indeling in inheemse soorten en in archeofyten en neofyten (soorten die vóór respectievelijk na 1500 ingeburgerd zijn), zodat de omschrijving van het criterium niet meer klopt. Met de nieuwe formulering sluiten we aan bij een van de selectiecriteria van soorten voor regionale Rode Lijsten van de IUCN: namelijk dat soorten ten minste 100 jaar in het land aanwezig moeten zijn.[5] Subcriterium B.a is door ons als volgt geherformuleerd:

B.a Alle soorten (of ondersoorten, respectievelijk variëteiten) die na 1900 inheems of ingeburgerd zijn, worden opgenomen.

Een nog niet eerder behandeld probleem bij de criteria voor het opnemen van taxa is hoe lang uitgestorven taxa op de Standaardlijst moeten blijven staan. Verschillende soorten zijn reeds vóór 1900 uitgestorven en deze soorten werden dan ook conform de richtlijnen voor regionale Rode Lijsten van de IUCN niet meegenomen in de beoordeling voor de Rode Lijst.[6] Conform de nieuwe omschrijving van het criterium B.a zijn voor deze Standaardlijst twaalf soorten geschrapt die na 1900 niet meer gevonden zijn.

Het subcriterium B.b luidde tot nog toe: “Voor nieuw optredende soorten wordt een onderscheid gemaakt tussen soorten die optreden als gevolg van menselijke activiteiten (b1) en die zich in Nederland vestigen als gevolg van een natuurlijke areaaluitbreiding (b2)". Subcriterium B.b1 is het criterium dat bondig geformuleerd, neerkomt op opname op de Standaardlijst als de nieuwe taxa zich met drie achtereenvolgende generaties op ten minste drie vindplaatsen spontaan kan handhaven. Dit subcriterium blijft ongewijzigd met twee kanttekeningen. De eerste kanttekening is dat de vindplaatsen nu betrekking hebben op drie verschillende kilometerhokken (die aangrenzend kunnen zijn). De tweede kanttekening is dat voor veel bomen het moeilijk, zo niet onmogelijk is om te bewijzen dat er drie generaties zijn. In zulke gevallen wordt bepleit om enige soepelheid te betrachten met dit criterium.

Het probleem met subcriterium B.b2 is dat ook door de mens geïntroduceerde soorten zich door natuurlijke areaaluitbreiding in Nederland kunnen vestigen.[7] Door subcriterium B.b als volgt te herformuleren krijgen we wel een sluitende indeling:

B.b Voor nieuw optredende soorten wordt een onderscheid gemaakt tussen soorten die zich vestigen als gevolg van menselijke activiteiten in Nederland (b1) en die zich vestigen als gevolg van een natuurlijke areaaluitbreiding (b2).

3. Wijzigingen in taxoncodes en wetenschappelijke namen

In tabel 3 zijn alle wijzigingen in taxoncodes en wetenschappelijke namen weergegeven ten opzichte van de vorige Standaardlijst. Bij alle wijzigingen is in de tabel met een noot de reden aangegeven van de wijziging. De noten hebben de volgende betekenis:

a = aanpassing schrijfwijze
f = fout in oude Standaardlijst (vergeten, verkeerd nummer, schrijfwijze)
l = samenvoeging van taxa van oude Standaardlijst
n = opnieuw/nieuw voor de Standaardlijst
s = splitsing in meer dan één(onder)soort op Standaardlijst en/of lijst wachtkamersoorten
t = taxonomische verandering
w = verwijderd van Standaardlijst (onvoldoende bewijs of uitgestorven vóór 1900)

Er is een algemene verandering doorgevoerd in de weergave van de wetenschappelijke namen die niet in tabel 3 zijn opgenomen. Dit betreft het niet langer gebruiken van *sensu stricto* (afkorting: s. str.) en *sensu lato* (afkorting: s. l.) in de Standaardlijst. Het gebruik van deze termen is ons inziens alleen noodzakelijk als in één lijst of tekst twee keer dezelfde wetenschappelijke naam voorkomt met een verschillende taxonomische inhoud. We hebben een uitzondering gemaakt voor soorten waarvan ook een cultivar op de Standaardlijst staat. Om een eenduidig onderscheid te maken tussen de wilde vorm en een cultivar wordt aan de wetenschappelijke naam van de wilde vorm 's. str.' toegevoegd.
Er zijn drie taxa verwijderd van de Standaardlijst omdat ze niet voldeden aan de criteria voor opname. Van *Beta vulgaris* subsp. *vulgaris* is onvoldoende bewijs dat de soort, buiten de akkers, levensvatbare populaties heeft. Bij *Trichophorum cespitosum* subsp. *cespitosum* en *Agrostis castellana* hebben we deels te maken met

deels nog onopgeloste taxonomische problemen.[8] Er is een groot aantal rozensoorten aan de Standaardlijst toegevoegd, die als 'microsoorten' van de oude soorten *Rosa canina, R. rubiginosa* en *R. villosa* beschouwd worden. De komende jaren moet duidelijk worden of in de praktijk deze 'microsoorten' voldoen aan het eerste herkenbaarheidscriterium voor opname op de Standaardlijst. Bij de splitsing van oude standaardlijsttaxa krijgen de nieuwe taxa in het algemeen een nieuw taxonnummer. Het oude taxonnummer blijft betekenis houden als een nummer voor de combinatie van taxa. Van deze regel wordt afgeweken als na splitsing een van de nieuwe taxa het overgrote deel van de vindplaatsen omvat. Dit is het geval bij de splitsing van *Carex arenaria* (taxonnummer 215) in *C. arenaria* (taxonnummer 215), *C. ligerica* (taxonnummer 241) en *C. reichenbachii* (taxonnummer 257) en bij de splitsing van *Dactylis glomerata* (taxonnummer 390) in *D. glomerata* (taxonnummer 390) en *D. polygama* (taxonnummer 391). Een andere verandering is dat, gebaseerd op recent systematisch onderzoek met behulp van moderne moleculair-biologische technieken, alle 'microsoorten' van *Taraxacum* in Nederland zijn samengevoegd tot *Taraxacum officinale.*[9]

4. Wijzigingen in Nederlandse namen

Nieuw op de Standaardlijst zijn de Nederlandse namen. Elk taxon op de Standaardlijst krijgt een eigen Nederlandse naam. Alle belangrijke veranderingen in de Nederlandse namen ten opzichte van de meest recente 22e editie van Heukels' Flora zijn opgenomen in Tabel 4. Sinds 2001 heeft er geregeld overleg plaatsgevonden over de afstemming van de Nederlandse plantennamen in Nederland en België. Aan beide zijden van de grens werd de behoefte gevoeld om een aantal neofyten te voorzien van Nederlandse namen en om enkele verschillen in Nederlandse namen in de Floras van beide landen zo mogelijk op te heffen. De resultaten van dit overleg zijn verwerkt in de vijfde editie van de 'Nouvelle Flore'[8], en in deze Standaardlijst. Uitgangspunt is dat de spelregels zoals die zijn vastgelegd in 1986 grotendeels zullen worden gevolgd.[10] Die zijn als volgt kort samen te vatten:

a. Nederlandse namen die in beide landen gelijkluidend zijn worden niet gewijzigd, behalve als de naam naar een persoon is genoemd, of te provinciaal, onnodig lang, dubbelzinnig. of misleidend is;
b. Dezelfde naam mag niet zowel op genus- als op (onder)soortniveau worden gebruikt (de zogenaamde Heimans-regel), behalve voor een aantal cultuurgewassen.

Toepassing van de Heimansregel heeft er in het verleden vaak toe geleid dat er soortsadjectieven als 'gewoon', 'groot', 'echt', en 'wild' werden toegevoegd, of dat genusnamen werden aangepast. Vele van de om deze reden veranderde namen zijn intussen geaccepteerd. Een aantal Heimans-namen, zoals 'Gewoon' herderstasje, is echter nooit ingeburgerd geraakt en wij stellen thans voor enkele van die soortsadjectieven te schrappen, en tevens de uitzonderingslijst van cultuurgewassen uit te breiden. Tijdens het overleg over de Nederlandse plantennamen is gebleken dat de Heimans-regel zowel in Belgie als in Nederland als te knellend wordt ervaren. Vooral doordat een flink aantal neofyten in onze Flora's wordt opgenomen, zouden veel bekende soortsnamen moeten worden aangepast bij toepassing van de Heimansregel. Wij hebben dan ook besloten die regel niet meer dwingend toe te passen.

Voor de voorliggende Standaardlijst is in een aantal gevallen teruggegrepen naar vroeger gebruikte namen (tussen haakjes de oude naam), zoals bijv. Appelbes (Zwarte appelbes), Duizendblad (Gewoon duizendblad), Heemst (Echte heemst) en Herderstasje (Gewoon herderstasje), zie Tabel 4. Hetzelfde is gebeurd voor een aantal standaardlijstsoorten die tevens gebruiksplanten zijn, zoals: Asperge (Tuinasperge), Es (Gewone es), Sering (Gewone sering) en Veldsla (Gewone veldsla), zie Tabel 4. Voorts zijn de Nederlandse namen voor *Carex divisa* en *Ceratochloa carinata* gecorrigeerd. Waardzegge is misleidend en provinciaal en is veranderd in Kustzegge. De Nederlandse naam voor *Ceratochloa carinata* was in de 22e editie van de Heukels' Flora per ongeluk veranderd in Platte dravik en is nu gecorrigeerd tot Gekielde dravik.

Naast de veranderingen opgesomd in Tabel 4 is er één algemene verandering. De toevoegingen s. str. of s. l. worden niet meer gebruikt bij de Nederlandse namen in de Standaardlijst, omdat hierin nooit tweemaal dezelfde Nederlandse naam wordt gebruikt.

5. KilometerhokFrequentieKlassen (KFK's)

De KilometerhokFrequentieKlasse (KFK) is een maat voor de mate van voorkomen van een plantensoort in Nederland, gebaseerd op het geschatte aantal kilometerhokken (1 km 1 km) waarin een soort in Nederland voorkomt. De KFK is de opvolger van de UurhokFrequentieKlasse (UFK).[11] Er worden drie KFK's gegeven, respectievelijk voor de periode 1902–1950 (KFK30), 1975–1988 (KFK80) en 1988–2000 (KFK95). Voor een aantal soorten zijn alleen KFK's bepaald voor combinaties van soorten. Deze soorten zijn gemarkeerd met een +. De KFK's van de combinatiesoorten worden vermeld in Tabel 2, waarin ook de samenstellende soorten zijn opgenomen (waarbij nummers tussen haakjes soorten betreffen die niet op de Standaardlijst staan). Indien geen KFK bekend is voor een soort (bij nieuwe soorten voor de Nederlandse flora) wordt dit gemarkeerd met een -.

Voor de KFK is een simpele tiendelige logaritmische schaal ontworpen. Deze is als volgt samengesteld:

KFK	aantal kilometerhokken	KFK	aantal kilometerhokken
0	0	5	101–300
1	1–3	6	301–1.000
2	4–10	7	1.001–3.000
3	11–30	8	3.001–10.000
4	31–100	9	Meer dan 10.000

De KFK is bepaald met gegevens uit de databestanden FLORIVON en FlorBase. Er is een driedeling in de gegevens gemaakt, te weten: betrouwbaar, minder betrouwbaar en onbetrouwbaar/onbruikbaar. Voor een aantal soorten is de KFK aangepast, omdat er nog enkele fouten in FLORIVON en FlorBase zitten. Voor enkele andere soorten geldt dat nog niet alle gegevens aan FlorBase zijn toegevoegd. De mate van betrouwbaarheid en bruikbaarheid en aanpassingen zijn gemarkeerd volgens onderstaande tabel:

*	=	aantalsschattingen voor de eerste periode zijn mogelijk minder betrouwbaar of er vindt naast spontane veranderingen ook veel aanplant plaats
#	=	KFK's zijn bijgesteld op basis van deskundigenoordeel
h	=	houtige gewassen; informatie minder bruikbaar omdat deze voornamelijk worden aangeplant
k	=	voornamelijk gekweekt; informatie minder bruikbaar omdat deze soorten voornamelijk worden aangeplant (gegevens van vóór 1950 zijn merendeels niet in de databank FLORIVON opgenomen)
t	=	taxonomische problemen; informatie minder betrouwbaar
x	=	hybride; informatie meestal minder betrouwbaar omdat deze taxa slecht worden herkend

6. Rode Lijst 2000

Een Rode Lijst is een lijst van soorten waarvan het verspreidingsgebied zo klein is of de achteruitgang zo groot, dat het voortbestaan van de soort in Nederland wordt bedreigd. De meest recente Rode Lijst voor planten dateert uit 2000.[6] De mate van bedreiging van de soorten wordt bepaald aan de hand van een zeldzaamheids- en een trendcriterium. Voor de mate van zeldzaamheid is het voorkomen van plantensoorten in het laatste decennium van de 20ᵉ eeuw genomen. De mate van achteruitgang is bepaald door het voorkomen in dit laatste decennium te vergelijken met het voorkomen in de eerste helft van de 20ᵉ eeuw.

Enkele nieuwe standaardlijstsoorten zijn niet eerder in beschouwing genomen voor eventuele opname in de Rode Lijst. Daarnaast zijn er ook nieuwe soorten in de Standaardlijst opgenomen als gevolg van het splitsen of samenvoegen van soorten die voorheen wel op de Rode Lijst voorkwamen. De betekenis van de Rode Lijstcategorieën is als volgt:

VN	=	verdwenen: soorten die voor 1989 aanwezig en in de periode 1989—1998 afwezig waren
EB	=	ernstig bedreigd: soorten die in minder dan 36 kilometerhokken voorkomen met een achteruitgang van ten minste 75%
BE	=	bedreigd: soorten die in minder dan 36 kilometerhokken voorkomen met een achteruitgang groter dan 50% maar kleiner dan 75%, of soorten die in ten minste 36 en ten hoogste 189 kilometerhokken voorkomen met een achteruitgang van ten minste van 50%
KW	=	kwetsbaar: soorten die in minder dan 189 kilometerhokken voorkomen met een achteruitgang groter dan 25% maar kleiner dan 50%, of soorten die in ten minste 190 en ten hoogste 550 kilometerhokken voorkomen met een achteruitgang van ten minste van 25%
GE	=	gevoelig: soorten die in minder dan 36 kilometerhokken voorkomen met een achteruitgang kleiner dan 25%, of soorten die in ten minste 551 kilometerhokken voorkomen met een achteruitgang van ten minste van 50%
-	=	thans niet bedreigd of niet voldoend aan de ministeriële richtlijnen voor de Rode Lijst

*	=	nieuw voor de Standaardlijst, niet geëvalueerd voor de Rode Lijst
**	=	thans gesplitste soort waarvan het oorspronkelijke taxon niet in de Rode Lijst is opgenomen of samengevoegde soort waarvan de taxa waaruit deze is voortgekomen niet in de Rode Lijst zijn opgenomen
+	=	thans gesplitste soort waarvan het oorspronkelijke taxon wel in de Rode Lijst is opgenomen of samengevoegde soort waarvan ten minste één van de taxa waaruit deze is voortgekomen wel in de Rode Lijst is opgenomen

7. Indigeniteit en herkomst

In deze Standaardlijst is voor het eerst onderscheid gemaakt tussen oorspronkelijk inheemse soorten en later gevestigde soorten. Van die laatste wordt de periode van inburgering vermeld en het oorspronkelijke herkomstgebied.

7.1. Periode van inburgering van nieuwe soorten

De periode van inburgering van een nieuwe plantensoort breekt aan als deze zelfstandig dus zonder de hulp van mensen stand weet te houden. De criteria voor inburgering van plantensoorten zijn reeds beschreven in paragraaf 2. Het is vaak niet goed bekend wanneer de eerste vestiging plaatsvond en veel eerste vestigingen zijn van korte duur. Daarom is er voor gekozen om de soorten in te delen naar de periode van inburgering en niet naar de periode van (eerste) vestiging. De informatie van de periode van inburgering is afkomstig uit de oudere standaardlijsten[1], flora's, floristische en andere wetenschappelijke publicaties en uit de archeobotanische database RADAR.[12]

De nieuwe plantensoorten zijn ingedeeld in twee hoofdgroepen: de archeofyten en de neofyten. De archeofyten zijn ingeburgerd vóór 1500 en de neofyten vanaf 1500. Voor de archeofyten hebben we nog niet kunnen beslissen wat de begindatum is van de periode; deze valt in elk geval ruim vóór de Romeinse tijd, omdat de meeste pionierplanten van akkers binnengekomen zijn met het verschijnen van de eerste landbouw in Nederland. Voor de neofyten is de periode na 1500 opgesplitst in eeuwen en voor de 20^e eeuw in vier perioden van 25 jaar. De betekenis van de codering van de perioden van inburgering is als volgt:

i	=	inheems
a	=	archeofyt
16	=	neofyt, 16e eeuw
17	=	neofyt, 17e eeuw
18	=	neofyt, 18e eeuw
19	=	neofyt, 19e eeuw
20.1	=	neofyt, 1900—1925
20.2	=	neofyt, 1925—1950
20.3	=	neofyt, 1950—1975
20.4	=	neofyt, 1975—2000
in	=	lagere taxonomische niveaus inheems, respectievelijk neofyt

7.2. *Herkomst van nieuwe soorten*

De herkomstgebieden zijn de verspreidingsgebieden waar de soort voorkwam zonder ingrijpen of hulp van de mens. De basisinformatie is verzameld uit floras, biogeografische atlassen, floristische en andere wetenschappelijke publicaties.[12] In een aantal gevallen is de informatie gecorrigeerd en aangevuld. De betekenis van de codering van de herkomstgebieden is als volgt:

1 = oorspronkelijk inheems
4 = herkomst onbekend
5 = herkomst lagere taxa verschillend
7 = verschillende herkomst ouders

100 = Europa
101 = Noord-Europa
102 = West-Europa
103 = Midden-Europa
104 = Oost-Europa
105 = Zuid-Europa
106 = Noord- en West-Europa
107 = Noord- en Oost-Europa
108 = Zuid- en West-Europa
109 = Zuidoost-Europa
110 = Middellandse-Zeegebied
111 = Oostelijk Middellandse-Zeegebied
112 = Westelijk Middellandse-Zeegebied
113 = Midden- en Zuid-Europa
115 = Midden-, Zuid- en Oost-Europa
151 = Corsica
152 = Italië
153 = Pyreneeën
155 = Noord-Rusland
157 = Zuid-Rusland
159 = Alpen en Jura
160 = Balkan

200 = Azië
201 = Noord-Azië
202 = West-Azië
203 = Midden-Azië
204 = Oost-Azië
207 = Noordoost-Azië
208 = Zuidwest-Azië
209 = Zuidoost-Azië
210 = Klein-Azië
211 = Voor-Azië
212 = gematigd Azië
250 = China
251 = Japan
252 = India
253 = Turkije
254 = Iran
255 = Himalaya
256 = Kaukasus
257 = Siberië

300 = Amerika
301 = Noord-Amerika
303 = Midden-Amerika
305 = Zuid-Amerika
306 = Oostelijk Noord-Amerika
307 = Westelijk Noord-Amerika
308 = tropisch Amerika
350 = Californië

400 = Afrika
405 = Zuid-Afrika

500 = Australië en Nieuw-Zeeland
501 = Australië

8. Dispersie in ruimte en tijd

De mobiliteit van planten komt het best tot uitdrukking in hun capaciteit om zich in de vorm van zaden of plantendelen over lange afstand te verbreiden; dit wordt wel dispersie in de ruimte genoemd. Voor de kolonisatie van nieuwe plekken is de afstand tot bronpopulaties van de meeste zeldzamere soorten in Nederland zo groot dat deze zich zonder aanpassingen voor lange afstandsdispersie niet snel zullen vestigen.[13] Kieming vanuit de lokale zaadvoorraad, ook wel dispersie in de tijd genoemd, is voor (her)kolonisatie dan nog de enige optie. De effectiviteit van dispersie in ruimte en tijd hangt onder andere af van de hoeveelheid en vorm van de zaden die een plant produceert en van het type landschap. De dispersiekenmerken in deze Standaardlijst zijn gebaseerd op geaggregeerde data uit het gegevensbestand IRIS waarin ook het bestaande plus het vernieuwde bestand over de overleving van zaden van Thompson e.a. is opgenomen.[14 15]

8.1. Dispersie over lange afstand

Zaden (hierna gebruikt voor alle typen diasporen) kunnen zich van vlakbij de moederplant tot kilometers verderop verbreiden. Om effectief nieuwe gebieden te kunnen koloniseren moeten soorten aanpassingen hebben voor lange afstandsdispersie.[16] Het is niet mogelijk om een absoluut getal voor de kans op dispersie over lange afstand te geven.

De vectoren die plantenzaden effectief doen verbreiden over lange afstand zijn: wind, water, zoogdieren, vogels en de mens. Naast specifieke aanpassingen van zaden voor een vector (bijvoorbeeld pluizen voor verspreiding door de wind, ballonstructuren voor verspreiding door water, haken voor verspreiding door dieren) worden ook meetgegevens gebruikt om soorten optimaal te classificeren. Efficiënte windverbreiders hebben een lage 'terminale valsnelheid' van het zaad (met 'terminale valsnelheid' wordt de constante snelheid bedoeld die een vallend zaad bereikt na een korte periode van versnelling). Het drijfvermogen van zaden (uitgedrukt in uren of dagen drijftijd) is experimenteel bepaald om de efficiëntie van de vector water te kunnen bepalen. Voor verbreiding in de vacht van zoogdieren geldt dat zaden met uitsteeksels, zoals haken en haren, langer in de vacht blijven hangen dan zaden zonder deze uitsteeksels. Morfologie en retentietijden in de vacht bepalen de dispersiecapaciteit van zaden via de vacht van dieren. De grootte en vorm van zaden dragen ook bij aan de kans dat zaden via de uitwerpselen verbreid worden. Accurate getallen voor dispersiecapaciteit van verbreiding via mest kunnen echter slechts verkregen door de overleving van zaden te meten in een nabootsingexperiment.

De mens kan door middel van kleding (bijvoorbeeld laarzen en broekspijpen), (landbouw)werk- en voertuigen (zoals maai- en oogstmachines, karren, wagens), het verplaatsen van vee, het binnenhalen van hooi en de oogst van gewas en het verplaatsen van grond, zaden van planten verplaatsen. Kwantitatieve gegevens over deze manier van zaadverbreiding zijn echter schaars. Plantenzaden die door meer dan één van bovengenoemde vectoren effectief over lange afstand kunnen worden verbreid worden polychoor genoemd.

De classificatie van alle soorten heeft plaatsgevonden na raadpleging van ruim 500 bronnen vanaf 1900 tot heden.[17–21] Voor elke vector zijn veel verschillende gegevens verzameld. De geaggregeerde data zijn voldoende betrouwbaar voor analyses van soortgroepen, maar niet voor uitspraken over individuele soorten; dan is het wenselijk om te kijken naar de basisgegevens en de gebruikte methoden.[22] Daarom wordt in deze Standaardlijst een globalere classificatie gekozen:

0 = geen aanpassingen voor lange afstanddispersie door één van de genoemde vijf dispersievectoren
1 = aangepast aan één van de vijf genoemde vectoren
2 = aangepast aan twee of meer van de vijf genoemde vectoren

8.2. Levensduur van zaden in de bodem

Veel plantensoorten overleven ongunstige perioden als zaad in de bodem en kunnen hierdoor bij lokaal uitsterven plekken weer snel (her-)koloniseren door te kiemen vanuit de zaadvoorraad. De levensduur van zaden in de bodem kan het nauwkeurigst worden gemeten door middel van begravingsexperimenten, maar het uitvoeren van zulke experimenten vergt veel tijd per soort. De verdeling van kiemkrachtige zaden over de diepte in de bodem van een optimale groeiplek geeft een betrouwbare schatting van het zaadbanktype.[23] Dit geeft echter geen uitsluitsel over de absolute overlevingsduur van zaden in de bodem. Voor een aantal taxa op de Standaardlijst was alleen informatie beschikbaar op soortsniveau en niet op ondersoortsniveau. In deze publicatie zijn wij er dan van uitgegaan dat de informatie ook geldig is op ondersoortsniveau; zulke gevallen zijn in de Standaardlijst apart gemarkeerd. De informatie over zaadbanktypen in deze Standaardlijst is geaggregeerde informatie uit het bestaande plus het vernieuwde bestand met basisgegevens over de levensduur van zaden in de bodem. Van veel, met name zeldzamere, plantensoorten is wel enige informatie aanwezig, maar vooralsnog te weinig voor een betrouwbare schatting van het zaadbanktype.[24] Orchideeën en sporenplanten zijn niet ingedeeld. De classificatie van de levensduur van zaden in de bodem is als volgt:

0	=	vrijwel geen zaadproductie in Nederland
1	=	zeer kortlevende zaden (transient, < 1 jaar overlevend, vaak grote zware zaden, zonder mechanisme voor langdurige kiemrust)
2	=	kortlevende zaden (1–5 jaar overlevend)
3	=	langlevende zaden (≥ 5 jaar overlevend, vaak kleine ronde zaden die makkelijk in de bodem kunnen door dringen en lang kiemkrachtig blijven door de aanwezigheid van kiemrust en metabolische aanpassingen voor een lange levensduur)
(nr.)	=	classificatie voor ondersoortsniveau afgeleid van de beschikbare informatie op soortsniveau (nr. = 0, 1, 2 of 3)

9. Ecologische groepen

Een ecologische groep is een groep van plantensoorten met min of meer overeenkomende standplaatsen en die daarom vaker samen voorkomen dan in combinatie met andere soorten die niet tot die groep behoren. In Nederland zijn twee veel gebruikte indelingen in ecologische groepen:

a. de indeling in sociologisch-ecologische groepen van Arnolds & Van der Maarel [25]
b. de indeling in ecologische groepen van Runhaar e.a. [26]

Een belangrijk verschil tussen beide indelingen is dat in de eerste indeling plantensoorten altijd bij één groep worden ingedeeld, terwijl in de tweede indeling soorten die in verschillende milieus voorkomen ook in verschillende groepen worden ingedeeld. Dit maakt de eerste indeling gemakkelijker toepasbaar, maar kan wringen bij soorten die een brede ecologische amplitude hebben. Anders dan bij de indeling in sociologisch-ecologische groepen zijn bij de indeling in ecologische groepen de standplaatskenmerken gedefinieerd in termen van meetbare fysisch-chemische grootheden, hetgeen van belang kan zijn wanneer een relatie moet worden gelegd met (veranderingen in) milieucondities.

9.1. De ecologische groepen van Arnolds & Van der Maarel[25]

Omschrijving van de ecologische groepen:

1. Planten van akkers en droge ruigten

   1a. akkers op voedselrijke, niet kalkhoudende grond
   1b. akkers op kalkrijke grond
   1c. akkers op matig voedselrijke, kalkarme grond
   1d. regelmatig betreden plaatsen op droge, voedselrijke grond
   1e. ruigten op weinig betreden, voedselrijke, niet humeuze of kalkrijke, droge grond
   1f. ruigten op weinig betreden, kalkrijke, niet humeuze, droge grond
   1g. ruigten op weinig betreden, voedselrijke, humeuze, matig droge grond

2. Planten van gestoorde plaatsen of open, vochtige tot natte, humusarme grond

   2a. voedselrijke plaatsen met wisselende waterstand of anderszins sterk fluctuerende milieu-omstandigheden
   2b. open, voedsel-(speciaal stikstof-)rijke, natte grond
   2c. open, matig voedselrijke tot voedselarme, vochtige grond

3. Planten van zeeduinen, zoute wateren en kwelders

   3a. stranden, zeeduinen en zandige vloedmerken
   3b. zoute en sterk brakke wateren, slikken en lage kwelders
   3c. hoge kwelders en contactsituaties tussen zout en zoet milieu

4. Planten van zoete wateren en oevers

   4a. zoete tot matig brakke, voedselrijke wateren
   4b. zoete, matig tot zeer voedselarme wateren en de periodiek droogvallende oevers daarvan
   4c. voedselrijke waterkanten en moerassen
   4d. aanspoelselgordels, natte ruigten en rivierbegeleidende wilgenstruwelen

5. Planten van bemeste graslanden op matig voedselrijke tot voedselrijke, vochtige tot natte grond

   5a. bemeste graslanden op matig vochtige grond
   5b. matig bemeste graslanden op natte grond

6. Planten van droge graslanden en muren

   6a. muren
   6b. graslanden op droge, matig voedselrijke tot voedselrijke, niet tot matig kalkhoudende zwak zure tot zwak basische grond
   6c. graslanden op droge, matig voedselrijke, kalrijke of zinkhoudende, neutrale tot basische grond
   6d. graslanden op droge, tamelijk voedselarme, kalkarme, zure grond

7. Planten van heiden, vennen, schraallanden en kalkmoerassen

7a. matig voedselrijke, kalkarme, zure laagveenmoerassen en natte, humeuze duinvalleien
7b. matig voedselarme, kalrijke, basische moerassen
7c. onbemeste graslanden op vochtige tot natte, matig voedselarme, zwak zure, venige grond
7d. hoogvenen, natte heiden en onbemeste graslanden op natte, zeer voedselarme, zure humeuze grond
7e. droge heiden en onbemeste graslanden op matig vochtige tot droge, voedselarme, zure humeuze grond

8. Planten van kaalslagen, zomen en struwelen

8a. kaalslagen op matig vochtige tot droge, matig voedselrijke tot voedselrijke grond
8b. zomen op voedsel-(vooral stikstof-)rijke, niet kalkrijke, humeuze, matig vochtige grond
8c. zomen op kalkhoudende, lemige, matig vochtige tot droge grond
8d. struwelen op matig vochtige tot droge, voedselrijke grond

9. Planten van bossen

9a. bossen op voedselrijke, vochtige tot natte grond en van brongebieden
9b. bossen op gerijpte, matig voedselrijke tot voedselrijke, matig vochtige tot droge grond
9c. bossen op jonge, voedselrijke, matig vochtige grond
9d. bossen op gerijpte, kalkrijke, droge grond
9e. bossen en bosranden op tamelijk tot zeer voedselarme, kalkarme, droge grond

Opmerking: Bij een aantal nieuw in de Standaardlijst opgenomen taxa is een ecologische groep toegekend. In een beperkt aantal gevallen heeft een bijstelling plaatsgevonden van de opgave.

9.2. Ecologische soortengroepen van het ecotopensysteem

Onlangs werd de herziening van de indeling van hogere planten in ecologische soortengroepen voor Nederland en Vlaanderen toegelicht.[26] Deze herziene indeling is thans opgenomen. De ecologische soortengroepen van het ecotopensysteem worden aangeduid met een code die bestaat uit drie tot vijf symbolen. Deze code is als volgt opgebouwd:

1. een voorvoegsel (prefix) met informatie over saliniteit (facultatief)
2. een hoofdletter voor de vegetatiestructuur en successiestadium
3. een getal voor de vochttoestand
4. een getal voor de voedselrijkdom (trofie-toestand) en de zuurgraad
5. een achtervoegsel (suffix) met aanvullende kenmerken over dynamiek, substraat e.d.

De gebruikte codes zijn:

1. Saliniteit (prefix)

- zoet
b brak
z zilt

2. Vegetatiestructuur en successiestadium

A aquatische (= V+W) vegetaties
B bos
G gesloten korte vegetatie
H bos en struweel (= B+S)
K kruidachtige vegetaties (= P+G+R)
P pioniersvegetaties
R ruigte
S struweel
V verlandingsvegetaties
W watervegetatie

3. Vochttoestand

1 aquatisch
2 nat
3 zeer vochtig
4 vochtig
5 matig vochtig
6 droog

4. Voedselrijkdom en zuurgraad

1 voedselarm zuur
2 voedselarm zwak zuur
3 voedselarm basisch
4 voedselarm
5 matig voedselrijk (zwak) zuur/zacht
6 matig voedselrijk basisch/hard
7 matig voedselrijk
8 zeer voedselrijk
9 matig-zeer voedselrijk

5. Additionele kenmerken (suffix)

(in lijst)
br bronbos
kr kalkrijk (basisch)
mu muren
ss stenig substraat
tr betreden
zt zeer zoet
(optioneel)
dw dwergstruweel
la laag struweel
mo mosvlakte
na naaldbos
pi pionierstruweel

De volgende ecologische soortengroepen worden onderscheiden:

zP20 soorten van pioniervegetaties op zilte natte bodem
bP20 soorten van pioniervegetaties op brakke natte bodem
bP40 soorten van pioniervegetaties op brakke vochtige bodem
bP60 soorten van pioniervegetaties op brakke droge bodem
P40mu soorten van pioniervegetaties op vochtige muren
P60mu soorten van pioniervegetaties op droge muren
P21 soorten van pioniervegetaties op natte voedselarme zure bodem
P22 soorten van pioniervegetaties op natte voedselarme zwak zure bodem
P23 soorten van pioniervegetaties op natte voedselarme basische bodem
P27 soorten van pioniervegetaties op natte matig voedselrijke bodem
P28 soorten van pioniervegetaties op natte zeer voedselrijke bodem
P42 soorten van pioniervegetaties op vochtige voedselarme zwak zure bodem
P43 soorten van pioniervegetaties op vochtige voedselarme basische bodem
P47 soorten van pioniervegetaties op vochtige matig voedselrijke bodem
P47kr soorten van pioniervegetaties op vochtige matig voedselrijke basische bodem
P48 soorten van pioniervegetaties op vochtige zeer voedselrijke bodem
P48tr soorten van pioniervegetaties op vochtige zeer voedselrijke betreden bodem
P61 soorten van pioniervegetaties op droge voedselarme zure bodem
P62 soorten van pioniervegetaties op droge voedselarme zwak zure bodem
P63 soorten van pioniervegetaties op droge voedselarme basische bodem
P63ss soorten van pioniervegetaties op droog voedselarm basisch stenig substraat
P67 soorten van pioniervegetaties op droge matig voedselrijke bodem
P67ss soorten van pioniervegetaties op droog matig voedselrijk stenig substraat
P68 soorten van pioniervegetaties op droge zeer voedselrijke bodem

zG20	soorten van gesloten korte vegetaties op zilte natte bodem
zG40	soorten van gesloten korte vegetaties op zilte vochtige bodem
bG20	soorten van gesloten korte vegetaties op brakke natte bodem
bG40	soorten van gesloten korte vegetaties op brakke vochtige bodem
G21	soorten van gesloten korte vegetaties op natte voedselarme zure bodem
G22	soorten van gesloten korte vegetaties op natte voedselarme zwak zure bodem
G23	soorten van gesloten korte vegetaties op natte voedselarme basische bodem
G27	soorten van gesloten korte vegetaties op natte matig voedselrijke bodem
G28	soorten van gesloten korte vegetaties op natte zeer voedselrijke bodem
G41	soorten van gesloten korte vegetaties op vochtige voedselarme zure bodem
G42	soorten van gesloten korte vegetaties op vochtige voedselarme zwak zure bodem
G43	soorten van gesloten korte vegetaties op vochtige voedselarme basische bodem
G47	soorten van gesloten korte vegetaties op vochtige matig voedselrijke bodem
G47kr	soorten van gesloten korte vegetaties op vochtige matig voedselrijke basische bodem
G48	soorten van gesloten korte vegetaties op vochtige zeer voedselrijke bodem
G61	soorten van gesloten korte vegetaties op droge voedselarme zure bodem
G62	soorten van gesloten korte vegetaties op droge voedselarme zwak zure bodem
G63	soorten van gesloten korte vegetaties op droge voedselarme basische bodem
G67	soorten van gesloten korte vegetaties op droge matig voedselrijke bodem
G68	soorten van gesloten korte vegetaties op droge zeer voedselrijke bodem
zR20	soorten van ruigten op zilte natte bodem
bR20	soorten van ruigten op brakke natte bodem
bR40	soorten van ruigten op vochtige natte bodem
bR60	soorten van ruigten op brakke, droge bodem
R24	soorten van ruigten op natte voedselarme bodem
R27	soorten van ruigten op natte matig voedselrijke bodem
R28	soorten van ruigten op natte zeer voedselrijke bodem
R44	soorten van ruigten op vochtige voedselarme bodem
R47	soorten van ruigten op vochtige matig voedselrijke bodem
R47kr	soorten van ruigten op vochtige matig voedselrijke basische bodem
R48	soorten van ruigten op vochtige zeer voedselrijke bodem
R64	soorten van ruigten op droge voedselarme bodem
R67	soorten van ruigten op droge matig voedselrijke bodem
R68	soorten van ruigten op droge zeer voedselrijke bodem
H21	soorten van bos en struweel op natte voedselarme zure bodem
H22	soorten van bos en struweel op natte voedselarme zwak zure bodem
H27	soorten van bos en struweel op natte matig voedselrijke bodem
H27br	bronnen en kwelplekken in bos op natte, matig voedselrijke bodem
H28	soorten van bos en struweel op natte zeer voedselrijke bodem
H41	soorten van bos en struweel op vochtige voedselarme zure bodem
H42	soorten van bos en struweel op vochtige voedselarme zwak zure bodem
H43	soorten van bos en struweel op vochtige voedselarme basische bodem
H47	soorten van bos en struweel op vochtige matig voedselrijke bodem
H47kr	soorten van bos en struweel op vochtige matig voedselrijke basische bodem
H48	soorten van bos en struweel op vochtige zeer voedselrijke bodem
H61	soorten van bos en struweel op droge voedselarme zure bodem
H62	soorten van bos en struweel op droge voedselarme zwak zure bodem
H63	soorten van bos en struweel op droge voedselarme basische bodem
H69	soorten van bos en struweel op droge voedselrijke bodem
bV10	soorten van verlandingsvegetaties in brak water
V11	soorten van verlandingsvegetaties in voedselarm zuur water
V12	soorten van verlandingsvegetaties in voedselarm zwak zuur water

V15	soorten van verlandingsvegetaties in matig voedselrijk zacht water
V16	soorten van verlandingsvegetaties in matig voedselrijk zoet tot licht brak hard water
V16zt	soorten van verlandingsvegetaties in matig voedselrijk zeer zoet hard water
V18	soorten van verlandingsvegetaties in zeer voedselrijk water
bW10	soorten van brak water
zW10	soorten van zout water
W11	soorten van voedselarm zuur water
W12	soorten van voedselarm zwak zuur water
W13	soorten van voedselarm hard water
W15	soorten van matig voedselrijk zacht water
W16	soorten van matig voedselrijk zoet tot licht brak hard water
W16zt	soorten van matig voedselrijk zeer zoet hard water
W18	soorten van zeer voedselrijk water
-	niet ingedeeld

Indien bij een taxon verschillende ecologische groepen vermeld staan, dan zijn deze geordend naar belangrijkheid: de eerstgenoemde groep heeft betrekking op het milieutype waarin de soort percentueel het meeste voorkomt, etc. De mate van belangrijkheid hangt af van de volgorde waarin de groepen vermeld staan en van het aantal ecologische groepen waaraan de soort is toegedeeld.[27]

Noten en referenties

1. Hier geven we een overzicht van de vijf eerdere standaardlijstpublicaties: 1. E. van der Maarel. 1971. Florastatistieken als bijdrage tot de evaluatie van natuurgbieden. Gorteria 5: 176–188; [De eerste versie van de Standaardlijst was toegevoegd in de vorm van een losse, gestencilde bijlage]. - 2. E.J.M. Arnolds & R. van der Meijden. 1976. Standaardlijst van de Nederlandse flora 1975. Leiden. - 3. R. van der Meijden., E.J.M. Arnolds, F. Adema, E.J. Weeda & C.L. Plate. 1984. Standaardlijst van de Nederlandse flora 1983. Leiden. - 4. R. van der Meijden, L. van Duuren, E.J. Weeda & C.L. Plate. 1991. Standaardlijst van de Nederlandse flora 1990. Gorteria 17: 75–130. - 5. R. van der Meijden, L. van Duuren & H. Duistermaat. 1996. Standaardlijst van de Nederlandse flora 1996. Overzicht van de wijzigingen sinds 1990. Gorteria 22: 1–5.
2. BioBase 2003 is een elektronische uitgave van het Centraal Bureau voor de Statistiek (CBS) te Voorburg met een database met biologische en ecologische informatie over planten en dieren in Nederland. BioBase 2003 is de opvolger van BioBase 1997, Register biodiversiteit. Centraal Bureau voor de Statistiek, Voorburg/Heerlen. BioBase omvat tevens een tabel van vaatplanten, die vroeger het Botanisch basisregister werd genoemd. Een eerste gedrukte versie verscheen hiervan in 1987: L. van Duuren. 1987 (1e ed.), 1991 (2e ed.), Botanisch basisregister. Centraal Bureau voor de Statistiek, Voorburg.
3. Zie voor recente kritiek op de criteria: F. Verloove. 2002. Ingeburgerde plantensoorten in Vlaanderen. Mededeling van het Instituut voor Natuurbehoud nr. 20. Instituut voor Natuurbehoud. Brussel.
4. H.C. van Hall. 1825. Flora Belgii Septotrionalis I (1/2). Amsterdam.
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9. J. Kirschner et al. 2003. Principal features of the cpDNA evolution in Taraxacum (Asteraceae, Lactuceae): a conflict with taxonomy. Pl. Syst. Evol. 239: 231–255.
10. R. van der Meijden & L. Vanhecke. 1986. Naamlijst van de flora van Nederland en België. Gorteria 13: 86–170.
11. W.L.M. Tamis & M. van 't Zelfde. 2003. KFK, een nieuwe zeldzaamheidsschaal voor de Nederlandse flora. Gorteria 29: 57–83.
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16. M.L. Cain, B.G. Milligan & A.E. Strand. 2000. Long-distance seed dispersal in plant populations. Am. J. Bot. 87: 1217–1227. Bij verbreidingsexperimenten hanteert men de afstand van minimaal 100 m als maatstaf voor lange afstandverbreiding.
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27. Een tabel met weegwaarden is op de volgende webpagina te vinden: http://www.synbiosys.alterra.nl/ecotopen.

Tabel 1. Alfabetische standaardlijst

Legenda

1. taxonnummer (afkorting: nr.)
2. wetenschappelijke naam (afkorting: wetensch. naam)
3. Nederlandse naam
4. KFK voor de perioden 1902–1950 (KFK30), 1975–1988 (KFK80) en 1988–2000 (KFK95)
5. KFK noot
6. Rode Lijst 2000 categorie (afkorting: RL2000)
7. indigeniteit (afkorting: indig.)
8. herkomst
9. dispersie
10. levensduur van zaden in de bodem (afkorting: zaadbank)
11. ecologische groepen van Arnolds & Van der Maarel[25] (afkorting: ARN)
12. ecologische groepen van Runhaar e.a.[26] (afkorting: RUN)

Tabel 1 Annex. Alfabetische standaardlijst (begin tabel)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1650	*Abutilon theophrasti*	Fluweelblad	0	4	6		–
1	*Acer campestre*	Spaanse aak	6	8	8	h	–
5001	*Acer negundo*	Vederesdoorn		–			*
1850	*Acer platanoides*	Noorse esdoorn	3	7	7	h	–
2	*Acer pseudoplatanus*	Gewone esdoorn	7	9	9	h	–
3	*Aceras anthropophorum*	Poppenorchis	2	2	2		KW
4	*Achillea millefolium*	Duizendblad	9	9	9		–
5	*Achillea ptarmica*	Wilde bertram	9	9	8		–
6	*Aconitum vulparia*	Gele monnikskap	2	2	2		KW
7	*Acorus calamus*	Kalmoes	8	8	8		–
8	*Actaea spicata*	Christoffelkruid	4	5	4		KW
1628	*Adonis aestivalis*	Zomeradonis	2	0	0		VN
10	*Adoxa moschatellina*	Muskuskruid	6	7	6		–
11	*Aegopodium podagraria*	Zevenblad	9	9	9		–
1851	*Aesculus hippocastanum*	Witte paardenkastanje		–			*
12	*Aethusa cynapium*	Hondspeterselie	8	8	8		–
13	*Agrimonia eupatoria*	Gewone agrimonie	8	8	7		GE
14	*Agrimonia procera*	Welriekende agrimonie	5	6	5		KW
15	*Agrostemma githago*	Bolderik	7	4	5		EB
1544	*Agrostis canina*	Moerasstruisgras		+			–
19	*Agrostis capillaris*	Gewoon struisgras	9	9	9		–
17	*Agrostis gigantea*	Hoog struisgras		+			–
18	*Agrostis stolonifera*	Fioringras		+			–
1545	*Agrostis vinealis*	Zandstruisgras		+			–
20	*Aira caryophyllea*	Zilverhaver	8	8	8		–
21	*Aira praecox*	Vroege haver	8	8	8		–
22	*Ajuga chamaepitys*	Akkerzenegroen	2	1	0		BE
2422	*Ajuga pyramidalis*	Piramidezenegroen	0	2	1		–
24	*Ajuga reptans*	Kruipend zenegroen	8	8	8		–
1453	*Alchemilla filicaulis*	Fijnstengelige vrouwenmantel		+			GE
1454	*Alchemilla glabra*	Kale vrouwenmantel		+			KW
1647	*Alchemilla micans*	Slanke vrouwenmantel		+			GE
1648	*Alchemilla mollis*	Fraaie vrouwenmantel		+			–
1455	*Alchemilla monticola*	Bergvrouwenmantel		+			GE
1649	*Alchemilla subcrenata*	Geplooide vrouwenmantel		+			EB
1452	*Alchemilla vulgaris*	Spitslobbige vrouwenmantel		+			GE
1456	*Alchemilla xanthochlora*	Geelgroene vrouwenmantel		+			GE
26	*Alisma gramineum*	Smalle waterweegbree		+			–
27	*Alisma lanceolatum*	Slanke waterweegbree		+			–
28	*Alisma plantago–aquatica*	Grote waterweegbree		+			–
29	*Alliaria petiolata*	Look–zonder–look	8	8	9		–
30	*Allium carinatum*	Berglook	1	1	2	#	–
31	*Allium oleraceum*	Moeslook	6	5	5	*	KW
1546	*Allium paradoxum*	Armbloemig look	2	2	3	*	–
32	*Allium schoenoprasum*	Bieslook	3	5	6		–
33	*Allium scorodoprasum*	Slangenlook	4	4	4		–
34	*Allium ursinum*	Daslook	5	6	6		–
35	*Allium vineale*	Kraailook	8	8	9		–
36	*Alnus glutinosa*	Zwarte els	9	9	9	h	–
37	*Alnus incana*	Witte els	6	8	7	h	–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
20.2	109	0	–	1a	P48
i	1	1	1	9d	H43 H47 H69
20.3	301	1	–	–	H48 H69
20.3	103	1	1	–	H47
17	103	1	1	9c	H47 H43 H42 H69 H63 H62
i	1	2	–	8c	G43 H43
i	1	0	1	5a	G67 G47
i	1	0	1	5b	G27 R27 G47 R47
i	1	1	–	9a	H43
17	209	1	1	4c	V18
i	1	2	–	9d	H43
a	105	0	–	1b	–
i	1	1	1	9b	H43 H47 H42
i	1	1	1	8b	R48 H48 H47
20.2	109	0	–	–	H47
i	1	0	3	1a	P47 P48
i	1	2	1	8c	G43 G47kr
i	1	1	–	8c	G47 H47
a	100	0	2	1a	P47kr
i	1	2	3	7a	G22 G27 H22 V12 G21 V11
i	1	1	3	6d	G67 G62 G47 G42 H69 H62
i	1	1	2	2a	R47 R48 G47 G48
i	1	2	2	2a	bG20 G28 bG40 V18 bV10 G47 G27 G48
i	1	2	3	6d	P61 P62 G61 G62 H61 H62
i	1	1	–	6d	P62 P67
i	1	1	3	6d	P62 P63
i	1	0	–	1b	P47kr
i	1	0	–	7e	–
i	1	0	3	5b	H42 H43 H47 G27 G47
i	1	1	–	5b	–
i	1	1	–	5b	G27 G47
i	1	1	–	5b	G27 G47
20.3	103	1	–	5a	G47 H47
i	1	1	–	5b	G47 G27
i	1	1	–	5b	G27
i	1	1	3	5b	G27 G47
i	1	1	–	5b	G47
i	1	1	–	4c	W16 W18 P28
i	1	1	–	4c	W18 P28 W16
i	1	1	3	4c	W18 W16 P28 P27
i	1	0	2	8b	H48 H47 H69
19	103	0	–	6c	G47
i	1	0	–	8c	G47kr G67
20.1	208	0	0	9c	H47
i	1	0	–	6b	G47
i	1	0	1	9c	H47kr G47kr
i	1	0	1	9d	H47kr
i	1	0	1	8b	G47 H47 G67
i	1	1	2	9a	H27 H22 H47
20.1	103	1	–	9b	H47

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
38	*Alopecurus aequalis*	Rosse vossenstaart	6	6	6		–
39	*Alopecurus bulbosus*	Knolvossenstaart	6	4	4		BE
40	*Alopecurus geniculatus*	Geknikte vossenstaart	8	9	9		–
41	*Alopecurus myosuroides*	Duist	8	8	7		–
42	*Alopecurus pratensis*	Grote vossenstaart	8	9	9		–
43	*Althaea officinalis*	Heemst	6	6	6		KW
44	*Alyssum alyssoides*	Bleek schildzaad	4	3	4		BE
1651	*Amaranthus albus*	Witte amarant	5	4	5		–
1758	*Amaranthus blitoides*	Nerfamarant	3	3	5		–
46	*Amaranthus blitum*	Kleine majer	5	5	6		–
5311	*Amaranthus hybridus* subsp. *bouchonii*	Franse amarant		+			**
5318	*Amaranthus hybridus* subsp. *hybridus*	Basterdamarant		+			**
47	*Amaranthus retroflexus*	Papegaaienkruid	6	6	7		–
1654	*Ambrosia psilostachya*	Zandambrosia	2	3	4	#	–
1852	*Amelanchier lamarckii*	Amerikaans krentenboompje	5	8	8	h	–
50	*Ammophila arenaria*	Helm	7	7	7		–
1658	*Amsinckia menziesii*	Amsinckia	2	6	6		–
51	*Anacamptis pyramidalis*	Hondskruid	3	3	4		GE
52	*Anagallis arvensis* subsp. *arvensis*	Rood guichelheil		+			–
1659	*Anagallis arvensis* subsp. *foemina*	Blauw guichelheil		+			EB
288	*Anagallis minima*	Dwergbloem	6	5	4	#	BE
53	*Anagallis tenella*	Teer guichelheil	5	4	4		KW
779	*Anchusa arvensis*	Kromhals	7	8	8		–
1660	*Anchusa ochroleuca*	Geelwitte ossentong	1	3	3		–
54	*Anchusa officinalis*	Gewone ossentong	5	6	6		–
55	*Andromeda polifolia*	Lavendelhei	6	6	5		KW
1620	*Anemone apennina*	Blauwe anemoon	2	4	4	*	–
56	*Anemone nemorosa*	Bosanemoon	8	8	8		–
58	*Anemone ranunculoides*	Gele anemoon	4	4	4		–
59	*Angelica archangelica*	Grote engelwortel	4	6	7		–
60	*Angelica sylvestris*	Gewone engelwortel	9	9	9		–
5313	*Anisantha diandra*	Stijve dravik		–			*
165	*Anisantha sterilis*	IJle dravik	8	8	9		–
166	*Anisantha tectorum*	Zwenkdravik	6	6	7		–
61	*Antennaria dioica*	Rozenkransje	6	4	4		EB
62	*Anthemis arvensis*	Valse kamille	8	7	6		KW
63	*Anthemis cotula*	Stinkende kamille	7	6	5		EB
64	*Anthemis tinctoria*	Gele kamille	3	4	5	*	–
65	*Anthericum liliago*	Grote graslelie	0	0	1		GE
67	*Anthoxanthum aristatum*	Slofhak	8	7	7		GE
66	*Anthoxanthum odoratum*	Gewoon reukgras	9	9	9		–
68	*Anthriscus caucalis*	Fijne kervel	7	6	7		–
70	*Anthriscus sylvestris*	Fluitenkruid	9	9	9		–
71	*Anthyllis vulneraria*	Wondklaver	6	6	6		KW
2423	*Apera interrupta*	Stijve windhalm	0	2	4		–
73	*Apera spica-venti*	Grote windhalm	9	8	8		–
74	*Aphanes arvensis*	Grote leeuwenklauw		+			BE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	3	2b	P28 P27
i	1	2	–	3c	bG40
i	1	2	3	2a	G28 P28 bG20
a	100	2	3	1a	P47kr P48
i	1	2	1	5a	G48
i	1	2	–	4d	bR40
i	1	0	–	6c	P63
19	301	2	–	1e	P68 P48
20.1	301	2	–	1e	P67
a	110	2	–	1a	P48 P68
20.3	305	2	(3)	1e	P68 P48
20.2	308	2	3	1e	P68 P48
19	301	2	3	1c	P68 P48
20.2	301	0	–	1e	G67 G63
20.1	301	1	1	9e	H41 H61
i	1	1	1	3a	bP60 bR60 R64
20.1	301	1	–	1a	P67 P68
i	1	2	–	6c	G63 G43
i	1	0	3	1a	P47 P48
a	105	0	(3)	1b	P47kr
i	1	0	–	2c	P22 P42
i	1	0	–	7b	P23 P22
a	100	1	2	1c	P67 P68
20.1	109	1	–	1f	P63
a	100	1	–	1f	P63 P67
i	1	1	1	7d	G21
19	105	0	–	9c	H47
i	1	0	1	9b	H42 H43 H47
i	1	0	1	9d	H43 H47kr
20.1	107	1	–	4d	R28 H28
i	1	1	1	4d	R47 R27 H27 G27 H28 R48 R28
20.4	105	2	2	–	–
a	100	1	1	8b	R48 P47 P68 P48 P67 R67
a	100	1	3	1f	P63 P67
i	1	1	–	7e	G62 G42
a	100	1	3	1c	P67
a	100	1	3	1e	P48
17	103	1	–	1e	P67
i	1	0	–	8c	–
19	108	1	–	1c	P67
i	1	1	2	5a	G47 G27 G42 G67 G22 G62
i	1	2	1	8d	H69 H63
i	1	1	1	8b	H48 R48 H47
i	1	1	1	6c	G63 G43
20.4	100	2	–	1e	P67
i	1	2	2	1c	P67 P47
i	1	2	3	1b	P47

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
75	*Aphanes inexpectata*	Kleine leeuwenklauw		+			–
76	*Apium graveolens*	Selderij	7	6	6		KW
77	*Apium inundatum*	Ondergedoken moerasscherm	6	5	5		KW
78	*Apium nodiflorum*	Groot moerasscherm	7	7	7		–
79	*Apium repens*	Kruipend moerasscherm	4	2	3	*	BE
80	*Aquilegia vulgaris*	Wilde akelei	5	5	6	*	–
81	*Arabidopsis thaliana*	Zandraket	8	8	9		–
206	*Arabis arenosa*	Rozetsteenkers	4	4	4		–
1315	*Arabis glabra*	Torenkruid	4	3	4		BE
82	*Arabis hirsuta* subsp. *hirsuta*	Ruige scheefkelk	5	5	5		–
1458	*Arabis hirsuta* subsp. *sagittata*	Pijlscheefkelk	1	2	2		EB
83	*Arctium lappa*	Grote klit	6	7	8		–
2457	*Arctium minus*	Gewone klit	8	9	9	*	–
87	*Arctium tomentosum*	Donzige klit	5	5	5		–
88	*Arctostaphylos uva–ursi*	Berendruif	2	1	2	*	GE
1459	*Arenaria leptoclados*	Tengere zandmuur		+			–
89	*Arenaria serpyllifolia*	Gewone zandmuur		+			–
90	*Aristolochia clematitis*	Pijpbloem	4	4	4		–
91	*Armeria maritima*	Engels gras	7	6	6		KW
92	*Armoracia rusticana*	Mierik	5	6	6		–
93	*Arnica montana*	Valkruid	7	5	4		BE
94	*Arnoseris minima*	Korensla	8	5	4		EB
1965	*Aronia ×prunifolia*	Appelbes	0	5	6	*	–
96	*Arrhenatherum elatius*	Glanshaver	9	9	9		–
97	*Artemisia absinthium*	Absintalsem	6	5	5		KW
1663	*Artemisia biennis*	Rechte alsem	0	2	5		–
98	*Artemisia campestris* subsp. *campestris*	Wilde averuit		+			BE
99	*Artemisia campestris* subsp. *maritima*	Duinaveruit		+			–
101	*Artemisia vulgaris*	Bijvoet	9	9	9		–
102	*Arum italicum*	Italiaanse aronskelk	4	6	5		–
103	*Arum maculatum*	Gevlekte aronskelk	6	7	7		–
5323	*Asclepias syriaca*	Zijdeplant		–			*
104	*Asparagus officinalis* subsp. *officinalis*	Asperge		+			–
105	*Asparagus officinalis* subsp. *prostratus*	Liggende asperge		+			–
106	*Asperugo procumbens*	Scherpkruid	4	2	1		EB
111	*Asplenium adiantum–nigrum*	Zwartsteel	2	3	4		–
112	*Asplenium ruta–muraria*	Muurvaren	7	6	7		–
934	*Asplenium scolopendrium*	Tongvaren	4	5	6		–
113	*Asplenium trichomanes*	Steenbreekvaren	5	5	5		–
1609	*Asplenium viride*	Groensteel	0	1	1		GE
114	*Aster lanceolatus*	Smalle aster	3	5	6	#	–
116	*Aster tradescantii*	Kleine aster	4	4	5	#	–
117	*Aster tripolium*	Zulte	8	7	7		–
118	*Astragalus glycyphyllos*	Hokjespeul	4	4	4		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	1c	P67
i	1	1	–	3c	bR20 bR40
i	1	1	–	4b	W12 P22 W15 P27
i	1	1	–	4c	V18 G28
i	1	1	–	2b	P28 P27
i	1	0	–	9d	H43
i	1	1	3	6b	P67
19	103	1	–	6b	P67ss
i	1	1	1	8c	G63 G67 G62
i	1	1	(3)	6c	G63
i	1	1	(3)	6a	P60mu
a	100	1	3	1g	R48 H48
i	1	1	–	1g	R48 H48 H69
a	103	1	–	1g	G48
i	1	2	–	7e	G62
i	1	1	–	1b	P47kr G63 P67 P63
i	1	1	3	1a	P47kr G63 P67 P63
a	103	1	–	8c	R67 R47
i	1	2	1	3c	zG40 bG40 zG20 bG20
a	109	1	0	1g	R48
i	1	0	1	7e	G42 G41
i	1	0	–	1c	P67
19	301	2	–	7a	H22 H21
i	1	2	1	5a	G47 G48
a	100	1	3	1e	P67
20.3	201	1	–	2b	P48 R48
i	1	1	(1)	6b	G63 G67
19	108	1	(1)	6b	P63
i	1	2	3	1g	R48 R47 R67
18	105	0	–	9c	H47
i	1	0	1	9b	H47kr H43
19	306	0	–	–	–
a	100	2	(1)	8d	G63 H63 H69
i	1	2	(1)	6b	G63
a	100	2	–	1f	P68
i	1	1	–	6a	P40mu
i	1	1	–	6a	P60mu
i	1	1	–	6a	P40mu
i	1	1	–	6a	P40mu P60mu
20.3	100	1	–	9b	P40mu
20.1	301	1	–	4d	R47 R48
19	301	1	–	4d	R47 R48
i	1	2	3	3b	zR20 bR20 zG20 bP20 zG40
i	1	1	–	8c	G47kr

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
119	*Athyrium filix–femina*	Wijfjesvaren	8	8	8		–
120	*Atriplex glabriuscula*	Kustmelde	4	4	5		–
124	*Atriplex laciniata*	Gelobde melde	4	3	3		GE
122	*Atriplex littoralis*	Strandmelde	6	7	6		–
123	*Atriplex patula*	Uitstaande melde	8	9	9		–
595	*Atriplex pedunculata*	Gesteelde zoutmelde	5	3	3		BE
596	*Atriplex portulacoides*	Gewone zoutmelde	6	6	6		–
121	*Atriplex prostrata*	Spiesmelde	8	9	9		–
125	*Atropa bella–donna*	Wolfskers	3	2	3		KW
126	*Avena fatua*	Oot	6	7	6		–
128	*Azolla filiculoides*	Grote kroosvaren	7	7	8		–
127	*Azolla mexicana*	Kleine kroosvaren	2	0	0	#	VN
129	*Ballota nigra* subsp. *foetida*	Stinkende ballote	7	6	6		–
130	*Barbarea intermedia*	Bitter barbarakruid	4	5	6		–
131	*Barbarea stricta*	Stijf barbarakruid	6	7	7		–
133	*Barbarea vulgaris*	Gewoon barbarakruid	6	7	8		–
134	*Bassia hirsuta*	Ruig zoutkruid	3	0	0		VN
135	*Bellis perennis*	Madeliefje	9	9	9		–
5212	*Berberis thunbergii*	Japanse berberis		–			*
136	*Berberis vulgaris*	Zuurbes	5	6	6	h	–
137	*Berteroa incana*	Grijskruid	6	6	7		–
1215	*Berula erecta*	Kleine watereppe	8	9	8		–
138	*Beta vulgaris* subsp. *maritima*	Strandbiet	4	5	4		–
140	*Betula pendula*	Ruwe berk	8	9	9	h	–
139	*Betula pubescens*	Zachte berk	8	9	9	h	–
141	*Bidens cernua*	Knikkend tandzaad	8	8	8		–
142	*Bidens connata*	Smal tandzaad	6	7	7		–
143	*Bidens frondosa*	Zwart tandzaad	6	8	8		–
2458	*Bidens radiata*	Riviertandzaad	0	0	3		GE
144	*Bidens tripartita*	Veerdelig tandzaad	9	9	9		–
1855	*Blackstonia perfoliata* subsp. *perfoliata*	Zomerbitterling		+			–
145	*Blackstonia perfoliata* subsp. *serotina*	Herfstbitterling		+			–
146	*Blechnum spicant*	Dubbelloof	8	7	7		GE
1157	*Blysmus compressus*	Platte bies	5	4	4		KW
1158	*Blysmus rufus*	Rode bies	4	4	4	*	GE
1156	*Bolboschoenus maritimus*	Heen	8	9	8		–
148	*Botrychium lunaria*	Gelobde maanvaren	5	5	5		KW
150	*Brachypodium pinnatum*	Gevinde kortsteel	4	5	5		–
151	*Brachypodium sylvaticum*	Boskortsteel	6	6	6		–
1802	*Brassica napus*	Koolzaad		+			–
152	*Brassica nigra*	Zwarte mosterd	7	7	8		–
1804	*Brassica rapa*	Raapzaad		+			–
153	*Briza media*	Bevertjes	8	6	6		KW
157	*Bromopsis erecta*	Bergdravik	3	4	4		GE
159	*Bromopsis inermis*	Kweekdravik	5	6	6		–
155	*Bromopsis ramosa* subsp. *benekenii*	Bosdravik		+			BE
163	*Bromopsis ramosa* subsp. *ramosa*	Ruwe dravik		+			EB

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	9b	H42 H47
i	1	2	–	3a	bP40
i	1	2	–	3a	bP60 bP40
i	1	2	–	3a	bP40
a	100	2	3	1e	P48
i	1	2	–	3b	zP20 zG20 zG40
i	1	2	–	3b	zP20 zG20 zG40
i	1	2	3	1e	bP40 P48
i	1	1	–	8a	H47kr
a	100	1	3	1a	P67 P47
20.1	300	1	–	4a	W18
19	301	1	–	4a	W18 W16
a	100	1	(3)	1g	R47kr
17	103	0	–	5a	P48 G48
i	1	0	–	4d	H28 H27 R48
i	1	0	2	4d	P48 G48
i	1	2	–	3a	–
i	1	2	3	5a	G47 bG40 G48
20.4	251	1	–	–	–
i	1	1	–	8d	H63 H69
19	103	0	2	1e	P67 G67
i	1	1	3	4c	V18 V16 G28 G27
i	1	2	3	3a	bP40
i	1	1	3	9e	H41 H62 H61 H42 H63 H43
i	1	2	3	9e	H21 H22 H41 H42 H27
i	1	2	–	2b	P28
20.1	301	2	–	2b	P28
20.1	301	2	–	2b	P28 R28
20.4	100	2	–	2b	P28
i	1	2	3	2b	P28
20.3	100	1	–	2c	P43
i	1	1	–	2c	P23 P43
i	1	1	–	9e	H41
i	1	2	–	2a	G23 G27
i	1	2	–	3c	bG20
i	1	1	3	4c	zR20 bR20 bV10 V18
i	1	1	–	7e	G43 G63 G62 G42
i	1	1	1	6c	G43
i	1	1	1	9b	H43 H47kr
17	4	0	–	1e	P48
i	1	0	3	4d	R48 P48
a	100	0	3	1e	P48
i	1	0	1	5a	G43 G42 G47
i	1	2	1	6c	G43
i	1	1	–	6c	G67 G47kr
i	1	2	–	8a	H43
i	1	2	–	8a	H43

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
2337	*Bromus hordeaceus*	Zachte dravik	9	9	9		–
160	*Bromus lepidus*	Sierlijke dravik		–			*
1610	*Bromus racemosus*	Trosdravik	7	6	5		KW
164	*Bromus secalinus*	Dreps	6	2	1		EB
167	*Bryonia dioica*	Heggenrank	7	7	8		–
5032	*Buddleja davidii*	Vlinderstruik	0	5	7	*	–
168	*Bunias orientalis*	Grote hardvrucht	4	3	4		–
169	*Bunium bulbocastanum*	Aardkastanje	3	4	4	*	KW
2459	*Bupleurum falcatum*	Sikkelgoudscherm	0	0	1		–
170	*Bupleurum tenuissimum*	Fijn goudscherm	5	3	3		BE
171	*Butomus umbellatus*	Zwanenbloem	8	8	8		–
172	*Cakile maritima*	Zeeraket	6	6	6		–
173	*Calamagrostis canescens*	Hennegras	8	9	8		–
174	*Calamagrostis epigejos*	Duinriet	7	8	8		–
176	*Calamagrostis pseudophragmites*	Rivierstruisriet	1	0	0		VN
175	*Calamagrostis stricta*	Stijf struisriet	3	6	4	*	BE
49	*Calammophila ×baltica*	Noordse helm	4	6	6	*	–
177	*Calepina irregularis*	Kalkraket	2	3	2		BE
178	*Calla palustris*	Slangenwortel	5	6	6		–
2460	*Callitriche brutia*	Gesteeld sterrenkroos		+			–
179	*Callitriche cophocarpa*	Gekield sterrenkroos		+			VN
180	*Callitriche hamulata*	Haaksterrenkroos		+			–
181	*Callitriche hermaphroditica*	Rond sterrenkroos		+			BE
182	*Callitriche obtusangula*	Stomphoekig sterrenkroos		+			–
183	*Callitriche palustris*	Klein sterrenkroos		+			EB
184	*Callitriche platycarpa*	Gewoon sterrenkroos		+			–
185	*Callitriche stagnalis*	Gevleugeld sterrenkroos		+			–
5315	*Callitriche truncata*	Doorschijnend sterrenkroos		+			–
186	*Calluna vulgaris*	Struikhei	9	9	8		–
1460	*Caltha palustris* subsp. *araneosa*	Spindotterbloem		+			KW
187	*Caltha palustris* subsp. *palustris*	Gewone dotterbloem		+			–
188	*Calystegia sepium*	Haagwinde	9	9	9		–
189	*Calystegia soldanella*	Zeewinde	5	5	5		–
190	*Camelina sativa* subsp. *alyssum*	Vlashuttentut	2	0	0		VN
191	*Campanula glomerata*	Kluwenklokje	3	4	3		BE
192	*Campanula latifolia*	Breed klokje	4	4	4	*	–
193	*Campanula patula*	Weideklokje	2	1	4	#	BE
194	*Campanula persicifolia*	Prachtklokje	4	4	5		–
195	*Campanula rapunculoides*	Akkerklokje	6	6	6		–
196	*Campanula rapunculus*	Rapunzelklokje	7	6	6		KW
198	*Campanula rotundifolia*	Grasklokje	8	8	8		–
199	*Campanula trachelium*	Ruig klokje	5	5	5		–
200	*Capsella bursa-pastoris*	Herderstasje	9	9	9		–
201	*Cardamine amara*	Bittere veldkers	6	7	7		–
202	*Cardamine flexuosa*	Bosveldkers	6	8	8		–
203	*Cardamine hirsuta*	Kleine veldkers	8	9	9		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	1	5a	G68 G48 G67 G47 G63
20.1	4	2	–	–	–
i	1	2	–	5b	G27 G47
a	100	1	–	1c	P47 P67
i	1	1	–	8d	H69 H47kr H63
20.2	250	0	–	6a	P60mu P40mu P67ss
19	104	1	–	1g	R48
i	1	1	–	6c	G47kr G63
20.3	100	1	–	6c	G47kr
i	1	2	–	3c	bP40 bG40
i	1	1	–	4c	V18 V16
i	1	1	1	3a	bP60 bP40
i	1	1	2	7a	R27 H22 H27 R24
i	1	1	2	8a	R44 R64 H63 G63 H62
i	1	2	–	4c	–
i	1	1	–	7a	G22 G27
i	1	1	0	3a	R64 bR60
19	108	0	–	1b	–
i	1	1	–	4c	V15 V16zt
i	1	1	–	4a	–
i	1	1	–	4a	–
i	1	1	–	4a	W15 P27
i	1	1	–	4a	W18
i	1	1	–	4a	W18 W16
i	1	1	–	9a	P27
i	1	1	–	4a	W18 W16
i	1	1	3	9a	H28 W18 P28
20.4	102	1	–	–	W18
i	1	2	3	7e	G61 G41 H61
i	1	1	(1)	4d	H28 R28
i	1	1	(1)	5b	G27 H28 H27 G28
i	1	2	2	4d	R48 R28 R27 R47 bR40 H28 H48
i	1	2	–	3a	bP60
a	100	0	–	1a	–
i	1	1	–	6c	G47kr
19	100	1	3	9c	H47
i	1	1	1	5a	G47
i	1	1	1	8c	H43
i	1	1	1	1g	G47kr P47kr
i	1	1	1	8c	G47kr
i	1	1	2	6d	G67 G62
i	1	1	–	9d	H43
i	1	1	3	1d	P48tr P68
i	1	0	–	9a	H28 H27br R28
i	1	0	3	9a	H27 H47 H28
i	1	0	3	6b	H63 H69 G63 P63 P47 P67

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
204	*Cardamine impatiens*	Springzaadveldkers	3	3	5		–
205	*Cardamine pratensis*	Pinksterbloem	9	9	9		–
207	*Carduus acanthoides*	Langstekelige distel	3	2	4	*	–
208	*Carduus crispus*	Kruldistel	8	8	9		–
209	*Carduus nutans*	Knikkende distel	7	7	7		–
210	*Carduus tenuiflorus*	Tengere distel	3	1	2		EB
211	*Carex acuta*	Scherpe zegge	8	9	8	*	–
212	*Carex acutiformis*	Moeraszegge		+			–
213	*Carex appropinquata*	Paardenhaarzegge	3	5	4	*	KW
214	*Carex aquatilis*	Noordse zegge	0	7	6	t	KW
215	*Carex arenaria*	Zandzegge	8	8	8	*	*
216	*Carex brizoides*	Trilgraszegge	1	2	3	*	GE
217	*Carex buxbaumii*	Knotszegge	2	4	3	*	GE
218	*Carex caryophyllea*	Voorjaarszegge	5	5	5	*	KW
1400	*Carex cespitosa*	Polzegge	0	2	0		GE
2455	*Carex crawfordii*	IJle hazenzegge		–			*
219	*Carex curta*	Zompzegge	7	8	8		–
221	*Carex diandra*	Ronde zegge	5	5	5	*	KW
222	*Carex digitata*	Vingerzegge	3	4	3	*	BE
223	*Carex dioica*	Tweehuizige zegge	4	3	1	*	EB
224	*Carex distans*	Zilte zegge	6	6	6	*	–
225	*Carex disticha*	Tweerijige zegge	8	8	8	*	–
226	*Carex divisa*	Kustzegge		–			*
1611	*Carex divulsa*	Groene bermzegge	4	3	4		KW
228	*Carex echinata*	Sterzegge	7	7	6		–
237	*Carex elata*	Stijve zegge	7	7	7	*	–
229	*Carex elongata*	Elzenzegge	6	7	7	*	–
230	*Carex ericetorum*	Heidezegge	3	1	2	*	BE
231	*Carex extensa*	Kwelderzegge	5	5	5		–
232	*Carex flacca*	Zeegroene zegge	7	7	7	*	–
233	*Carex flava*	Gele zegge	3	2	2	*	BE
234	*Carex hartmanii*	Kleine knotszegge	0	1	1		GE
235	*Carex hirta*	Ruige zegge	8	9	9		–
236	*Carex hostiana*	Blonde zegge	6	5	5		BE
238	*Carex laevigata*	Gladde zegge	2	0	1	*	GE
239	*Carex lasiocarpa*	Draadzegge	6	6	6	*	KW
240	*Carex lepidocarpa*	Schubzegge	4	0	1	*	BE
241	*Carex ligerica*	Rivierduinzegge		–			*
242	*Carex limosa*	Slijkzegge	4	2	0	#	VN
243	*Carex muricata*	Dichte bermzegge	4	3	4	*	BE
244	*Carex nigra*	Zwarte zegge	8	9	8	*	–
261	*Carex oederi* subsp. *oederi*	Dwergzegge		+			–
220	*Carex oederi* subsp. *oedocarpa*	Geelgroene zegge		+			–
245	*Carex otrubae*	Valse voszegge		+			–
246	*Carex ovalis*	Hazenzegge	8	8	8	*	–
247	*Carex pallescens*	Bleke zegge	6	6	6		KW
248	*Carex panicea*	Blauwe zegge	8	8	7		–
249	*Carex paniculata*	Pluimzegge	7	8	8	*	–
250	*Carex pendula*	Hangende zegge	3	2	3		GE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	3	9a	–
i	1	1	2	5a	G27 G28 G47 G48 H27
a	100	1	1	1f	R67
i	1	1	–	1g	R48 R68
i	1	1	–	1f	G47kr G67
i	1	1	2	1f	–
i	1	1	3	4c	R27 V16 R28 H27 H28
i	1	1	2	4c	R27 H27
i	1	2	–	7c	G27 H27
i	1	1	1	4c	G27 V16zt
i	1	1	–	6b	G63 G62 P63 P62 H63 H62
19	102	1	3	9a	H42 H47
i	1	0	3	7c	G22
i	1	1	1	6c	G43 G63 G42 G62
i	1	1	1	7a	G27
20.3	301	1	–	–	–
i	1	1	–	7a	H22 H21 G22 G21
i	1	2	2	7b	V12 G22
i	1	1	2	9d	H43
i	1	2	–	7b	G22
i	1	1	3	3c	bG40 bG20
i	1	2	1	5b	G27 G28
20.3	102	2	–	–	bG20
i	1	1	–	8c	H47kr G47kr
i	1	2	1	7a	G22
i	1	1	3	4c	G27 H27 V15 V16zt
i	1	1	–	9a	H22 H27
i	1	1	–	7e	G62
i	1	1	2	3c	bG20 zG20
i	1	1	2	7b	G43 G23
i	1	2	–	7b	G27 G22 G23
i	1	0	1	7a	G22
i	1	2	1	2a	G28 G47 G67 G27 G48 G68
i	1	2	–	7c	G22
i	1	1	–	9a	H27br
i	1	2	–	7a	V12 V11
i	1	2	–	7b	G23
i	1	1	–	6b	–
i	1	1	–	7d	V12 V11 G21 G22
i	1	1	–	8b	G67 G47
i	1	0	1	7a	G22 G27 G42 G21 G41
i	1	1	–	7c	G23 P23 P22 G22
i	1	1	–	7a	G22 G27
i	1	2	2	2a	bG40 bG20 G28 G27 G47
i	1	1	2	2a	G47 G42
i	1	1	3	8a	G42 G22 H42
i	1	1	2	7c	G22 G42
i	1	2	–	4c	V16zt H27
i	1	0	3	9a	H27br

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
251	*Carex pilulifera*	Pilzegge	7	8	8	*	–
253	*Carex praecox*	Vroege zegge	2	1	2	#	BE
254	*Carex pseudocyperus*	Hoge cyperzegge	8	8	8	*	–
255	*Carex pulicaris*	Vlozegge	6	5	4		BE
256	*Carex punctata*	Stippelzegge	2	3	2		GE
257	*Carex reichenbachii*	Valse zandzegge		–			*
258	*Carex remota*	IJle zegge	7	8	8		–
259	*Carex riparia*	Oeverzegge		+			–
260	*Carex rostrata*	Snavelzegge	8	8	8	*	–
262	*Carex spicata*	Gewone bermzegge	7	7	7		–
263	*Carex strigosa*	Slanke zegge	2	3	2	*	KW
264	*Carex sylvatica*	Boszegge	5	6	5		–
265	*Carex tomentosa*	Viltzegge	2	0	1	#	VN
266	*Carex trinervis*	Drienervige zegge	6	6	6		–
267	*Carex vesicaria*	Blaaszegge	7	7	7	*	–
268	*Carex vulpina*	Voszegge		+			KW
2419	*Carex vulpinoidea*	Ribbelzegge	2	1	1		–
269	*Carlina vulgaris*	Driedistel	6	6	6		KW
270	*Carpinus betulus*	Haagbeuk	7	8	8	h	–
271	*Carum carvi*	Karwij	7	7	6		GE
272	*Carum verticillatum*	Kranskarwij	4	0	1	#	EB
273	*Castanea sativa*	Tamme kastanje	6	8	8	h	–
274	*Catabrosa aquatica*	Watergras	6	7	7		–
275	*Catapodium marinum*	Laksteeltje	3	3	3		GE
276	*Catapodium rigidum*	Stijf hardgras	1	3	3	*	GE
278	*Centaurea calcitrapa*	Kalketrip	4	0	2		EB
279	*Centaurea cyanus*	Korenbloem	9	8	7		GE
1766	*Centaurea jacea*	Knoopkruid	9	9	9		–
284	*Centaurea scabiosa*	Grote centaurie	5	5	5		KW
5314	*Centaurea stoebe*	Rijncentaurie		–			*
286	*Centaurium erythraea*	Echt duizendguldenkruid	7	7	7		–
285	*Centaurium littorale*	Strandduizendguldenkruid	6	6	6		–
287	*Centaurium pulchellum*	Fraai duizendguldenkruid	6	6	7		–
289	*Cephalanthera damasonium*	Bleek bosvogeltje	2	2	2		KW
290	*Cephalanthera longifolia*	Wit bosvogeltje	2	1	0		BE
291	*Cephalanthera rubra*	Rood bosvogeltje	1	2	0		VN
292	*Cerastium arvense*	Akkerhoornbloem	8	8	8		–
294	*Cerastium brachypetalum*	Kalkhoornbloem	1	0	1	#	GE
293	*Cerastium diffusum*	Scheve hoornbloem	6	5	6		–
1465	*Cerastium fontanum* subsp. *holosteoides*	Glanzige hoornbloem		+			KW
296	*Cerastium fontanum* subsp. *vulgare*	Gewone hoornbloem		+			–
295	*Cerastium glomeratum*	Kluwenhoornbloem	7	8	9		–
297	*Cerastium pumilum*	Steenhoornbloem	3	2	3	*	GE
298	*Cerastium semidecandrum*	Zandhoornbloem	8	8	9		–
362	*Ceratocapnos claviculata*	Rankende helmbloem	8	8	8		–
1759	*Ceratochloa carinata*	Gekielde dravik	0	4	6		–
299	*Ceratophyllum demersum*	Grof hoornblad	7	8	9		–
300	*Ceratophyllum submersum*	Fijn hoornblad	6	6	5		–
301	*Ceterach officinarum*	Schubvaren	2	2	3		GE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	3	7e	G61 G41 G42 H61 H62
i	1	2	–	6b	G67
i	1	2	–	4c	V16zt H27 R27
i	1	1	–	7c	G22
i	1	1	–	3c	G23 G42
i	1	1	–	9e	–
i	1	2	3	9a	H27 H47
i	1	1	2	4c	R28 R27 H27 V16 V18 H28
i	1	1	1	7a	V11 V12 G22 G21 V15 G27
i	1	1	–	8b	G47kr
i	1	1	3	9a	H27br
i	1	2	3	9b	H43 H42
i	1	1	–	6c	G47kr
i	1	0	1	7a	G23 G22
i	1	1	2	4c	G27 G22 V16zt H27
i	1	2	–	2a	G28 G27
20.2	301	0	–	2a	G28
i	1	0	1	6c	G43 G63
i	1	1	1	9d	H42 H43 H47
i	1	2	1	5a	G47kr
i	1	2	–	7c	G22
a	105	0	–	9e	H62 H42 H61 H41
i	1	0	–	2b	P28 V18
i	1	0	–	3c	bP60 bP40
i	1	0	–	6c	P63ss P67ss
a	105	2	–	1f	G47kr
a	111	2	2	1c	P67
i	1	2	1	5a	G47 G43 G42
i	1	2	1	6c	G43 G47kr
20.3	103	2	3	–	–
i	1	1	3	8a	P47 P43 P42
i	1	0	3	2c	P43 P23 bP40 bP20
i	1	0	3	2c	bP20 P23 bP40 P43 P47kr
i	1	2	–	9d	H43
i	1	2	–	9d	H43
i	1	2	–	9d	H43
i	1	1	3	6c	G67 G63 G62
20.2	103	1	–	6b	–
i	1	1	3	3a	bP60 P63 bP40
i	1	2	(3)	4d	G47 G48
i	1	1	3	5a	G47 G48 bG40
i	1	1	2	1e	P68 P48 P67 P47
i	1	2	1	6b	P67
i	1	2	3	6b	P63 P62 P67
i	1	0	–	9e	H41 H61
20.2	301	2	–	1g	G47 G67
i	1	1	1	4a	W18
i	1	1	–	4a	bW10 W18
i	1	1	–	6a	P60mu

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
743	*Chaenorhinum minus*	Kleine leeuwenbek	6	7	7		–
302	*Chaerophyllum bulbosum*	Knolribzaad	3	4	5		–
303	*Chaerophyllum temulum*	Dolle kervel	8	8	8		–
450	*Chamerion angustifolium*	Wilgenroosje	8	9	9		–
305	*Chelidonium majus*	Stinkende gouwe	8	8	9		–
306	*Chenopodium album*	Melganzenvoet	9	9	9		–
2477	*Chenopodium ambrosioides*	Welriekende ganzenvoet		–			*
307	*Chenopodium bonus–henricus*	Brave hendrik	5	4	2		EB
5174	*Chenopodium botrys*	Druifkruid	2	3	4		–
309	*Chenopodium chenopodioides*	Beursjesganzenvoet		–			*
310	*Chenopodium ficifolium*	Stippelganzenvoet	7	8	8		–
311	*Chenopodium foliosum*	Rode aardbeispinazie	3	4	5		–
312	*Chenopodium glaucum*	Zeegroene ganzenvoet	6	7	8		–
313	*Chenopodium hybridum*	Esdoornganzenvoet	4	5	5		–
314	*Chenopodium murale*	Muurganzenvoet	6	4	5		–
315	*Chenopodium polyspermum*	Korrelganzenvoet	7	8	8		–
2456	*Chenopodium pumilio*	Liggende ganzenvoet	0	2	5		–
316	*Chenopodium rubrum*	Rode ganzenvoet	8	8	8		–
318	*Chenopodium vulvaria*	Stinkende ganzenvoet	3	2	2		EB
1677	*Chondrilla juncea*	Knikbloem	3	0	2		EB
321	*Chrysanthemum segetum*	Gele ganzenbloem	8	8	8		–
322	*Chrysosplenium alternifolium*	Verspreidbladig goudveil	5	5	4		–
323	*Chrysosplenium oppositifolium*	Paarbladig goudveil	4	5	4		–
324	*Cicendia filiformis*	Draadgentiaan	6	3	4		BE
325	*Cichorium intybus*	Wilde cichorei	7	7	7		–
326	*Cicuta virosa*	Waterscheerling	8	7	7		–
327	*Circaea alpina*	Alpenheksenkruid	1	1	1	#	GE
328	*Circaea ×intermedia*	Klein heksenkruid	2	1	2	#	GE
329	*Circaea lutetiana*	Groot heksenkruid	6	7	7		–
330	*Cirsium acaule*	Aarddistel	4	4	3		EB
331	*Cirsium arvense*	Akkerdistel	9	9	9		–
332	*Cirsium dissectum*	Spaanse ruiter	7	6	6		KW
333	*Cirsium eriophorum*	Wollige distel	2	2	3		GE
334	*Cirsium oleraceum*	Moesdistel	4	5	4		–
335	*Cirsium palustre*	Kale jonker	9	9	9		–
336	*Cirsium vulgare*	Speerdistel	9	9	9		–
337	*Cladium mariscus*	Galigaan	6	6	5		KW
338	*Claytonia perfoliata*	Winterpostelein	6	7	8		–
1679	*Claytonia sibirica*	Roze winterpostelein	0	5	7		–
339	*Clematis vitalba*	Bosrank	6	6	7	*	–
340	*Clematis viticella*	Italiaanse clematis	2	1	2	h	–
1141	*Clinopodium acinos*	Kleine steentijm	5	4	5		KW
2421	*Clinopodium calamintha*	Kleine bergsteentijm	0	2	2		–
1142	*Clinopodium menthifolium*	Bergsteentijm	1	1	2	*	GE
1143	*Clinopodium vulgare*	Borstelkrans	6	5	5		KW
342	*Cochlearia danica*	Deens lepelblad	6	7	8		–

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
a	100	0	3	1b	P47kr
i	1	0	–	4d	R47kr R48
i	1	0	3	8b	H47 H48 R47 R48
i	1	2	3	8a	R67 R47 R64 R44
i	1	0	3	8b	R47 R67 H47 H69
i	1	1	3	1e	P68 P48
20.4	308	1	–	–	P48 P68 R48 R68
a	100	2	–	1g	P48
20.1	110	1	–	1e	P48 P68
i	1	1	–	–	–
a	103	1	–	1e	P48 P68
19	105	2	–	1f	P67 P63
a	100	1	–	2b	P28 P48
a	100	1	3	1e	P48
a	100	1	–	1f	P68 P48
a	100	1	3	1a	P48
20.4	501	1	–	2a	P48 P68
i	1	2	3	2b	P28 bP20 P48
a	100	1	–	1e	P48
i	1	2	–	1f	R67
a	100	1	3	1c	P47
i	1	0	–	9a	H27br
i	1	0	–	9a	H27br
i	1	0	–	2c	P22
a	100	0	–	5a	G47kr
i	1	1	–	4c	V16zt
i	1	1	1	9a	H47 H27br
i	1	0	1	9a	H47
i	1	1	1	9a	H47
i	1	0	2	6c	G43
i	1	2	2	1g	R48 P48 bR40 R68 P68 bR60
i	1	2	–	7c	G22
i	1	0	–	5a	G47kr
i	1	2	1	5b	R27 H27 G27
i	1	2	1	5b	G27 H27 G22 G23
i	1	1	1	1e	R48 G47 H63 H69 H48 G68
i	1	2	–	4c	R27 V16
19	301	1	–	8b	H69 H63
20.2	307	1	2	9e	H47
i	1	1	–	8d	H43 H47kr
19	109	1	–	8d	H47kr
i	1	1	3	6c	G63 P63
i	1	1	–	8c	P67ss
i	1	1	–	8c	P63ss
i	1	1	–	8c	G43 H43 G47kr
i	1	1	–	3c	bP60 bP40 G63

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
341	*Cochlearia officinalis* subsp. *anglica*	Engels lepelblad		+			KW
343	*Cochlearia officinalis* subsp. *officinalis*	Echt lepelblad		+			KW
344	*Coeloglossum viride*	Groene nachtorchis	3	3	2		BE
1728	*Coincya monensis* subsp. *recurvata*	Muurbloemmosterd	5	2	5		–
345	*Colchicum autumnale*	Herfsttijloos	5	4	4		BE
347	*Conium maculatum*	Gevlekte scheerling	6	6	6		–
2461	*Conopodium majus*	Franse aardkastanje	0	0	1		GE
396	*Consolida regalis*	Wilde ridderspoor	4	3	3		EB
349	*Convallaria majalis*	Lelietje–van–dalen	7	8	8		–
350	*Convolvulus arvensis*	Akkerwinde	9	9	9		–
475	*Conyza canadensis*	Canadese fijnstraal	8	9	9		–
5328	*Conyza sumatrensis*	Hoge fijnstraal		–			*
352	*Corallorhiza trifida*	Koraalwortel	2	0	0		VN
353	*Corispermum intermedium*	Smal vlieszaad	5	6	6		–
354	*Corispermum marschallii*	Breed vlieszaad	5	0	0		VN
1422	*Cornus mas*	Gele kornoelje	2	5	5	h	GE
355	*Cornus sanguinea*	Rode kornoelje	7	8	8	h	–
356	*Cornus suecica*	Zweedse kornoelje	2	1	1	#	EB
358	*Coronopus didymus*	Kleine varkenskers	5	7	8		–
359	*Coronopus squamatus*	Grove varkenskers	8	8	8		–
360	*Corrigiola litoralis*	Riempjes	6	5	4		BE
361	*Corydalis cava*	Holwortel	2	4	5		–
365	*Corydalis solida*	Vingerhelmbloem	6	6	6		–
366	*Corylus avellana*	Hazelaar	8	8	9	h	–
367	*Corynephorus canescens*	Buntgras	8	8	8		–
5172	*Cotoneaster integerrimus*	Wilde dwergmispel		–			*
1760	*Cotula coronopifolia*	Goudknopje	0	2	4		–
368	*Crambe maritima*	Zeekool	1	4	5	*	–
5307	*Crassula helmsii*	Watercrassula		–			*
1287	*Crassula tillaea*	Mosbloempje	3	3	3		GE
370	*Crataegus laevigata*	Tweestijlige meidoorn	7	7	7	h	–
369	*Crataegus monogyna*	Eenstijlige meidoorn	9	9	9	h	–
371	*Crepis biennis*	Groot streepzaad	8	7	7		–
372	*Crepis capillaris*	Klein streepzaad	9	9	9		–
1768	*Crepis foetida*	Stinkend streepzaad	1	2	2		BE
373	*Crepis paludosa*	Moerasstreepzaad	5	6	5		KW
374	*Crepis tectorum*	Smal streepzaad	5	5	6		–
375	*Crepis vesicaria* subsp. *taraxacifolia*	Paardenbloemstreepzaad	5	6	5		–
376	*Crithmum maritimum*	Zeevenkel	3	2	3		GE
1622	*Crocus tommasinianus*	Boerenkrokus	4	4	4	#	–
1623	*Crocus vernus*	Bonte krokus	3	5	5	*	–
548	*Cruciata laevipes*	Kruisbladwalstro	7	6	6		KW
377	*Cucubalus baccifer*	Besanjelier	3	3	3		BE
1681	*Cuscuta campestris*	Veldwarkruid	0	3	3		–
378	*Cuscuta epilinum*	Vlaswarkruid	2	0	0		VN
379	*Cuscuta epithymum*	Klein warkruid	7	6	6		KW
380	*Cuscuta europaea*	Groot warkruid	6	6	6		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	3b	zG40
i	1	1	–	4c	bR20
i	1	2	–	7c	G42
19	103	0	–	1e	P67
i	1	0	1	5b	H47kr G47kr
a	100	0	3	1g	R47
20.3	100	0	2	9b	–
a	100	0	–	1b	P47kr
i	1	1	1	9e	H62 H42 H43
i	1	1	1	1e	P47 P48 P67 P68
18	301	1	3	1d	P67 P68 P48 P47
20.4	305	1	–	–	P67 P68
i	1	2	–	9e	H42
20.1	103	1	–	1f	P67 P68
19	104	2	–	1f	P67
i	1	2	–	9c	H43 H47kr
i	1	2	1	8d	H43 H47kr
i	1	2	–	9e	H41
18	305	0	–	1d	P48
i	1	0	–	1d	P48tr
i	1	1	–	1d	P47 P42 P67
i	1	0	–	9c	H47kr
i	1	0	–	9c	H47
i	1	1	1	9b	H43 H42 H47
i	1	0	3	6d	P62 P61
20.3	100	1	–	–	–
19	405	0	–	2b	bP20
20.2	100	1	–	3a	bP40
20.4	500	0	–	–	W16 P27
i	1	2	–	2c	P47
i	1	2	1	9b	H47 H42 H43
i	1	2	1	8d	H47 H48 H69 H63 H43 H62 H42
i	1	0	–	5a	G47kr
i	1	1	1	1e	G47 G48 G67 G68
a	102	1	–	1f	P67
i	1	1	1	5b	G27 H27
20.2	106	1	–	1e	P67
i	1	1	–	5a	G47kr
i	1	1	–	3a	bP40
19	160	0	–	9c	G47 H47
19	103	0	–	9c	G47 H47
i	1	1	1	8b	R47 G47
i	1	2	–	4d	H47kr
20.3	301	2	–	1a	P48
a	100	2	–	1a	–
i	1	2	3	7e	G61 G41 G63 G43
i	1	2	–	4d	R48 H48 H47

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
381	*Cuscuta gronovii*	Oeverwarkruid	0	1	2		–
382	*Cuscuta lupuliformis*	Hopwarkruid	2	4	5		–
741	*Cymbalaria muralis*	Muurleeuwenbek	6	6	7		–
384	*Cynodon dactylon*	Handjesgras	5	6	6		–
385	*Cynoglossum officinale*	Veldhondstong	6	6	6		–
386	*Cynosurus cristatus*	Kamgras	9	9	8		GE
5175	*Cyperus esculentus*	Knolcyperus	0	3	3		–
387	*Cyperus flavescens*	Geel cypergras	3	0	0		VN
388	*Cyperus fuscus*	Bruin cypergras	4	4	5		–
389	*Cystopteris fragilis*	Blaasvaren	4	4	3		BE
1140	*Cytisus scoparius*	Brem	9	9	9	*	–
390	*Dactylis glomerata*	Kropaar	9	9	9		–
391	*Dactylis polygama*	IJle kropaar		–			*
883	*Dactylorhiza fuchsii*	Bosorchis		+			+
884	*Dactylorhiza incarnata*	Vleeskleurige orchis	6	6	6		KW
885	*Dactylorhiza maculata*	Gevlekte orchis		+			+
886	*Dactylorhiza majalis* subsp. *majalis*	Brede orchis		+			KW
890	*Dactylorhiza majalis* subsp. *praetermissa*	Rietorchis		+			–
1199	*Danthonia decumbens*	Tandjesgras	8	8	8		–
392	*Daphne mezereum*	Rood peperboompje	3	4	3		KW
393	*Datura stramonium*	Doornappel	6	6	7		–
394	*Daucus carota*	Peen	9	9	9		–
397	*Deschampsia cespitosa*	Ruwe smele	8	9	8		–
398	*Deschampsia flexuosa*	Bochtige smele	8	9	9		–
399	*Deschampsia setacea*	Moerassmele	6	4	3	*	EB
400	*Descurainia sophia*	Sofiekruid	7	6	7		–
402	*Dianthus armeria*	Ruige anjer	5	4	4		BE
403	*Dianthus carthusianorum*	Karthuizer anjer	2	0	1	#	EB
404	*Dianthus deltoides*	Steenanjer	6	6	6		KW
405	*Dianthus superbus*	Prachtanjer	2	0	0	#	VN
406	*Digitalis purpurea*	Vingerhoedskruid	6	8	8		–
407	*Digitaria ischaemum*	Glad vingergras	7	8	8		–
408	*Digitaria sanguinalis*	Harig vingergras	6	6	7		–
776	*Diphasiastrum tristachyum*	Kleine wolfsklauw	3	2	3		EB
409	*Diplotaxis muralis*	Kleine zandkool	6	6	6		–
410	*Diplotaxis tenuifolia*	Grote zandkool	7	7	8		–
412	*Dipsacus fullonum*	Grote kaardebol	7'	7	8		–
411	*Dipsacus pilosus*	Kleine kaardebol	4	4	5		–
2483	*Dittrichia graveolens*	Kamferalant		–			*
413	*Doronicum pardalianches*	Hartbladzonnebloem		+			–
414	*Doronicum plantagineum*	Weegbreezonnebloem		+			–
415	*Draba muralis*	Wit hongerbloempje	4	4	4		–
417	*Drosera intermedia*	Kleine zonnedauw	8	7	7		GE
416	*Drosera longifolia*	Lange zonnedauw	5	2	1	#	EB
418	*Drosera rotundifolia*	Ronde zonnedauw	8	7	7		GE
1607	*Dryopteris affinis*	Geschubde mannetjesvaren	0	4	3	*	–
426	*Dryopteris carthusiana*	Smalle stekelvaren		+			–
420	*Dryopteris cristata*	Kamvaren	6	7	6	*	–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
20.1	301	2	–	4d	R48 H48
20.1	103	2	–	4d	R47kr H47kr
17	105	0	–	6a	P40mu P60mu
19	4	1	–	6b	P67 P47
i	1	1	1	1f	P63 H63
i	1	2	1	5a	G47
20.3	100	1	–	1a	P48 P68
i	1	2	–	2c	P27 P22
i	1	2	–	2c	P28 P27
i	1	1	–	6a	P40mu
i	1	0	3	6d	H62 H61
i	1	1	1	5a	G48 H48 G47
i	1	1	–	9d	–
i	1	2	–	9d	G43
i	1	2	–	7b	G23
i	1	2	–	7c	G42 G41 G22 G21
i	1	2	–	7c	G27
i	1	2	–	5b	G27 G23 G22
i	1	1	2	7e	G42 G62 G61 G41
i	1	1	–	9d	H43
18	301	0	3	1e	P68 P48
i	1	2	2	5a	G47kr G43 G63 G67
i	1	0	2	2a	H47 H42 H27 G47 G27
i	1	2	1	9e	R64 H61 G61
i	1	1	–	4b	V12 P22
a	100	1	–	1f	P67
i	1	0	–	8c	P47kr G47kr
i	1	0	–	6c	G62
i	1	0	1	6d	G67 G62
i	1	0	–	7c	G22
i	1	0	3	8a	H42 H47 R44
a	100	1	3	1d	P68 P47 P48
a	100	1	3	1e	P68 P48
i	1	1	–	7e	G61
19	103	1	–	1f	P67
a	100	1	–	1f	P63 P67
a	103	1	–	1f	G47kr
i	1	1	–	8a	H47kr
20.4	113	1	–	–	P48
i	1	1	–	9c	H47
19	102	1	–	9c	H47
i	1	0	–	6c	P67 P47
i	1	0	–	7d	P21
i	1	1	–	7d	G22
i	1	2	3	7d	P21 G21 G22
i	1	1	–	9b	H47
i	1	1	–	9e	H22 H27 H41 H42 H21 G22 P40mu
i	1	1	–	7a	H22 G22 R24

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
419	*Dryopteris dilatata*	Brede stekelvaren		+			–
421	*Dryopteris filix-mas*	Mannetjesvaren	8	8	8		–
428	*Echinochloa crus-galli*	Europese hanenpoot	8	8	9		–
429	*Echinodorus ranunculoides*	Stijve moerasweegbree		+			BE
430	*Echinodorus repens*	Kruipende moerasweegbree		+			KW
431	*Echium vulgare*	Slangenkruid	7	7	7		–
432	*Elatine hexandra*	Gesteeld glaskroos	2	5	4		–
433	*Elatine hydropiper*	Klein glaskroos	3	0	2		KW
435	*Eleocharis acicularis*	Naaldwaterbies	6	7	7	*	–
436	*Eleocharis multicaulis*	Veelstengelige waterbies	6	6	6	*	–
439	*Eleocharis ovata*	Eivormige waterbies	0	0	1		GE
437	*Eleocharis palustris*	Gewone waterbies		+			–
438	*Eleocharis quinqueflora*	Armbloemige waterbies	6	5	5	*	BE
440	*Eleocharis uniglumis*	Slanke waterbies		+			–
1154	*Eleogiton fluitans*	Vlottende bies	7	6	6		KW
441	*Elodea canadensis*	Brede waterpest	9	8	7		GE
442	*Elodea nuttallii*	Smalle waterpest	0	9	9		–
1073	*Elymus caninus*	Hondstarwegras	5	5	5	*	–
2462	*Elytrigia arenosa*	Zandkweek		+			**
5463	*Elytrigia atherica*	Strandkweek		+			**
444	*Elytrigia juncea* subsp. *boreoatlantica*	Biestarwegras	6	6	6		–
446	*Elytrigia repens*	Kweek	9	9	9		–
447	*Empetrum nigrum*	Kraaihei	7	7	7		–
448	*Epilobium ciliatum*	Beklierde basterdwederik		+			–
451	*Epilobium hirsutum*	Harig wilgenroosje	8	9	9		–
453	*Epilobium lanceolatum*	Lancetbladige basterdwederik		+			EB
454	*Epilobium montanum*	Bergbasterdwederik		+			–
455	*Epilobium obscurum*	Donkergroene basterdwederik		+			–
456	*Epilobium palustre*	Moerasbasterdwederik		+			GE
457	*Epilobium parviflorum*	Viltige basterdwederik	8	9	9		–
458	*Epilobium roseum*	Bleke basterdwederik		+			–
1642	*Epilobium tetragonum*	Kantige basterdwederik		+			–
459	*Epipactis atrorubens*	Bruinrode wespenorchis	3	2	2		KW
460	*Epipactis helleborine*	Brede wespenorchis	7	8	8		–
1423	*Epipactis muelleri*	Geelgroene wespenorchis	1	2	1	#	BE
461	*Epipactis palustris*	Moeraswespenorchis	6	6	6		KW
462	*Equisetum arvense*	Heermoes	9	9	9		–
463	*Equisetum fluviatile*	Holpijp	9	9	8		–
464	*Equisetum hyemale*	Schaafstro	6	6	5		**
465	*Equisetum ×litorale*	Bastaardpaardenstaart	5	6	7	×	–
466	*Equisetum palustre*	Lidrus	9	9	9		–
467	*Equisetum ramosissimum*	Vertakte paardenstaart	2	1	2		GE
468	*Equisetum sylvaticum*	Bospaardenstaart	5	5	4		–
469	*Equisetum telmateia*	Reuzenpaardenstaart	4	5	4		–
470	*Equisetum ×trachyodon*	Ruwe paardenstaart	0	2	2	×	–
471	*Equisetum variegatum*	Bonte paardenstaart	4	4	3		BE
1685	*Eragrostis minor*	Klein liefdegras	3	5	6		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	9e	H41 H42 H61 H22 H27 H62 H21 H47
i	1	1	–	9b	H43 H42 H47 H63
a	100	2	3	1c	P68 P48 P28
i	1	1	–	4b	W13 P23 W12 P22
i	1	1	–	4b	W12 P22
a	100	1	1	1f	P63
i	1	0	–	4b	W12 P22 W15
i	1	0	–	4b	P28 W18
i	1	1	–	4b	W12 W16 W15 P22 P27 P28
i	1	1	–	4b	W11 W12 P21 P22
i	1	1	–	2c	P28
i	1	1	2	4c	G28 V12 bG20 bV10 V18 V16 W13 G23 G27
i	1	1	–	7b	G23 bG20
i	1	1	–	2a	bG20 bV10 G23 G27
i	1	1	–	4b	W12 W15
19	301	1	0	4a	W16
20.2	301	1	–	4a	W18 W16
i	1	2	1	9b	H47
i	1	2	–	6b	–
i	1	2	1	3a	bR40
i	1	0	–	3a	bP60 bP40
i	1	2	1	1e	G68 R48 G48 R68 bR40 R47 R67 H48 H69
i	1	1	1	7e	G41 G61 H61
20.1	301	2	3	1g	P28 P48 P27 P47
i	1	2	3	4d	R28 R48 bR40 bR20
i	1	2	–	8a	P67ss
i	1	2	3	8b	P47 H47
i	1	2	–	4c	P27
i	1	2	2	7a	G27
i	1	2	1	4c	P28 R28
i	1	2	–	8b	P27 P47 H27
i	1	2	3	8a	P28 G28 P27 G27 P48 P47
i	1	2	–	8c	G43 H43
i	1	2	–	9b	H47 H63 H62 H43 H69
i	1	2	–	9d	H43
i	1	2	–	7b	G23
i	1	1	–	1e	P47 P48 P67 P68 R47 R48
i	1	2	–	4c	V16zt G27
i	1	1	–	9b	R67 H47
i	1	0	–	2a	P27 R47 G27 P47
i	1	1	–	2a	G28 G27
i	1	1	–	8c	R47
i	1	1	–	9b	H47 H27br
i	1	1	–	9a	R27 H27br
i	1	0	–	7b	G23
i	1	1	–	7b	G23
20.1	105	1	–	1d	P48tr P68 P67

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1762	*Eragrostis pilosa*	Straatliefdegras	0	6	8		–
1858	*Eranthis hyemalis*	Winterakoniet	3	5	5		–
472	*Erica cinerea*	Rode dophei	2	3	2		GE
1431	*Erica scoparia*	Bezemdophei	0	1	2	#	–
473	*Erica tetralix*	Gewone dophei	9	8	8		–
474	*Erigeron acer*	Scherpe fijnstraal	7	7	6		–
1720	*Erigeron annuus*	Zomerfijnstraal	3	5	6		–
2485	*Erigeron karvinskianus*	Muurfijnstraal		–			*
476	*Eriophorum angustifolium*	Veenpluis	8	8	7		–
477	*Eriophorum gracile*	Slank wollegras	4	4	2		EB
478	*Eriophorum latifolium*	Breed wollegras	4	1	1		EB
479	*Eriophorum vaginatum*	Eenarig wollegras	6	6	6		KW
1917	*Erodium cicutarium*	Gewone reigersbek	8	9	9		**
481	*Erodium lebelii*	Kleverige reigersbek	5	6	6	*	KW
483	*Erophila verna*	Vroegeling	8	8	9		–
484	*Erucastrum gallicum*	Schijnraket	6	6	6		–
485	*Eryngium campestre*	Kruisdistel	8	7	7		–
486	*Eryngium maritimum*	Blauwe zeedistel	6	5	5		–
487	*Erysimum cheiranthoides*	Gewone steenraket	8	8	8		–
304	*Erysimum cheiri*	Muurbloem	4	3	4		EB
488	*Erysimum hieracifolium*	Stijve steenraket	4	3	3		EB
489	*Euonymus europaeus*	Wilde kardinaalsmuts	7	8	8	*	–
490	*Eupatorium cannabinum*	Koninginnenkruid	8	9	9		–
491	*Euphorbia amygdaloides*	Amandelwolfsmelk	2	3	2		GE
492	*Euphorbia cyparissias*	Cipreswolfsmelk	6	5	6		–
2388	*Euphorbia esula*	Heksenmelk	7	7	8		–
494	*Euphorbia exigua*	Kleine wolfsmelk	7	6	5		BE
495	*Euphorbia helioscopia*	Kroontjeskruid	8	8	8		–
1689	*Euphorbia lathyrus*	Kruisbladige wolfsmelk	3	5	6		–
496	*Euphorbia palustris*	Moeraswolfsmelk	6	5	5		KW
497	*Euphorbia paralias*	Zeewolfsmelk	4	4	3		KW
498	*Euphorbia peplus*	Tuinwolfsmelk	8	8	8		–
499	*Euphorbia platyphyllos*	Brede wolfsmelk	2	1	1	#	BE
500	*Euphorbia seguieriana*	Zandwolfsmelk	5	4	3		EB
501	*Euphorbia stricta*	Stijve wolfsmelk	3	0	2		EB
511	*Euphrasia rostkoviana*	Beklierde ogentroost	3	2	2	#	EB
2316	*Euphrasia stricta*	Stijve ogentroost	8	7	7		GE
512	*Fagopyrum tataricum*	Franse boekweit	6	0	0	#	VN
513	*Fagus sylvatica*	Beuk	8	8	8	h	–
2379	*Falcaria vulgaris*	Sikkelkruid		–			*
970	*Fallopia convolvulus*	Zwaluwtong	9	9	9		–
971	*Fallopia dumetorum*	Heggenduizendknoop	7	7	8		–
1873	*Fallopia japonica*	Japanse duizendknoop	5	7	8		–
1875	*Fallopia sachalinensis*	Sachalinse duizendknoop	3	6	6		–
517	*Festuca arenaria*	Duinzwenkgras	5	6	6	*	–
514	*Festuca arundinacea*	Rietzwenkgras	8	9	9		–
1472	*Festuca cinerea*	Hard zwenkgras		+			–
1474	*Festuca filiformis*	Fijn schapengras		+			–
515	*Festuca gigantea*	Reuzenzwenkgras	7	8	7		–
1473	*Festuca ovina*	Genaald schapengras		+			EB
519	*Festuca pratensis*	Beemdlangbloem	9	9	8		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
20.2	105	1	–	1d	P48tr P67
17	103	0	–	9c	H47
i	1	0	3	7e	G41 G61
20.2	108	0	–	7e	G42
i	1	1	3	7d	G41 G21 H21
i	1	2	–	6b	G63 G43 G62
19	301	2	3	1g	P48 R47
20.4	303	2	–	–	P60mu P40mu
i	1	2	1	7d	V11 G21 G22 V12
i	1	2	–	7b	V12 G22
i	1	2	–	7b	G22
i	1	2	1	7d	G21 H21
i	1	1	1	1c	P63 P67 G63 G67 P68
i	1	1	–	6b	P63
i	1	0	2	6b	P67 P63 P62
19	103	0	3	1e	P48 P47
i	1	1	–	6c	G47kr G67
i	1	1	–	3a	bP60
a	100	0	3	1a	P48 P47
a	110	0	–	6a	P60mu
i	1	1	–	4d	R47
i	1	1	–	8d	H63 H43 H47kr H69
i	1	2	2	4d	R27 R47 H27 H47
i	1	0	–	9d	H43
i	1	0	2	6c	G63 G67
in	5	0	3	1f	G47kr G67
a	100	0	3	1b	P47kr
a	100	1	3	1a	P48
a	105	0	–	1b	P48
i	1	1	–	4d	R27 R28
i	1	1	–	3a	bP60
a	100	0	3	1a	P48
i	1	0	–	1b	P48
i	1	0	–	6c	G67 G63
i	1	0	–	1b	R48
i	1	1	–	6c	G42
i	1	0	1	7e	G42 G43
19	257	1	–	1c	P67
i	1	0	1	9b	H62 H42 H43 H61 H47 H41
20.4	115	0	1	–	–
a	100	1	3	1a	P68 P48 P67 P47 H69 H63
i	1	1	–	8b	H47 H69 R67 R47 H63
19	251	1	–	1g	R47 R48
19	204	1	–	1g	H48 H47 R48 R47
i	1	1	–	3a	P63 bP60
i	1	1	1	2a	G47 bG40
i	1	2	–	6b	G62 G67 P62
i	1	1	–	6d	G62 G42 G61 G67 G41 H62 H61
i	1	0	1	9b	H47
i	1	2	1	6d	G62 G67
i	1	2	1	5a	G47 G48

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
520	*Festuca rubra*	Rood zwenkgras	9	9	9		–
522	*Filago arvensis*	Akkerviltkruid	2	0	1	#	VN
1424	*Filago lutescens*	Geel viltkruid	2	0	1		EB
524	*Filago minima*	Dwergviltkruid	8	6	6		GE
525	*Filago pyramidata*	Spatelviltkruid	3	0	1	#	VN
523	*Filago vulgaris*	Duits viltkruid	5	4	4		EB
526	*Filipendula ulmaria*	Moerasspirea	9	9	9		–
527	*Filipendula vulgaris*	Knolspirea	2	0	1		EB
528	*Fragaria moschata*	Grote bosaardbei	3	2	1		EB
529	*Fragaria vesca*	Bosaardbei	8	7	7		GE
531	*Fraxinus excelsior*	Es	9	9	9	h	–
532	*Fritillaria meleagris*	Wilde kievitsbloem	5	6	5		BE
1691	*Fumaria capreolata*	Rankende duivenkervel	3	1	4		–
1690	*Fumaria muralis* subsp. *boraei*	Middelste duivenkervel	4	4	5		–
533	*Fumaria officinalis*	Gewone duivenkervel	8	8	8		–
534	*Gagea lutea*	Bosgeelster	3	4	4		–
535	*Gagea pratensis*	Weidegeelster	4	5	5		–
536	*Gagea spathacea*	Schedegeelster	4	4	4	*	GE
537	*Gagea villosa*	Akkergeelster	3	4	3	*	KW
538	*Galanthus nivalis*	Gewoon sneeuwklokje	6	7	7		–
539	*Galeopsis angustifolia*	Smalle raai	5	3	3		EB
540	*Galeopsis bifida*	Gespleten hennepnetel		+			–
1692	*Galeopsis ladanum*	Brede raai	4	0	0	#	VN
1403	*Galeopsis pubescens*	Zachte hennepnetel	3	1	2		EB
541	*Galeopsis segetum*	Bleekgele hennepnetel	8	7	6		KW
542	*Galeopsis speciosa*	Dauwnetel	7	7	7		–
543	*Galeopsis tetrahit*	Gewone hennepnetel		+			–
545	*Galinsoga parviflora*	Kaal knopkruid	7	8	9		–
544	*Galinsoga quadriradiata*	Harig knopkruid	5	8	9		–
546	*Galium aparine*	Kleefkruid	9	9	9		–
547	*Galium boreale*	Noords walstro	1	2	1		GE
109	*Galium glaucum*	Zeegroen walstro	1	0	0		VN
550	*Galium mollugo*	Glad walstro	9	8	8		–
110	*Galium odoratum*	Lievevrouwebedstro	5	6	6		–
2376	*Galium palustre*	Moeraswalstro	9	9	9		–
553	*Galium pumilum*	Kalkwalstro	4	4	3		KW
549	*Galium saxatile*	Liggend walstro	8	8	8		–
554	*Galium sylvaticum*	Boswalstro	3	0	0		VN
555	*Galium tricornutum*	Driehoornig walstro	4	0	0		VN
556	*Galium uliginosum*	Ruw walstro	7	8	7		–
557	*Galium verum*	Geel walstro	8	8	8		–
558	*Genista anglica*	Stekelbrem	8	7	7		GE
559	*Genista germanica*	Duitse brem	3	1	1		EB
560	*Genista pilosa*	Kruipbrem	8	7	6		KW
561	*Genista tinctoria*	Verfbrem	6	5	5		BE
566	*Gentiana cruciata*	Kruisbladgentiaan	4	3	4		GE
568	*Gentiana pneumonanthe*	Klokjesgentiaan	8	7	6		GE
562	*Gentianella amarella*	Slanke gentiaan	4	4	4		KW

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	2	5a	G47 bG40 zG40 G67 G43 G63 bP60 G62 G42
i	1	0	–	6b	P62
i	1	0	–	6b	P67
i	1	0	1	6d	P62
i	1	0	–	6b	P62
i	1	0	–	6b	P47 P67
i	1	2	1	5b	R27 H27 G27
i	1	2	–	6b	G47
i	1	2	–	9b	H47
i	1	2	2	8a	H43 G43 H63
i	1	1	1	9a	H47 H43 H48
i	1	1	–	5b	G47 G27
20.3	103	0	–	8b	H48 P48
i	1	0	–	1g	P47 P48
a	100	0	3	1a	P48 P47
i	1	0	2	9b	H47
i	1	0	–	6b	G47kr
i	1	0	–	9b	H42 H47
a	100	0	–	8b	P67 P47
18	105	0	–	9c	H47
a	103	1	–	1b	P47kr P67ss
i	1	1	1	8a	R47 H27 R27
i	1	1	–	1b	P47kr P67ss
i	1	1	–	8a	–
i	1	1	–	1c	P67
i	1	1	1	1c	P47 P48
i	1	1	2	8b	R47 P47 H47 H48 R67 H69 P67
19	305	2	3	1c	P68 P48
19	303	2	–	1a	P48 P68
i	1	1	1	8b	bR40 H48 R48 H47 R47
i	1	1	1	5b	G47
i	1	1	–	6c	–
i	1	0	1	5a	G63 G47kr H63 G43
i	1	1	1	9d	H43 H47kr
i	1	1	2	4c	G27 R27 H27 V16 G23 H28 G28 R28 G22
i	1	1	1	6c	G43
i	1	0	3	7e	G61 G42 G62 H61 G41
i	1	1	–	9d	H42 H43
a	105	1	–	1b	P47kr
i	1	1	1	7a	G23 G27 G22
i	1	0	1	6b	G63 G67 G62 G47kr G43
i	1	0	1	7e	G41 G61 G42
i	1	0	–	9e	G42
i	1	0	–	7e	G61 G41
i	1	0	1	7e	G42 G43
i	1	0	–	6c	G63
i	1	1	–	7d	G41 G42 G21 G22
i	1	0	–	7b	G23

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
563	*Gentianella campestris*	Veldgentiaan	4	3	2		EB
565	*Gentianella ciliata*	Franjegentiaan	2	3	1	#	EB
567	*Gentianella germanica*	Duitse gentiaan	3	4	2		KW
569	*Geranium columbinum*	Fijne ooievaarsbek	4	4	4		–
570	*Geranium dissectum*	Slipbladige ooievaarsbek	8	9	9		–
2443	*Geranium lucidum*	Glanzige ooievaarsbek	0	0	4		–
571	*Geranium molle*	Zachte ooievaarsbek	9	9	9		–
572	*Geranium phaeum*	Donkere ooievaarsbek	4	5	5		–
573	*Geranium pratense*	Beemdooievaarsbek	4	5	6		–
2442	*Geranium purpureum*	Klein robertskruid	0	2	4		–
574	*Geranium pusillum*	Kleine ooievaarsbek	8	9	9		–
575	*Geranium pyrenaicum*	Bermooievaarsbek	5	5	6		–
576	*Geranium robertianum*	Robertskruid	8	8	8		–
577	*Geranium rotundifolium*	Ronde ooievaarsbek	2	4	4		–
578	*Geum rivale*	Knikkend nagelkruid	4	4	4		EB
579	*Geum urbanum*	Geel nagelkruid	8	8	8		–
580	*Glaucium flavum*	Gele hoornpapaver	3	3	4		GE
581	*Glaux maritima*	Melkkruid	8	7	7		–
582	*Glechoma hederacea*	Hondsdraf	9	9	9		–
583	*Glyceria declinata*	Getand vlotgras		+			–
584	*Glyceria fluitans*	Mannagras	9	9	9		–
585	*Glyceria maxima*	Liesgras	9	9	9		–
586	*Glyceria notata*	Stomp vlotgras		+			–
1568	*Glyceria* ×*pedicellata*	Bastaardvlotgras	0	2	3	×	–
587	*Gnaphalium luteo–album*	Bleekgele droogbloem	5	6	7		–
588	*Gnaphalium sylvaticum*	Bosdroogbloem	7	7	7		GE
589	*Gnaphalium uliginosum*	Moerasdroogbloem	9	9	9		–
590	*Goodyera repens*	Dennenorchis	4	4	4		GE
591	*Gratiola officinalis*	Genadekruid	4	1	1		EB
991	*Groenlandia densa*	Paarbladig fonteinkruid	5	6	6		–
593	*Gymnadenia conopsea*	Grote muggenorchis	5	4	3		EB
422	*Gymnocarpium dryopteris*	Gebogen driehoeksvaren	4	4	4		–
425	*Gymnocarpium robertianum*	Rechte driehoeksvaren	2	3	2		GE
594	*Gypsophila muralis*	Gipskruid	3	1	3	#	EB
597	*Hammarbya paludosa*	Veenmosorchis	5	3	3		EB
598	*Hedera helix*	Klimop	8	8	9		–
1923	*Helianthemum nummularium*	Geel zonneroosje	3	3	2		GE
1614	*Helianthus tuberosus*	Aardpeer		–			*
602	*Helichrysum arenarium*	Strobloem	2	0	1		EB
603	*Helictotrichon pratense*	Beemdhaver	3	4	3	*	GE
604	*Helictotrichon pubescens*	Zachte haver	7	6	6		–
2489	*Helleborus foetidus*	Stinkend nieskruid		–			*
605	*Helleborus viridis* subsp. *occidentalis*	Wrangwortel	3	2	3		BE
606	*Heracleum mantegazzianum*	Reuzenberenklauw	6	7	8	#	–
607	*Heracleum sphondylium*	Gewone berenklauw	9	9	9		–
608	*Herminium monorchis*	Honingorchis	4	3	3		EB
609	*Herniaria glabra*	Kaal breukkruid	6	5	6		–
2439	*Herniaria hirsuta*	Behaard breukkruid	2	3	3		–
1860	*Hesperis matronalis*	Damastbloem		–			*

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	–	7e	G42
i	1	0	–	6c	G43
i	1	0	2	6c	G43
i	1	1	–	8b	G47kr
a	100	1	3	1a	G47kr P48 G48
20.3	113	1	–	1e	H47 H69
i	1	1	1	1e	G67 G63 G47
18	105	1	–	9c	H47
i	1	1	3	5a	G47kr
20.3	100	1	–	8d	P67ss
a	100	1	3	1e	P68 P67 P48
19	105	1	1	1g	G47
i	1	1	2	8b	H47 H69
i	1	1	–	1e	P67ss
i	1	2	1	9a	H47 H27
i	1	2	1	8b	H47 H43 H63
i	1	0	–	3a	bP40 bP60
i	1	2	3	3c	bG20 bP20 zG20 bG40 zG40
i	1	0	1	8b	H48 H47 G68 H69 G48 G47
i	1	1	–	9a	P28 P27
i	1	2	3	4c	V18 G28 P28
i	1	2	1	4c	V18 R28
i	1	1	–	4c	P28 V18 G28 bV10
i	1	0	–	4c	V16
i	1	2	–	2c	P47 P27
i	1	1	3	8a	G62 G67
i	1	2	3	2c	P27 P47
i	1	2	–	9e	H41 H61
i	1	1	–	2a	G27
i	1	1	0	4a	W16zt
i	1	2	–	7c	G43 G23
i	1	1	–	9d	P40mu H42
i	1	1	–	9d	P40mu H43
i	1	0	3	2c	P47
i	1	2	–	7a	V12 G22
i	1	1	1	9b	H47 H43 H42
i	1	1	1	6c	G43
20.1	301	1	–	–	R48
i	1	1	1	6b	G62
i	1	2	–	6c	G43
i	1	2	1	6c	G63 G43 G47kr
20.4	100	0	1	–	–
i	1	0	1	9c	H47kr
20.1	208	0	1	9c	R48 H48
i	1	1	1	8b	R48 H48 G48
i	1	2	–	6c	G43 G23
i	1	1	–	2a	P67 P62
20.4	105	1	–	1d	P67ss
20.4	103	0	–	–	H47 R47

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
2285	*Hieracium amplexicaule*	Stengelomvattend havikskruid	1	3	2		GE
611	*Hieracium aurantiacum*	Oranje havikskruid	4	6	7		–
615	*Hieracium caespitosum*	Weidehavikskruid	5	6	5		–
612	*Hieracium lactucella*	Spits havikskruid	6	3	3		EB
618	*Hieracium laevigatum*	Stijf havikskruid	8	8	9	*	–
2417	*Hieracium murorum*	Muurhavikskruid	5	5	5	*	KW
1407	*Hieracium peleterianum*	Vals muizenoor	0	0	3	*	GE
621	*Hieracium pilosella*	Muizenoor	9	9	8		–
5163	*Hieracium praealtum*	Grijs havikskruid	4	5	5		–
624	*Hieracium sabaudum*	Boshavikskruid	6	6	7	*	–
625	*Hieracium umbellatum*	Schermhavikskruid	8	8	8		–
5303	*Hieracium vulgatum*	Dicht havikskruid	7	8	7	*	–
626	*Hierochloe odorata*	Veenreukgras	7	6	6	*	KW
627	*Himantoglossum hircinum*	Bokkenorchis	2	1	2		GE
628	*Hippocrepis comosa*	Paardenhoefklaver	0	2	0		–
629	*Hippophae rhamnoides*	Duindoorn	7	7	7	*	–
630	*Hippuris vulgaris*	Lidsteng	7	7	7		–
1763	*Hirschfeldia incana*	Grijze mosterd	3	3	5		–
631	*Holcus lanatus*	Gestreepte witbol	9	9	9		–
632	*Holcus mollis*	Gladde witbol	9	9	9		–
633	*Holosteum umbellatum*	Heelbeen	6	4	4		BE
634	*Honckenya peploides*	Zeepostelein	6	6	6		–
1695	*Hordeum jubatum*	Kwispelgerst	4	4	4		–
635	*Hordeum marinum*	Zeegerst	6	5	4		BE
636	*Hordeum murinum*	Kruipertje	8	8	9		–
637	*Hordeum secalinum*	Veldgerst	8	8	7		GE
638	*Hottonia palustris*	Waterviolier	8	8	8		–
639	*Humulus lupulus*	Hop	9	9	9		–
778	*Huperzia selago*	Dennenwolfsklauw	2	2	2		EB
640	*Hydrocharis morsus-ranae*	Kikkerbeet	9	8	8		–
2490	*Hydrocotyle ranunculoides*	Grote waternavel	0	0	4		–
641	*Hydrocotyle vulgaris*	Gewone waternavel	9	8	8		–
642	*Hyoscyamus niger*	Bilzekruid	6	5	5		KW
643	*Hypericum canadense*	Canadees hertshooi	2	1	1		EB
647	*Hypericum dubium*	Kantig hertshooi		+			–
644	*Hypericum elodes*	Moerashertshooi	7	6	6		KW
645	*Hypericum hirsutum*	Ruig hertshooi	5	4	4		KW
646	*Hypericum humifusum*	Liggend hertshooi	7	7	7		–
1482	*Hypericum maculatum*	Gevlekt hertshooi		+			BE
648	*Hypericum montanum*	Berghertshooi	4	3	2		EB
649	*Hypericum perforatum*	Sint-Janskruid	9	9	9		–
650	*Hypericum pulchrum*	Fraai hertshooi	6	5	5		BE
651	*Hypericum tetrapterum*	Gevleugeld hertshooi	8	8	8		–
652	*Hypochaeris glabra*	Glad biggenkruid	7	5	5		BE
653	*Hypochaeris maculata*	Gevlekt biggenkruid	1	0	0		VN
654	*Hypochaeris radicata*	Gewoon biggenkruid	9	9	9		–
658	*Ilex aquifolium*	Hulst	8	8	8	*	–
659	*Illecebrum verticillatum*	Grondster	8	6	6		GE
2463	*Impatiens capensis*	Oranje springzaad	0	0	3		–
1862	*Impatiens glandulifera*	Reuzenbalsemien	4	7	8		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
19	103	1	–	6a	P60mu
i	1	1	1	6d	G47 G42
i	1	1	1	5a	G47
i	1	0	1	6d	G47 G42
i	1	0	1	9e	G67 H62 G42 G62
i	1	0	–	9d	H62 H42 P60mu
i	1	1	–	6d	G62
i	1	1	1	6b	G62 G67
20.1	5	1	–	6c	P67
i	1	1	–	9e	H42
i	1	1	1	9e	G62 G67
i	1	0	–	9e	H62 G42 G67 G62
i	1	0	–	5b	G27
i	1	2	–	6c	G43
i	1	2	1	6c	G67
i	1	1	–	8d	H63 H69
i	1	1	–	4a	W16 W18 bW10
20.3	110	0	1	1e	P48
i	1	2	3	5a	G47 G27 G48 G28 bG40 H48 H47 H27
i	1	1	1	9e	H69 R67 H47 R47 H41 H62 H61
i	1	0	–	6b	P67 P62
i	1	1	–	3a	bP40 bP60
20.1	204	1	3	3c	bG40
i	1	2	–	3c	bG40
i	1	1	–	1d	P48 P47 P68
i	1	2	1	5a	bG40 G48
i	1	1	–	4a	W16zt W15
i	1	0	–	8d	H27 H47
i	1	1	–	7e	G41 H41
i	1	2	–	4a	W16
20.4	301	1	–	4a	W18
i	1	1	3	2a	G23 G22 G27
a	100	2	3	1f	P47kr P67
20.1	306	0	–	2c	P22 P42
i	1	0	3	7e	G47 G27
i	1	0	–	4b	P22 W12
i	1	0	3	8a	H43
i	1	0	3	2c	P47 P42
i	1	0	3	7e	–
i	1	0	–	9d	H43 H42
i	1	0	3	6d	G67 G62 G47
i	1	0	3	9e	H62 G42 H42
i	1	0	3	5b	G27 R27
i	1	2	–	1c	P67
i	1	2	–	7e	G62
i	1	2	1	6b	G67 G62 G42 G47
i	1	2	1	9e	H42
i	1	1	–	2c	P42 P47
20.4	301	0	1	4d	H28
20.1	252	0	–	4d	R48 R28 H48 H28

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
660	*Impatiens noli-tangere*	Groot springzaad	6	7	7		–
661	*Impatiens parviflora*	Klein springzaad	5	7	8		–
662	*Inula britannica*	Engelse alant	6	5	6		–
663	*Inula conyzae*	Donderkruid	5	6	6		–
664	*Inula salicina*	Wilgalant	2	0	0		VN
665	*Iris pseudacorus*	Gele lis	9	9	9		–
666	*Isatis tinctoria*	Wede	3	4	5		–
668	*Isoetes echinospora*	Kleine biesvaren	3	3	2		BE
667	*Isoetes lacustris*	Grote biesvaren	3	2	1		EB
1159	*Isolepis setacea*	Borstelbies	6	7	7	*	–
669	*Jasione montana*	Zandblauwtje	9	8	8		–
2303	*Juglans regia*	Okkernoot		–			*
670	*Juncus acutiflorus*	Veldrus	8	8	8	*	–
682	*Juncus alpinoarticulatus* subsp. *alpinoarticulatus*	Alpenrus		+			GE
672	*Juncus alpinoarticulatus* subsp. *atricapillus*	Duinrus		+			–
671	*Juncus ambiguus*	Zilte greppelrus		+			–
673	*Juncus articulatus*	Zomprus	8	9	9	*	–
674	*Juncus balticus*	Noordse rus	5	4	5		–
675	*Juncus bufonius*	Greppelrus		+			–
2343	*Juncus bulbosus*	Knolrus	8	8	8		–
1409	*Juncus canadensis*	Canadese rus	0	2	2		–
677	*Juncus capitatus*	Koprus	4	0	3		EB
678	*Juncus compressus*	Platte rus	7	7	7	*	–
679	*Juncus conglomeratus*	Biezenknoppen	8	9	9	*	–
680	*Juncus effusus*	Pitrus	9	9	9		–
2425	*Juncus ensifolius*	Zwaardrus	0	3	3		–
681	*Juncus filiformis*	Draadrus	5	5	5		KW
683	*Juncus gerardii*	Zilte rus	8	8	7		–
684	*Juncus inflexus*	Zeegroene rus	8	8	8		–
685	*Juncus maritimus*	Zeerus	6	6	6		–
686	*Juncus pygmaeus*	Dwergrus	4	3	4		EB
687	*Juncus squarrosus*	Trekrus	8	8	8		–
688	*Juncus subnodulosus*	Paddenrus	6	7	7	*	–
689	*Juncus tenageia*	Wijdbloeiende rus	6	4	4		BE
690	*Juncus tenuis*	Tengere rus	8	8	8		–
691	*Juniperus communis*	Jeneverbes	7	7	7		GE
742	*Kickxia elatine*	Spiesleeuwenbek	5	5	5		KW
744	*Kickxia spuria*	Eironde leeuwenbek	4	4	4		KW
692	*Knautia arvensis*	Beemdkroon	7	7	6		GE
693	*Koeleria macrantha*	Smal fakkelgras	6	6	6		–
695	*Koeleria pyramidata*	Breed fakkelgras	2	3	3		KW
698	*Lactuca saligna*	Wilgsla	3	1	0		VN
699	*Lactuca serriola*	Kompassla	5	7	8		–
2384	*Lactuca virosa*	Gifsla	3	3	3		–
1698	*Lagurus ovatus*	Hazenstaart	4	3	4		–
1898	*Lamiastrum galeobdolon* 'Florentinum'	Bonte gele dovenetel		+			–
702	*Lamiastrum*						

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	–	9a	H27 H28 H47
19	203	0	1	8b	H47 H42
i	1	1	–	2a	G48 G47
i	1	1	–	8c	H43 G43 G47kr H63
i	1	1	–	6c	G47kr
i	1	1	1	4c	H27 R28 R27 V16 H28 V18
a	105	2	–	1f	P67
i	1	1	–	4b	W12
i	1	1	–	4b	W12
i	1	1	3	2c	P27 P22
i	1	1	1	6d	G62
20.3	109	0	–	–	–
i	1	2	3	5b	G22 G27
i	1	2	(3)	7b	G22 G27
i	1	2	(3)	7b	G23 bG20
i	1	2	–	3c	bP20
i	1	2	3	2a	P27 G27 P23 G23 G28 bG20
i	1	2	3	7a	G22
i	1	2	3	2b	P27 P47 P22 P42 P28 P48 bP20
i	1	2	3	4b	W11 W12 P21 P22
20.3	301	2	–	7a	G21
i	1	2	–	2c	P42 P22
i	1	2	–	2a	G48 G28 bG40
i	1	2	2	7c	G22 G27 G42 R24 R44
i	1	2	3	2a	R24 R27 G27 G22 G21 H22 H27
20.3	301	2	–	5a	–
i	1	2	2	7a	G22 G27
i	1	2	3	3c	bG20 zG20 bG40 zG40
i	1	1	3	2a	G28 G27
i	1	2	–	3c	zR20 bR20
i	1	2	–	2c	P22
i	1	2	3	7d	G41
i	1	2	1	7a	V16 G27
i	1	2	–	2c	P22 P27
19	301	2	3	2a	P47
i	1	2	1	7e	H61 H62
a	100	0	3	1b	P47kr
a	100	0	3	1b	P47kr
i	1	1	1	5a	G47kr G43
i	1	1	1	6c	G63
i	1	2	–	6c	G43
i	1	2	–	5a	G47kr
a	100	1	2	1f	P48 P47kr P68
20.1	103	1	3	1g	–
20.1	105	2	–	3a	P67
20.3	103	0	(1)	9c	–

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
	galeobdolon s. str.	Gele dovenetel		+			–
700	*Lamium album*	Witte dovenetel	9	9	9		–
701	*Lamium amplexicaule*	Hoenderbeet	8	8	8		–
705	*Lamium confertum*	Brede dovenetel		–			*
703	*Lamium hybridum*	Ingesneden dovenetel		+			–
2464	*Lamium maculatum* 'Variegatum'	Gestreepte dovenetel		+			–
704	*Lamium maculatum* s. str.	Gevlekte dovenetel		+			–
706	*Lamium purpureum*	Paarse dovenetel		+			–
708	*Lapsana communis*	Akkerkool	9	9	9		–
709	*Lathraea squamaria*	Bleke schubwortel	0	0	1		GE
710	*Lathyrus aphaca*	Naakte lathyrus	5	3	1	#	EB
1699	*Lathyrus hirsutus*	Ruige lathyrus	3	2	3		–
1426	*Lathyrus japonicus*	Zeelathyrus	0	3	3		GE
711	*Lathyrus linifolius*	Knollathyrus	5	3	3		EB
712	*Lathyrus niger*	Zwarte lathyrus	1	1	0	#	VN
713	*Lathyrus nissolia*	Graslathyrus	3	4	4	*	KW
714	*Lathyrus palustris*	Moeraslathyrus	6	6	6		–
715	*Lathyrus pratensis*	Veldlathyrus	8	9	9		–
716	*Lathyrus sylvestris*	Boslathyrus	4	4	5		–
717	*Lathyrus tuberosus*	Aardaker	6	7	7		–
719	*Leersia oryzoides*	Rijstgras	5	4	5		KW
720	*Legousia hybrida*	Klein spiegelklokje	3	3	3		KW
721	*Legousia speculum-veneris*	Groot spiegelklokje	6	4	4		EB
722	*Lemna gibba*	Bultkroos	8	8	8		–
723	*Lemna minor*	Klein kroos	9	9	9		–
2426	*Lemna minuta*	Dwergkroos	0	4	6	*	–
724	*Lemna trisulca*	Puntkroos	9	9	8		–
5362	*Lemna turionifera*	Knopkroos		–			*
725	*Leontodon autumnalis*	Vertakte leeuwentand	9	9	9		–
726	*Leontodon hispidus*	Ruige leeuwentand	7	7	6	*	KW
727	*Leontodon saxatilis*	Kleine leeuwentand	8	8	8		–
728	*Leonurus cardiaca*	Hartgespan	5	4	5		–
729	*Lepidium campestre*	Veldkruidkers	6	5	6		–
1700	*Lepidium densiflorum*	Dichtbloemige kruidkers		–			*
730	*Lepidium draba*	Pijlkruidkers	6	7	7		–
731	*Lepidium graminifolium*	Graskers	2	2	3		GE
1701	*Lepidium heterophyllum*	Rozetkruidkers	3	3	4	*	–
732	*Lepidium latifolium*	Peperkers	5	3	4		–
733	*Lepidium ruderale*	Steenkruidkers	6	6	7		–
1704	*Lepidium virginicum*	Amerikaanse kruidkers	5	5	6		–
319	*Leucanthemum vulgare*	Gewone margriet	9	8	9		–
734	*Leucojum aestivum*	Zomerklokje	4	4	4		KW
1625	*Leucojum vernum*	Lenteklokje	3	4	4	*	–
443	*Leymus arenarius*	Zandhaver	7	6	6		–
736	*Ligustrum vulgare*	Wilde liguster	7	8	7	*	–
737	*Lilium bulbiferum* subsp. *croceum*	Roggelelie	3	2	2		EB
738	*Limonium vulgare*	Lamsoor	6	6	6		–
739	*Limosella aquatica*	Slijkgroen	4	5	6		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	1	9c	H42 H43 H47
a	100	0	3	8b	R48 H48 G48
i	1	0	3	1a	P48 P68
i	1	0	–	–	–
i	1	0	–	1a	P48
20.3	103	0	–	9c	–
i	1	0	–	9c	H48 H47 R48 R47
i	1	0	3	1a	P48
i	1	1	3	8b	H48 P48 P47 H47
i	1	0	–	9d	H47
a	105	0	–	1b	P47kr
20.2	103	0	–	1e	–
i	1	1	–	3a	bP40 bP60
i	1	0	–	9e	G42 H42
i	1	0	–	9d	–
i	1	0	–	8c	G47kr
i	1	0	1	5b	G27 R27
i	1	0	1	5a	G47
i	1	0	1	8c	H43
i	1	0	–	5a	P47kr G47kr
i	1	2	–	2b	P28
a	100	0	–	1b	P47kr
a	100	0	–	1b	P47kr
i	1	1	–	4a	W18
i	1	1	1	4a	W18 W16
20.3	301	1	–	4a	W18
i	1	1	1	4a	W18 W16 bW10
20.4	301	1	–	–	–
i	1	2	1	2a	G47 G48 bG40 G67
i	1	1	1	6c	G43 G47kr
i	1	2	2	6b	G43 G42 G47 bG40 bP60 G62 G63 G67
a	100	2	–	1g	R48 R47kr
a	100	0	3	1e	P48
20.4	301	0	–	–	P67 P68
19	208	0	3	1e	P68 P48 bP40
i	1	0	–	4d	P47 P48
i	1	0	–	1e	G67
i	1	0	–	4d	bR40 R47
a	100	1	–	1d	P48tr
19	301	0	3	1e	P67 P68
i	1	1	2	5a	G47 G67
i	1	1	–	4c	R28
19	103	1	–	9c	H47
i	1	1	–	3a	bP60 bR60
i	1	2	1	8d	H63
19	103	0	–	1c	–
i	1	1	1	3b	zG20
i	1	0	3	2c	P28

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
740	*Linaria arvensis*	Blauwe leeuwenbek	3	0	0		VN
1706	*Linaria repens*	Gestreepte leeuwenbek	2	4	5		–
745	*Linaria vulgaris*	Vlasbekje	9	9	9		–
746	*Linnaea borealis*	Linnaeusklokje	2	3	3		GE
747	*Linum catharticum*	Geelhartje	7	6	6		KW
748	*Liparis loeselii*	Groenknolorchis	5	4	5		BE
749	*Listera cordata*	Kleine keverorchis	1	2	4		GE
750	*Listera ovata*	Grote keverorchis	7	7	6		KW
751	*Lithospermum arvense*	Ruw parelzaad	6	4	4		EB
752	*Lithospermum officinale*	Glad parelzaad	5	5	5		–
753	*Littorella uniflora*	Oeverkruid	6	5	5		BE
754	*Lobelia dortmanna*	Waterlobelia	5	4	3		EB
755	*Lolium multiflorum*	Italiaans raaigras	8	8	8	*	–
756	*Lolium perenne*	Engels raaigras	9	9	9		–
757	*Lolium remotum*	Vlasdolik	4	0	0		VN
758	*Lolium temulentum*	Dolik	4	0	0	#	VN
759	*Lonicera periclymenum*	Wilde kamperfoelie	9	9	9	*	–
760	*Lonicera xylosteum*	Rode kamperfoelie	3	5	5	h	–
761	*Lotus corniculatus* var. *corniculatus*	Gewone rolklaver		+			–
2465	*Lotus corniculatus* var. *sativus*	Rechte rolklaver		+			–
762	*Lotus glaber*	Smalle rolklaver	7	7	7		–
763	*Lotus pedunculatus*	Moerasrolklaver	9	9	9		–
5335	*Ludwigia grandiflora*	Waterteunisbloem		–			*
764	*Ludwigia palustris*	Waterlepeltje	5	2	3		EB
1866	*Lunaria annua*	Judaspenning		–			*
1899	*Lupinus polyphyllus*	Vaste lupine	0	7	7	k	–
765	*Luronium natans*	Drijvende waterweegbree	7	6	6		KW
766	*Luzula campestris*	Gewone veldbies		+			–
769	*Luzula luzuloides*	Witte veldbies	4	4	4		–
1933	*Luzula multiflora*	Veelbloemige veldbies		+			–
770	*Luzula pilosa*	Ruige veldbies	6	7	6		–
771	*Luzula sylvatica*	Grote veldbies	5	5	4		–
2326	*Lychnis coronaria*	Prikneus		–			*
772	*Lychnis flos–cuculi*	Echte koekoeksbloem	9	9	9		–
773	*Lycium barbarum*	Boksdoorn	5	5	5	h	–
777	*Lycopodiella inundata*	Moeraswolfsklauw	7	6	6		KW
774	*Lycopodium annotinum*	Stekende wolfsklauw	3	3	3		KW
775	*Lycopodium clavatum*	Grote wolfsklauw	6	5	4		BE
780	*Lycopus europaeus*	Wolfspoot	9	9	9		–
781	*Lysimachia nemorum*	Boswederik	5	5	5		–
782	*Lysimachia nummularia*	Penningkruid	9	9	9		–
783	*Lysimachia thyrsiflora*	Moeraswederik	7	8	8		–
784	*Lysimachia vulgaris*	Grote wederik	9	9	9		–
1709	*Lythrum hyssopifolia*	Kleine kattenstaart	3	2	3		GE
925	*Lythrum portula*	Waterpostelein	7	7	7		–
785	*Lythrum salicaria*	Grote kattenstaart	9	9	9		–
2101	*Mahonia aquifolium*	Mahonie	0	6	7	h	–
786	*Maianthemum bifolium*	Dalkruid	7	8	8		–
1934	*Malus sylvestris*	Appel	6	8	8	h	–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
a	105	1	–	1c	–
19	105	1	–	6d	P67
i	1	1	1	1e	G67 R67 R47
i	1	1	1	9e	H61 H41
i	1	1	3	6b	G43 G23
i	1	2	–	7b	G23
i	1	1	–	9e	H41
i	1	2	–	9b	H43 H47
a	100	1	1	1b	P47kr
i	1	0	–	8d	H63
i	1	0	3	4b	W13 W12 P23 P22
i	1	0	–	4b	W12
19	100	2	2	1e	P48 G48
i	1	1	1	1d	G48 bG40
a	203	1	–	1a	–
a	110	2	–	1a	P47kr
i	1	2	1	9e	H42 H62 H61 H63 H41 H47
i	1	2	1	9d	H43
i	1	1	(2)	6b	G43 G47 G63 G62 G42 G67
20.3	103	1	(2)	5a	–
i	1	1	–	3c	bG40 bG20 G47
i	1	1	1	5b	G27 G22 G23
20.4	300	0	–	–	W18
i	1	1	–	2b	W12 W15 P27
20.3	109	0	–	–	–
19	301	0	–	–	G67
i	1	1	–	4b	W12 W15
i	1	1	2	6d	G63 G62 G67 G42
i	1	1	3	9e	H42
i	1	2	3	5b	G42 G22 G27 H42
i	1	1	3	9b	H42
i	1	1	3	9e	H42
20.4	109	0	–	–	–
i	1	0	3	5b	G27
19	250	1	–	8d	H63
i	1	1	–	7d	P21
i	1	1	–	9e	H41
i	1	1	–	7e	G61 G41 H61
i	1	2	2	4c	R27 H27 H28 R28
i	1	0	2	9a	H47 H42 H27br
i	1	0	1	2a	H27 G27 H47 G47
i	1	1	1	7a	V15 R27 H27 G27
i	1	1	1	5b	H27 R27 H22 R24 G22 G27
20.4	105	0	–	2c	P28
i	1	0	3	2c	P22 P27 W12
i	1	1	3	4d	H28 H27 R27 R28 V16
19	301	1	–	9c	–
i	1	1	1	9e	H42 H62 H41 H61
i	1	2	–	8d	H47

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
788	*Malva alcea*	Vijfdelig kaasjeskruid	4	5	5		–
789	*Malva moschata*	Muskuskaasjeskruid	6	7	7		–
790	*Malva neglecta*	Klein kaasjeskruid	8	8	8		–
5089	*Malva parviflora*	Kleinbloemig kaasjeskruid		–			*
791	*Malva pusilla*	Rond kaasjeskruid		–			*
792	*Malva sylvestris*	Groot kaasjeskruid	8	8	8		–
793	*Marrubium vulgare*	Malrove	5	3	2		EB
796	*Matricaria discoidea*	Schijfkamille	8	9	9		–
794	*Matricaria recutita*	Echte kamille	9	9	9		–
2232	*Matteuccia struthiopteris*	Struisvaren		–			*
797	*Medicago arabica*	Gevlekte rupsklaver	7	7	7		–
798	*Medicago falcata*	Sikkelklaver	7	6	6		–
799	*Medicago lupulina*	Hopklaver	9	9	9		–
800	*Medicago minima*	Kleine rupsklaver	3	3	4		GE
1711	*Medicago polymorpha*	Ruige rupsklaver	2	2	3		–
801	*Medicago sativa*	Luzerne	7	7	7		–
802	*Medicago ×varia*	Bonte luzerne	5	5	5	×	–
803	*Melampyrum arvense*	Wilde weit	5	2	1	#	EB
804	*Melampyrum pratense*	Hengel	8	8	7		–
808	*Melica uniflora*	Eenbloemig parelgras	5	5	5		–
809	*Melilotus albus*	Witte honingklaver	6	7	8		–
810	*Melilotus altissimus*	Goudgele honingklaver	7	7	7		–
811	*Melilotus indicus*	Kleine honingklaver	5	3	3		–
812	*Melilotus officinalis*	Citroengele honingklaver	7	7	8		–
5255	*Melissa officinalis*	Citroenmelisse		–			*
813	*Mentha aquatica*	Watermunt		+			–
814	*Mentha arvensis*	Akkermunt	9	8	8		–
815	*Mentha longifolia*	Hertsmunt	5	5	6		–
817	*Mentha pulegium*	Polei	4	3	3		EB
1772	*Mentha ×rotundifolia*	Wollige munt		+			–
818	*Mentha suaveolens*	Witte munt		+			BE
820	*Mentha ×verticillata*	Kransmunt		+			–
821	*Menyanthes trifoliata*	Waterdrieblad	8	7	7		GE
822	*Mercurialis annua*	Tuinbingelkruid	7	7	7		–
823	*Mercurialis perennis*	Bosbingelkruid	4	5	4		–
824	*Mespilus germanica*	Mispel	5	6	6	h	–
825	*Mibora minima*	Dwerggras	2	2	2	*	KW
2496	*Micropyrum tenellum*	Grindstijfgras	0	0	1		–
826	*Milium effusum*	Bosgierstgras	6	7	6		–
827	*Milium vernale*	Ruw gierstgras	5	4	4	*	–
828	*Mimulus guttatus*	Gele maskerbloem	3	4	5		–
829	*Minuartia hybrida*	Tengere veldmuur	4	3	2		EB
72	*Misopates orontium*	Akkerleeuwenbek	7	6	6		KW
830	*Moehringia trinervia*	Drienerfmuur	8	8	8		–
831	*Moenchia erecta*	Kruismuur	2	0	0		VN
832	*Molinia caerulea*	Pijpenstrootje	9	9	9		–
833	*Moneses uniflora*	Eenbloemig wintergroen	1	1	2	#	GE
834	*Monotropa hypopitys*	Stofzaad	5	4	3		BE
835	*Montia fontana* subsp. *chondrosperma*	Klein bronkruid		+			–
2427	*Montia fontana*						

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
a	100	1	–	1g	G47kr G48 R48 G47 R47kr
i	1	1	–	8b	G47 G48
a	100	1	3	1e	P48 R48
20.3	110	1	–	–	–
18	101	1	–	–	–
a	100	1	3	1e	G48 R48 G47
i	1	1	–	1f	P67
19	207	2	3	1d	P48tr
a	100	2	3	1a	P48 P68
20.4	103	1	–	–	H47
i	1	2	–	5a	G47kr
i	1	1	–	6c	G47kr G67 G63
i	1	2	3	5a	G47 G67
i	1	2	2	6b	G63
19	105	2	3	1e	P67
19	105	1	3	1e	G47kr
in	7	1	–	6c	G47kr
i	1	1	–	1b	P47kr
i	1	0	1	9e	H62 H61 H42 H41
i	1	0	1	9d	H43
a	100	0	1	1e	R67 R47 P47 P67
i	1	0	–	4d	R47 P47
20.1	105	0	–	1e	P67
a	100	0	3	1e	P47 P67 R47 R67
20.3	105	0	–	–	–
i	1	2	3	4c	G23 V16 R27 G27 bR20 bV10
i	1	1	2	2a	P47 P48 P27 G27 P28
i	1	1	–	4d	R28
i	1	2	–	2a	G27 G28
19	103	1	–	2a	G47 G48
i	1	1	–	2a	G47kr R47kr
i	1	1	–	4c	G27 G28
i	1	1	1	7a	V15 V12
a	103	0	3	1a	P48 P47kr
i	1	0	1	9d	H43
a	105	2	–	8d	H42
20.1	102	1	–	1c	P67 P62
20.4	100	0	–	6b	P67
i	1	2	2	9b	H42
i	1	2	–	6b	G63
19	307	1	–	4c	R28 R27
i	1	0	–	1b	P47kr
a	100	0	–	1c	P47
i	1	1	3	9b	H63 H69 H62 H43 H47 H42
i	1	1	–	6c	P67
i	1	1	2	7d	R24 R44 H21 H41 G21 G41 G22
i	1	1	–	9e	H42
i	1	1	–	9e	–
i	1	0	(3)	2c	P47 P27

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
	subsp. *fontana*	Groot bronkruid		+			–
837	*Muscari botryoides*	Blauwe druifjes	4	6	6	*	–
838	*Muscari comosum*	Kuifhyacint	3	4	4		–
839	*Mycelis muralis*	Muursla	6	6	6		–
840	*Myosotis arvensis*	Akkervergeet-mij-nietje	8	9	9		–
842	*Myosotis discolor*	Veelkleurig vergeet-mij-nietje	7	7	8		–
841	*Myosotis laxa*						
	subsp. *cespitosa*	Zompvergeet-mij-nietje		+			–
843	*Myosotis ramosissima*	Ruw vergeet-mij-nietje	7	7	7	*	–
844	*Myosotis scorpioides*	Moerasvergeet-mij-nietje		+			–
845	*Myosotis stricta*	Stijf vergeet-mij-nietje	4	4	4	#	BE
846	*Myosotis sylvatica*	Bosvergeet-mij-nietje	5	6	6	*	–
848	*Myosurus minimus*	Muizenstaart	6	6	6	*	–
849	*Myrica gale*	Wilde gagel	8	7	7	*	GE
850	*Myriophyllum alterniflorum*	Teer vederkruid	6	5	5		BE
851	*Myriophyllum spicatum*	Aarvederkruid	7	8	8		–
852	*Myriophyllum verticillatum*	Kransvederkruid	5	7	6		–
853	*Myrrhis odorata*	Roomse kervel	3	5	5		–
854	*Najas marina*	Groot nimfkruid	4	4	4		–
855	*Najas minor*	Klein nimfkruid	0	0	2		GE
856	*Narcissus pseudonarcissus*						
	subsp. *pseudonarcissus*	Wilde narcis	6	6	4	k#	BE
857	*Nardus stricta*	Borstelgras	8	8	7		GE
858	*Narthecium ossifragum*	Beenbreek	7	6	5		BE
861	*Neottia nidus-avis*	Vogelnestje	4	3	2		EB
862	*Nepeta cataria*	Wild kattenkruid	4	4	4		KW
863	*Nicandra physalodes*	Zegekruid		–			*
865	*Nuphar lutea*	Gele plomp	8	8	8		–
866	*Nymphaea alba*	Witte waterlelie	8	8	8		–
867	*Nymphoides peltata*	Watergentiaan	8	8	8		–
509	*Odontites vernus*						
	subsp. *serotinus*	Rode ogentroost		+			GE
1496	*Odontites vernus*						
	subsp. *vernus*	Akkerogentroost		+			BE
868	*Oenanthe aquatica*	Watertorkruid	9	9	8		–
1630	*Oenanthe crocata*	Dodemansvingers	0	1	2		GE
869	*Oenanthe fistulosa*	Pijptorkruid	8	8	8		–
870	*Oenanthe lachenalii*	Zilt torkruid	6	6	6		KW
1713	*Oenanthe pimpinelloides*	Beverneltorkruid	0	0	1		GE
871	*Oenanthe silaifolia*	Weidekervel-torkruid	0	0	1		GE
872	*Oenothera biennis*	Middelste teunisbloem		+			–
873	*Oenothera erythrosepala*	Grote teunisbloem		+			–
874	*Oenothera parviflora*	Kleine teunisbloem	5	6	6		–
875	*Onobrychis viciifolia*	Esparcette	3	2	3		GE
876	*Ononis repens*						
	subsp. *repens*	Kruipend stalkruid		+			–
877	*Ononis repens*						
	subsp. *spinosa*	Kattendoorn		+			GE
878	*Onopordum acanthium*	Wegdistel	6	6	6		–
879	*Ophioglossum vulgatum*	Addertong	6	6	6		–
880	*Ophrys apifera*	Bijenorchis	3	4	5		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	(3)	9a	P27 W15
16	105	0	–	9c	H47
19	110	0	–	1e	G63 G67
i	1	1	1	9b	P40mu H47 H43 H42
a	100	2	3	8b	P47 P67 P48 P68 H63 H69
i	1	1	–	1e	P67 P47
i	1	0	2	2a	P27 P28 G27
i	1	0	3	6b	P63 G63
i	1	1	1	4c	R28 G28 H28 V18
i	1	2	1	6b	P62 P67
i	1	2	1	9b	H47 H43
i	1	1	–	2c	P48tr
i	1	1	1	7d	H21 H22
i	1	1	–	4b	W12 W15
i	1	1	–	4a	W18
i	1	1	–	4b	W16
18	105	1	–	1e	G47 H47
i	1	1	–	4a	W16 bW10
i	1	1	–	4a	W18
i	1	0	–	7e	H47 G47
i	1	1	1	7e	G42 G61 G62 G41
i	1	1	–	7d	G21
i	1	2	–	9d	H43
a	100	1	–	1f	P67 H69
20.1	305	1	–	–	–
i	1	2	1	4a	W16 W18
i	1	1	1	4a	W16zt W18 W15
i	1	1	–	4a	W18 W16
i	1	0	–	2a	bG20 bG40 P47kr
i	1	0	–	–	P47kr
i	1	1	–	4c	W16zt W18 P28 P27
20.3	112	1	–	4d	–
i	1	0	1	4c	G28 V16 V18 G27
i	1	1	–	3c	bR20
20.1	105	1	–	5a	–
i	1	1	–	5a	G47
17	301	1	3	1f	P67 P62 P63
19	301	1	–	1f	P67 P63 P62
18	301	0	–	1f	bP60 P63 P67
19	104	2	–	6c	G47kr
i	1	0	1	6b	G63 G43
i	1	0	1	5a	G47kr bG40
a	105	0	3	1f	P67
i	1	1	–	7a	G43 G42 R44 G23 G22
i	1	1	–	6c	G43 G47kr

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
881	*Ophrys insectifera*	Vliegenorchis	4	3	3		EB
882	*Orchis coriophora*	Wantsenorchis	2	0	0		VN
887	*Orchis mascula*	Mannetjesorchis	4	4	3		EB
888	*Orchis militaris*	Soldaatje	4	4	3		BE
889	*Orchis morio*	Harlekijn	7	5	5		EB
891	*Orchis purpurea*	Purperorchis	4	4	3		KW
892	*Orchis simia*	Aapjesorchis	1	1	2		GE
893	*Orchis ustulata*	Aangebrande orchis	2	0	0		VN
423	*Oreopteris limbosperma*	Stippelvaren	4	4	4		–
894	*Origanum vulgare*	Wilde marjolein	7	6	6		–
895	*Ornithogalum nutans*	Knikkende vogelmelk	5	5	5		–
896	*Ornithogalum umbellatum*	Gewone vogelmelk	7	8	8		–
5267	*Ornithopus compressus*	Geel vogelpootje	0	0	3	#	–
897	*Ornithopus perpusillus*	Klein vogelpootje	8	8	8		–
907	*Orobanche caryophyllacea*	Walstrobremraap	6	5	5		–
899	*Orobanche hederae*	Klimopbremraap	3	1	3		GE
900	*Orobanche lutea*	Rode bremraap	1	2	2		BE
901	*Orobanche minor*	Klavervreter	6	6	5		BE
902	*Orobanche picridis*	Bitterkruidbremraap	3	4	4		–
903	*Orobanche purpurea*	Blauwe bremraap	4	3	4		KW
904	*Orobanche ramosa*	Hennepvreter	3	0	0		VN
905	*Orobanche rapum–genistae*	Grote bremraap	5	3	4		EB
906	*Orobanche reticulata*	Distelbremraap	2	3	4		GE
1039	*Orthilia secunda*	Eenzijdig wintergroen	1	0	0		VN
908	*Osmunda regalis*	Koningsvaren	7	7	7		–
909	*Oxalis acetosella*	Witte klaverzuring	7	7	7		–
910	*Oxalis corniculata*	Gehoornde klaverzuring	5	5	6		–
5337	*Oxalis dillenii*	Knobbelklaverzuring		–			*
911	*Oxalis fontana*	Stijve klaverzuring	8	8	8		–
912	*Oxycoccus macrocarpos*	Grote veenbes	5	5	5		–
913	*Oxycoccus palustris*	Kleine veenbes	6	6	6		KW
1715	*Panicum capillare*	Draadgierst		–			*
5461	*Panicum dichotomiflorum*	Kale gierst		+			**
5338	*Panicum schinzii*	Zuid–Afrikaanse gierst		+			**
914	*Papaver argemone*	Ruige klaproos	7	6	7		–
915	*Papaver dubium*	Bleke klaproos	8	8	8		–
916	*Papaver rhoeas*	Grote klaproos	8	9	8		–
917	*Parapholis strigosa*	Dunstaart	6	6	5		–
1717	*Parentucellia viscosa*	Kleverige ogentroost	4	5	5		–
919	*Parietaria judaica*	Klein glaskruid	4	4	5		–
918	*Parietaria officinalis*	Groot glaskruid	4	3	5		–
920	*Paris quadrifolia*	Eenbes	5	6	5		KW
921	*Parnassia palustris*	Parnassia	7	6	6		KW
2102	*Parthenocissus inserta*	Valse wingerd	0	5	6	h	–
922	*Pastinaca sativa* subsp. *sativa*	Pastinaak		+			–
5340	*Pastinaca sativa* subsp. *urens*	Brandpastinaak		+			*
923	*Pedicularis palustris*	Moeraskartelblad	7	6	5		KW
924	*Pedicularis sylvatica*	Heidekartelblad	8	6	5		BE
1871	*Pentaglottis sempervirens*	Overblijvende ossentong	0	4	5	*	–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	–	8c	H43
i	1	2	–	6b	G47kr
i	1	2	–	8c	G43 H43
i	1	2	–	8c	G43 H43
i	1	2	–	7c	G47 G42 G43
i	1	2	–	8c	H43
i	1	2	–	6c	G43
i	1	2	–	6c	G47kr
i	1	1	–	9a	H41 H42
i	1	0	3	8c	G47kr G43
18	109	0	–	9c	H47
i	1	0	–	8b	H47 G47
20.4	105	1	–	6d	–
i	1	2	2	6d	G67 G62
i	1	1	–	6b	G63
i	1	1	–	8b	H43
i	1	1	–	6c	G67
i	1	1	–	5a	G47
i	1	1	–	6c	G63
i	1	1	–	6b	G63
a	105	1	–	1a	–
i	1	1	–	7e	H62 H61
i	1	1	–	1f	R48 R68
19	102	1	1	9e	–
i	1	1	–	9a	R24 H22 H21
i	1	0	1	9b	H42
19	105	1	–	1a	P48
20.4	301	1	–	–	–
17	301	1	3	1a	P48 P47
19	301	2	3	7d	G21 G22
i	1	2	1	7d	G21
20.4	301	1	–	–	–
20.3	301	1	–	1a	P48 P68
20.4	405	1	–	1a	P48 P68
a	100	0	3	1c	P47 P67
a	100	0	2	1c	P47 P67
a	100	0	3	1a	P47 P48 P67
i	1	0	–	3c	bP20 bP40
20.1	100	1	–	2c	P23 G23 P47kr
i	1	0	–	6a	P60mu P40mu
a	103	0	–	8b	P40mu H47
i	1	2	1	9d	H43 H47
i	1	1	1	7b	G23
19	301	1	–	8b	R67
i	1	1	(3)	5a	G47 G48
20.4	103	1	(3)	1e	–
i	1	1	2	7a	G27 G23 G22
i	1	0	1	7d	G41 G42 G22 G21
20.1	108	0	–	9c	H47

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
967	*Persicaria amphibia*	Veenwortel	9	9	9		–
969	*Persicaria bistorta*	Adderwortel	6	6	6		–
972	*Persicaria hydropiper*	Waterpeper	9	9	9		–
973	*Persicaria lapathifolia*	Beklierde duizendknoop	9	9	9		–
977	*Persicaria maculosa*	Perzikkruid	9	9	9		–
975	*Persicaria minor*	Kleine duizendknoop	7	7	8		–
976	*Persicaria mitis*	Zachte duizendknoop	8	8	8		–
1874	*Persicaria wallichii*	Afghaanse duizendknoop	0	4	4	*	–
926	*Petasites hybridus*	Groot hoefblad	7	7	8		–
696	*Petrorhagia prolifera*	Slanke mantelanjer	4	3	3		EB
927	*Petroselinum segetum*	Wilde peterselie	1	2	2	#	GE
928	*Peucedanum carvifolia*	Karwijvarkenskervel	6	6	6		KW
929	*Peucedanum palustre*	Melkeppe	8	8	8		–
1820	*Phacelia tanacetifolia*	Phacelia		–			*
930	*Phalaris arundinacea*	Rietgras	9	9	9		–
424	*Phegopteris connectilis*	Smalle beukvaren	4	3	4	*	–
931	*Phleum arenarium*	Zanddoddegras	7	7	7		–
932	*Phleum pratense* subsp. *pratense*	Timoteegras		+			–
1411	*Phleum pratense* subsp. *serotinum*	Klein timoteegras		+			–
933	*Phragmites australis*	Riet	9	9	9		–
935	*Phyteuma spicatum* subsp. *nigrum*	Zwartblauwe rapunzel		+			KW
936	*Phyteuma spicatum* subsp. *spicatum*	Witte rapunzel		+			KW
2104	*Phytolacca americana*	Westerse karmozijnbes	2	4	4		–
1823	*Phytolacca esculenta*	Oosterse karmozijnbes	3	4	6	#	–
937	*Picris echioides*	Dubbelkelk	5	6	6		–
938	*Picris hieracioides*	Echt bitterkruid	7	7	7		–
939	*Pilularia globulifera*	Pilvaren	5	5	5		–
940	*Pimpinella major*	Grote bevernel	7	7	7		–
941	*Pimpinella saxifraga*	Kleine bevernel	7	7	7		–
942	*Pinguicula vulgaris*	Vetblad	6	3	3		EB
943	*Pinus sylvestris*	Grove den	8	8	8	h	–
1722	*Plantago arenaria*	Zandweegbree	4	3	4		–
944	*Plantago coronopus*	Hertshoornweegbree	7	7	7		–
946	*Plantago lanceolata*	Smalle weegbree	9	9	9		–
945	*Plantago major* subsp. *intermedia*	Getande weegbree		+			–
947	*Plantago major* subsp. *major*	Grote weegbree		+			–
948	*Plantago maritima*	Zeeweegbree	7	6	6		KW
949	*Plantago media*	Ruige weegbree	8	7	6		KW
950	*Platanthera bifolia*	Welriekende nachtorchis	7	6	5		BE
951	*Platanthera chlorantha*	Bergnachtorchis	4	4	3		KW
1500	*Poa angustifolia*	Smal beemdgras		+			–
952	*Poa annua*	Straatgras	9	9	9		–
953	*Poa bulbosa*	Knolbeemdgras	4	4	5		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	1	2a	G28 R28 V18 W18 V16 R27 G27 G47 G48
i	1	1	1	5b	G27 G47
i	1	0	2	2b	P28
i	1	1	3	1e	P48 P28
i	1	1	3	1a	P48
i	1	1	–	2c	P27 P28
i	1	1	–	2b	P28 P27
20.1	203	0	0	1g	–
i	1	1	1	4d	R48
i	1	1	1	6c	P67
i	1	1	–	5a	G47kr
i	1	1	–	5a	G47kr
i	1	1	1	7a	H27 R27 G22 H22 V15
20.4	350	0	–	–	–
i	1	2	1	4c	R28 H28 G28 R48 V18
i	1	1	–	9a	H42
i	1	1	–	6b	P63
i	1	2	(2)	5a	G48
i	1	2	(2)	6b	G67 G47
i	1	2	1	4c	R28 R27 bR20 bV10 V16 V18 bR40 R48 R47 V15
i	1	2	1	9a	H43 H42
i	1	2	1	9a	H47 H42
20.1	301	1	–	1g	R48
20.2	204	1	–	1g	R48
a	105	1	–	1f	P47kr
i	1	1	3	6c	G63 G43 G47kr
i	1	0	–	4b	P22 W12
i	1	1	1	5a	G47kr
i	1	1	1	6b	G43 G47 G67 G63 G62
i	1	0	1	7c	G22
17	100	1	1	9e	H61 H41 H62 H21
20.1	202	1	–	1e	P67
i	1	1	3	3c	bP40
i	1	1	2	5a	G67 G47 G63 G43 G62
i	1	1	(3)	2c	P47 P27 P28 bP20
i	1	1	(3)	1d	P48tr P47 bG40
i	1	2	1	3b	zG20 bG20 bP20
i	1	1	2	6c	G43 G47kr
i	1	2	–	7c	G22 G42
i	1	2	–	8c	H43 G43
i	1	1	2	6b	G47kr G67
i	1	1	3	1d	P48tr P68 P47
i	1	0	–	6b	P62 P63

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	KFK 80	KFK 95	noot	RL2000
954	*Poa chaixii*	Bergbeemdgras	3	3	2		–
955	*Poa compressa*	Plat beemdgras	6	7	7		–
956	*Poa nemoralis*	Schaduwgras	7	8	8		–
957	*Poa palustris*	Moerasbeemdgras	7	8	8		–
958	*Poa pratensis*	Veldbeemdgras		+			–
959	*Poa trivialis*	Ruw beemdgras	9	9	9		–
2466	*Polycarpon tetraphyllum*	Kransmuur	0	0	3		–
961	*Polygala comosa*	Kuifvleugeltjesbloem	3	3	3		KW
962	*Polygala serpyllifolia*	Liggende vleugeltjesbloem	6	6	5		KW
963	*Polygala vulgaris*	Gewone vleugeltjesbloem	7	7	6		GE
964	*Polygonatum multiflorum*	Gewone salomonszegel	8	8	8		–
965	*Polygonatum odoratum*	Welriekende salomonszegel	6	6	6		–
966	*Polygonatum verticillatum*	Kranssalomonszegel	2	1	2		BE
968	*Polygonum aviculare*	Gewoon varkensgras	9	9	9		–
1413	*Polygonum oxyspermum* subsp. *raii*	Zandvarkensgras	0	1	1		GE
1415	*Polypodium interjectum*	Brede eikvaren		+			–
978	*Polypodium vulgare*	Gewone eikvaren		+			–
979	*Polystichum aculeatum*	Stijve naaldvaren	3	4	4		GE
1618	*Polystichum lonchitis*	Lansvaren	0	2	2	#	GE
2007	*Polystichum setiferum*	Zachte naaldvaren	1	2	3		GE
5114	*Pontederia cordata*	Moerashyacint		–			*
980	*Populus alba*	Witte abeel	7	8	8	h	–
981	*Populus* ×*canescens*	Grauwe abeel	5	8	8	h×	–
982	*Populus nigra*	Zwarte populier	6	7	7	h	–
983	*Populus tremula*	Ratelpopulier	8	9	9	h	–
984	*Portulaca oleracea*	Postelein	4	5	6		–
985	*Potamogeton acutifolius*	Spits fonteinkruid	4	6	6	*	KW
986	*Potamogeton alpinus*	Rossig fonteinkruid	5	6	6		–
987	*Potamogeton berchtoldii*	Klein fonteinkruid		+			–
988	*Potamogeton coloratus*	Weegbreefonteinkruid	1	2	2		GE
989	*Potamogeton compressus*	Plat fonteinkruid	6	7	6	*	KW
990	*Potamogeton crispus*	Gekroesd fonteinkruid	7	8	8		–
1632	*Potamogeton* ×*decipiens*	Wilgfonteinkruid	0	1	2	×	–
5369	*Potamogeton filiformis*	Draadfonteinkruid		–			*
1619	*Potamogeton* ×*fluitans*	Vlottend fonteinkruid	0	0	3	×	–
993	*Potamogeton gramineus*	Ongelijkbladig fonteinkruid	5	5	5	*	BE
994	*Potamogeton lucens*	Glanzig fonteinkruid	8	8	7		–
992	*Potamogeton mucronatus*	Puntig fonteinkruid	6	7	6	*	–
995	*Potamogeton natans*	Drijvend fonteinkruid	8	8	8		–
996	*Potamogeton nodosus*	Rivierfonteinkruid	3	4	4		–
997	*Potamogeton obtusifolius*	Stomp fonteinkruid	5	7	6	*	KW
998	*Potamogeton pectinatus*	Schedefonteinkruid	8	8	8		–
999	*Potamogeton perfoliatus*	Doorgroeid fonteinkruid	8	7	7		–
1000	*Potamogeton polygonifolius*	Duizendknoopfonteinkruid	7	6	7		–
1001	*Potamogeton praelongus*	Langstengelig fonteinkruid	4	2	3	*	BE
1002	*Potamogeton pusillus*	Tenger fonteinkruid		+			–
5116	*Potamogeton* ×*sparganifolius*	Zwaardfonteinkruid	0	0	2	×	–
1003	*Potamogeton trichoides*	Haarfonteinkruid	2	8	8	*	–
1004	*Potamogeton* ×*zizii*	Gegolfd fonteinkruid	1	2	3		GE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
19	103	1	1	9c	H47 H42
i	1	1	2	6c	P60mu P67ss
i	1	1	1	9b	H47 H42 H69 H62
i	1	1	3	4c	R27 R47 R28 R48
i	1	1	2	5a	G63 G47 G67 G48 G43 G62 bG40
i	1	2	3	2a	G48 G28 G47 H48 H28 bG40 G27 H27 H47
20.4	100	1	–	1d	P68
i	1	0	3	6c	G43
i	1	0	1	7d	G42 G41
i	1	0	1	6d	G43 G63 G42 G62
i	1	1	1	9b	H42 H47
i	1	1	1	8d	G63 H63
i	1	1	–	9e	H42
i	1	1	3	1d	P48tr P67 P47 P68
20.4	101	1	–	3a	bP40
i	1	1	–	8d	H62 H63
i	1	1	–	9e	G62 H62 H63
i	1	1	–	9d	H47 P40mu
20.4	100	1	–	9b	–
i	1	1	–	9d	H47
20.4	301	1	–	–	–
17	103	1	–	9c	H63 H69 H47
18	103	1	–	9c	H63 H69 H62
i	1	1	–	4d	H48
i	1	1	1	9e	H63 H69 H62 H42 H43 H47
a	110	2	3	1c	P67 P47
i	1	1	–	4a	W16zt
i	1	1	–	4b	W16zt
i	1	1	–	4a	W16
i	1	1	–	4a	W13 bW10
i	1	1	–	4a	W16zt
i	1	1	–	4a	W18
i	1	1	–	4a	W18
i	1	1	–	–	W16
i	1	1	–	4a	W16
i	1	1	–	4b	W12 W16 W15
i	1	1	–	4a	W16 W18
i	1	1	–	4a	W18
i	1	1	–	4a	W16 W15
i	1	1	–	4a	W18
i	1	1	–	4a	W16zt W15
i	1	1	1	4a	W18 bW10
i	1	1	1	4a	W18 bW10 W16
i	1	1	–	4b	W12 W15
i	1	1	–	4a	W16zt
i	1	1	–	4a	W18
i	1	1	–	–	–
i	1	1	–	4a	W16
i	1	1	–	4a	W16

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1005	*Potentilla anglica*	Kruipganzerik	8	8	8		–
1006	*Potentilla anserina*	Zilverschoon	9	9	9		–
1007	*Potentilla argentea*	Viltganzerik	7	6	7		–
1008	*Potentilla erecta*	Tormentil	9	9	8		–
5117	*Potentilla indica*	Schijnaardbei		–			*
1009	*Potentilla intermedia*	Middelste ganzerik	5	5	6		–
1726	*Potentilla norvegica*	Noorse ganzerik	5	5	6		–
346	*Potentilla palustris*	Wateraardbei	8	8	7		GE
1727	*Potentilla recta*	Rechte ganzerik	4	5	6		–
1010	*Potentilla reptans*	Vijfvingerkruid	8	9	9		–
1011	*Potentilla sterilis*	Aardbeiganzerik	5	5	5		KW
1012	*Potentilla supina*	Liggende ganzerik	4	5	6		–
1013	*Potentilla verna*	Voorjaarsganzerik	6	5	5		–
1014	*Primula elatior*	Slanke sleutelbloem	6	7	6		–
1015	*Primula veris*	Gulden sleutelbloem	5	5	5		KW
1016	*Primula vulgaris*	Stengelloze sleutelbloem	4	4	4		BE
1017	*Prunella vulgaris*	Gewone brunel	9	9	9		–
1018	*Prunus avium*	Zoete kers	6	8	8	h	–
1841	*Prunus cerasifera*	Kerspruim	0	4	5	h	–
5120	*Prunus mahaleb*	Weichselboom		–			*
1019	*Prunus padus*	Gewone vogelkers	7	9	9	h	–
1020	*Prunus serotina*	Amerikaanse vogelkers	6	9	9	h	–
1021	*Prunus spinosa*	Sleedoorn	8	8	8	h	–
5047	*Pseudofumaria alba*	Geelwitte helmbloem	0	2	2	#	–
364	*Pseudofumaria lutea*	Gele helmbloem	4	5	6		–
2259	*Pseudotsuga menziesii*	Douglasspar		–			*
1022	*Pteridium aquilinum*	Adelaarsvaren	8	8	8		–
1027	*Puccinellia distans* subsp. *borealis*	Bleek kweldergras		+			–
1023	*Puccinellia distans* subsp. *distans*	Stomp kweldergras		+			–
1024	*Puccinellia fasciculata*	Blauw kweldergras	4	5	4		GE
1025	*Puccinellia maritima*	Gewoon kweldergras	7	7	6		–
1028	*Puccinellia rupestris*	Dichtbloemig kweldergras	4	2	0		VN
1029	*Pulicaria dysenterica*	Heelblaadjes	8	8	8		–
G27							
1030	*Pulicaria vulgaris*	Klein vlooienkruid	4	3	6		–
1031	*Pulmonaria montana*	Smal longkruid	1	0	0		VN
1032	*Pulmonaria officinalis*	Gevlekt longkruid	4	5	6		–
57	*Pulsatilla vulgaris*	Wildemanskruid	2	0	0		VN
1033	*Pyrola minor*	Klein wintergroen	6	5	5		BE
1034	*Pyrola rotundifolia*	Rond wintergroen	6	6	6		KW
1035	*Pyrus communis*	Peer	4	6	6	h	–
1036	*Quercus petraea*	Wintereik	6	7	6	h	–
1037	*Quercus robur*	Zomereik	9	9	9	h	–
1876	*Quercus rubra*	Amerikaanse eik	0	8	8	h	–
1038	*Radiola linoides*	Dwergvlas	8	5	5		BE
1040	*Ranunculus acris*	Scherpe boterbloem	9	9	9		–
1041	*Ranunculus aquatilis*	Fijne waterranonkel		+			–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	2a	G22 G42 G27 G47
i	1	2	2	2a	bG40 bG20 P48tr bP40 bP20 G28 P28 G47 P27
i	1	1	3	6d	G62 G67
i	1	1	2	7e	G42 G22 G41
20.3	209	2	–	–	H48
19	155	1	–	1e	P67
19	101	1	3	1e	P67 P47
i	1	2	1	7a	V12 V15 G22 G27
19	103	1	1	1e	G67
i	1	1	2	2a	G47 G48 G67 G68
i	1	1	3	9d	H43 H42
i	1	1	–	2c	P28
i	1	1	1	6c	G43 G63 G62
i	1	0	1	9b	H43 H47 H42
i	1	0	1	6c	H43 G43
i	1	0	3	9b	H47 G47
i	1	2	2	5a	G47 G43 G42
i	1	1	1	9b	H43 H47 H42
20.3	109	1	–	8d	H47
20.1	103	1	–	–	–
i	1	1	1	9b	H47 H42
20.1	301	1	1	9e	H41 H61 H42 H62
i	1	1	1	8d	H47
20.3	152	0	–	6a	P60mu
19	159	0	–	6a	P60mu P40mu
20.4	301	1	3	–	–
i	1	1	1	9e	R64 H61 H62
i	1	0	(3)	3b	bP20
i	1	0	(3)	3b	bG20 bG40 bP20
i	1	0	–	3b	zG20 bP20
i	1	0	1	3b	zG20 zP20
i	1	0	–	3b	bP20 bP40
i	1	2	3	2a	R47kr G47kr bG40 bG20 R27
i	1	1	–	2c	P28
i	1	0	–	9d	H42
i	1	0	1	9d	H47
i	1	0	–	6c	G62
i	1	1	–	9e	H42 H62
i	1	1	–	7a	G42 H42
a	100	2	–	8d	H47
i	1	1	1	9e	H62 H42 H61 H41
i	1	1	1	9b	H42 H62 H41 H61 H47 H69 H63 H43
20.1	301	1	–	9e	H61 H41 H62 H42 H47
i	1	1	3	2c	P42 P22
i	1	0	1	5a	G47 G48
i	1	1	–	4a	W16 W18 P27

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1042	*Ranunculus arvensis*	Akkerboterbloem	6	4	2		EB
1043	*Ranunculus auricomus*	Gulden boterbloem	6	6	6		–
1044	*Ranunculus baudotii*	Zilte waterranonkel	6	6	6		–
1045	*Ranunculus bulbosus*	Knolboterbloem	8	8	8		–
1046	*Ranunculus circinatus*	Stijve waterranonkel	8	8	8		–
1047	*Ranunculus ficaria* subsp. *bulbilifer*	Gewoon speenkruid	8	8	9		–
1048	*Ranunculus flammula*	Egelboterbloem	9	9	9		–
1049	*Ranunculus fluitans*	Vlottende waterranonkel	5	5	4		BE
1050	*Ranunculus hederaceus*	Klimopwaterranonkel	6	6	5		KW
1051	*Ranunculus lingua*	Grote boterbloem	8	7	7		–
1053	*Ranunculus ololeucos*	Witte waterranonkel	5	4	4		BE
1054	*Ranunculus omiophyllus*	Drijvende waterranonkel	1	0	0	#	VN
1055	*Ranunculus peltatus*	Grote waterranonkel		+			–
2404	*Ranunculus polyanthemos* subsp. *nemorosus*	Bosboterbloem		+			EB
1512	*Ranunculus polyanthemos* subsp. *polyanthemoides*	Kalkboterbloem		+			EB
1056	*Ranunculus repens*	Kruipende boterbloem	9	9	9		–
1057	*Ranunculus sardous*	Behaarde boterbloem	7	7	7		–
1058	*Ranunculus sceleratus*	Blaartrekkende boterbloem	9	9	9		–
1059	*Ranunculus tripartitus*	Driedelige waterranonkel	1	0	0		VN
1061	*Raphanus raphanistrum*	Knopherik	8	8	8		–
1764	*Rapistrum rugosum*	Bolletjesraket	4	6	6		–
1062	*Reseda lutea*	Wilde reseda	7	7	7		–
1063	*Reseda luteola*	Wouw	6	6	7		–
1064	*Rhamnus cathartica*	Wegedoorn	7	7	7		–
530	*Rhamnus frangula*	Sporkehout	9	9	9	h	–
1065	*Rhinanthus alectorolophus*	Harige ratelaar	4	4	4		KW
1066	*Rhinanthus angustifolius*	Grote ratelaar	9	7	7		–
1067	*Rhinanthus minor*	Kleine ratelaar	8	7	6		GE
2105	*Rhododendron ponticum*	Pontische rododendron	0	7	7	h	–
1068	*Rhynchospora alba*	Witte snavelbies	7	6	6		GE
1069	*Rhynchospora fusca*	Bruine snavelbies	7	6	6		GE
2106	*Ribes alpinum*	Alpenbes	3	5	5	h	–
1070	*Ribes nigrum*	Zwarte bes	7	8	8	h	–
1071	*Ribes rubrum*	Aalbes	6	8	8	h	–
1072	*Ribes uva-crispa*	Kruisbes	6	8	8	*	–
1877	*Robinia pseudoacacia*	Robinia	7	8	8	*	–
1074	*Rorippa amphibia*	Gele waterkers	9	9	9		–
2467	*Rorippa ×armoracioides*	Valse akkerkers	0	0	4	×	–
1075	*Rorippa austriaca*	Oostenrijkse kers	4	5	6		–
859	*Rorippa microphylla*	Slanke waterkers		+			–
860	*Rorippa nasturtium-aquaticum*	Witte waterkers		+			–
1076	*Rorippa palustris*	Moeraskers	8	9	9		–
1078	*Rorippa sylvestris*	Akkerkers	8	8	9		–
5419	*Rosa agrestis*	Kraagroos		+			**
1080	*Rosa arvensis*	Bosroos	4	4	4	*	–
5420	*Rosa caesia*	Behaarde struweelroos		+			**
5421	*Rosa canina*	Hondsroos		+			**

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
a	103	1	–	1b	P47kr
i	1	0	1	9b	H43 H47 G47
i	1	1	–	4a	bW10 W16 P27
i	1	0	3	6b	G47kr G43 G67 G63
i	1	1	–	4a	W18 W16
i	1	0	(1)	9b	H47 H48 G48
i	1	2	3	7a	P23 P22 G23 P27 G27 G22
i	1	1	–	4a	W15 W16zt
i	1	0	–	4a	W15 W18 P27 P28
i	1	2	–	4c	V16zt
i	1	1	–	4b	W12 P22
i	1	0	–	4b	W12
i	1	1	–	4a	W15 W18 P27
i	1	0	(1)	9d	H43
i	1	0	(1)	6c	G43
i	1	2	3	2a	G28 G47 G48 G27 H28 H48
i	1	0	–	2a	bG40 P48
i	1	2	3	2b	P28
i	1	1	–	4a	–
a	100	0	2	1c	P47 P67
20.2	105	0	–	1e	P48
a	100	0	3	1f	P67
a	100	0	–	1f	P67
i	1	1	–	8d	H47kr H63 H43
i	1	2	1	9a	H41 H22 H42 H21
i	1	1	–	5a	G47kr
i	1	1	1	5b	G27 G47 G22 G42
i	1	1	2	7e	G43 G47 G42 G63
20.1	105	0	–	9e	H41 H42 H47
i	1	2	–	7d	P21
i	1	2	–	7d	P21
19	101	1	1	8d	H47
i	1	1	–	9a	H27
i	1	1	–	9a	H47 H27 H42
i	1	1	1	8d	H43 H47 H63
19	301	0	3	9e	H69 H47 H62
i	1	2	1	4c	V18 H28 R28 V16
i	1	2	–	1e	–
20.1	104	2	–	2a	R48
i	1	2	–	4c	P27 P28 V18 V16
i	1	2	–	4c	P28 P27 V18
i	1	2	3	2b	P28 P48
i	1	2	–	2a	P28 G28 P48
i	1	2	–	8d	–
i	1	2	–	9d	H43 H47kr
i	1	1	–	8d	–
i	1	2	1	8d	–

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
5422	*Rosa columnifera*	Schijnegelantier		+			**
5423	*Rosa corymbifera*	Heggenroos		+			**
5424	*Rosa dumalis*	Kale struweelroos		+			**
5425	*Rosa elliptica*	Wigbladige roos		+			**
1879	*Rosa majalis*	Kaneelroos	3	3	3	h	–
5426	*Rosa micrantha*	Kleinbloemige roos		+			**
1083	*Rosa pimpinellifolia*	Duinroos	6	6	6	h	–
5427	*Rosa pseudoscabriuscula*	Ruwe viltroos		+			**
5471	*Rosa rubiginosa*	Egelantier		+			**
1085	*Rosa rugosa*	Rimpelroos	3	7	8	h	–
5428	*Rosa sherardii*	Berijpte viltroos		+			+
5430	*Rosa subcanina*	Schijnhondsroos		+			**
5431	*Rosa subcollina*	Schijnheggenroos		+			**
5432	*Rosa tomentella*	Beklierde heggenroos		+			**
5433	*Rosa tomentosa*	Viltroos		+			+
5434	*Rosa villosa*	Bottelroos		+			+
1088	*Rubia tinctorum*	Meekrap	3	1	0	*	–
1089	*Rubus caesius*	Dauwbraam	8	9	9		–
2009	*Rubus corylifolius*	Hazelaarbraam	5	5	7	h#	–
1634	*Rubus fruticosus*	Gewone braam	9	9	9	*	–
1091	*Rubus idaeus*	Framboos	8	8	8	*	–
1829	*Rubus laciniatus*	Peterseliebraam		–			*
5132	*Rubus phoenicolasius*	Japanse wijnbes		–			*
1092	*Rubus saxatilis*	Steenbraam	2	1	1		BE
5133	*Rubus spectabilis*	Prachtframboos	2	3	5	*	–
1880	*Rudbeckia laciniata*	Slipbladige rudbeckia	3	4	4		–
1093	*Rumex acetosa*	Veldzuring	9	9	9		–
1094	*Rumex acetosella*	Schapenzuring	9	9	9		–
1096	*Rumex aquaticus*	Paardenzuring	3	0	0		VN
1097	*Rumex conglomeratus*	Kluwenzuring	9	9	9		–
1098	*Rumex crispus*	Krulzuring	9	9	9		–
1099	*Rumex hydrolapathum*	Waterzuring	9	9	9		–
1100	*Rumex maritimus*	Goudzuring		+			–
1101	*Rumex obtusifolius*	Ridderzuring	9	9	9		–
1102	*Rumex palustris*	Moeraszuring		+			–
1095	*Rumex ×pratensis*	Bermzuring	5	8	8	×	–
1103	*Rumex sanguineus*	Bloedzuring	7	7	7		–
1104	*Rumex scutatus*	Spaanse zuring	3	3	3		GE
1106	*Rumex thyrsiflorus*	Geoorde zuring	6	6	6		–
1108	*Ruppia cirrhosa*	Spiraalruppia		+			BE
1107	*Ruppia maritima*	Snavelruppia		+			KW
1522	*Sagina apetala* subsp. *apetala*	Donkere vetmuur		+			**
1523	*Sagina apetala* subsp. *erecta*	Uitstaande vetmuur		+			**
1110	*Sagina maritima*	Zeevetmuur	6	6	6		–
1111	*Sagina nodosa*	Sierlijke vetmuur	7	6	6		KW
1112	*Sagina procumbens*	Liggende vetmuur	9	9	9		–
1113	*Sagina subulata*	Priemvetmuur	1	0	0		VN
1114	*Sagittaria sagittifolia*	Pijlkruid	9	8	8		–
1635	*Salicornia europaea*	Kortarige zeekraal		+			–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
19	100	2	–	8d	H63 H69
i	1	2	–	8d	–
i	1	2	–	8c	G63 G62 H63
i	1	2	–	8d	–
i	1	2	1	8d	–
20.2	204	2	–	8d	H69 H63
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
i	1	2	–	8d	–
17	111	0	–	1g	R47
i	1	2	1	8d	R47kr R64 R44 G63 H63 H69 G43 H47kr
i	1	2	–	–	R47 R67 H47 H69
i	1	2	1	9b	R47 R67 R44 R64 H47 H42 H41 H69 H62 H61
i	1	2	3	8a	R47 H47 H42
20.4	4	2	–	–	–
20.4	204	2	–	8d	–
i	1	2	1	9e	H47
20.1	301	2	–	9c	–
19	301	0	1	4d	R28
i	1	1	2	5a	G47 G27 G48
i	1	1	3	6d	P67 P62 P61
i	1	2	–	4d	–
i	1	2	–	2a	H28 G28
i	1	2	3	2a	G48 bP40 G28 P48 bR40
i	1	2	–	4c	V16 R27 V18 R28
i	1	2	3	2b	P28
i	1	1	3	1g	R48 H48 G48
i	1	1	–	2b	P28
i	1	1	–	1g	G48
i	1	2	3	9a	H47
i	1	1	–	6a	P40mu
i	1	1	–	5a	G47kr G67
i	1	2	–	3b	bW10
i	1	2	–	3b	bW10
a	100	1	(2)	2c	–
a	100	1	(2)	1d	–
i	1	1	–	3c	bP40
i	1	1	2	2c	P23 P43 bP40
i	1	1	3	1d	P47 P48tr
i	1	1	–	2c	–
i	1	1	–	4c	V18 V16 W16 W18
i	1	1	3	3b	zP20

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1636	*Salicornia procumbens*	Langarige zeekraal		+			–
2428	*Salicornia pusilla*	Eenbloemige zeekraal		+			BE
1116	*Salix alba*	Schietwilg	8	9	9	h	–
1117	*Salix aurita*	Geoorde wilg		+			–
1118	*Salix caprea*	Boswilg	8	8	9	h	–
2468	*Salix cinerea* subsp. *cinerea*	Grauwe wilg		+			–
1417	*Salix cinerea* subsp. *oleifolia*	Rossige wilg		+			–
1120	*Salix dasyclados*	Duitse dot	0	7	6	h	–
1121	*Salix fragilis*	Kraakwilg	6	8	8	h	–
1122	*Salix pentandra*	Laurierwilg	5	6	6	h	–
1123	*Salix purpurea*	Bittere wilg	6	7	7	h	–
1124	*Salix repens*	Kruipwilg	9	8	8		–
1125	*Salix triandra*	Amandelwilg	8	8	8	h	–
1126	*Salix viminalis*	Katwilg	8	8	8	h	–
1127	*Salsola kali* subsp. *kali*	Stekend loogkruid		+			–
1524	*Salsola kali* subsp. *ruthenica*	Zacht loogkruid		+			–
1128	*Salvia pratensis*	Veldsalie	6	5	5		KW
1129	*Salvia verbenaca*	Kleinbloemige salie	2	0	1		EB
1130	*Salvia verticillata*	Kranssalie	5	3	3		GE
1131	*Salvinia natans*	Kleine vlotvaren	1	1	0	*	–
1132	*Sambucus ebulus*	Kruidvlier	4	4	4		BE
1133	*Sambucus nigra*	Gewone vlier	9	9	9		–
1134	*Sambucus racemosa*	Trosvlier	4	7	8	h	–
1135	*Samolus valerandi*	Waterpunge	7	7	7		–
5450	*Sanguisorba minor* subsp. *minor*	Kleine pimpernel		+			+
1137	*Sanguisorba officinalis*	Grote pimpernel	7	7	7		–
1138	*Sanicula europaea*	Heelkruid	5	5	4		KW
1139	*Saponaria officinalis*	Zeepkruid	7	7	7		–
1627	*Saxifraga granulata* 'Plena'	Haarlems klokkenspel	3	3	3	*	–
1144	*Saxifraga granulata* s. str.	Knolsteenbreek	6	6	5		BE
1146	*Saxifraga tridactylites*	Kandelaartje	6	6	6		–
1147	*Scabiosa columbaria*	Duifkruid	6	5	4		BE
1148	*Scandix pecten-veneris*	Naaldenkervel	6	3	2		EB
1149	*Scheuchzeria palustris*	Veenbloembies	3	2	1	#	EB
1155	*Schoenoplectus lacustris*	Mattenbies		+			–
1152	*Schoenoplectus pungens*	Stekende bies	4	1	2		EB
1161	*Schoenoplectus tabernaemontani*	Ruwe bies		+			–
1162	*Schoenoplectus triqueter*	Driekantige bies	5	4	4		BE
1150	*Schoenus nigricans*	Knopbies	6	5	5		KW
1885	*Scilla bifolia*	Vroege sterhyacint	3	4	5	*	–
1151	*Scilla non-scripta*	Wilde hyacint	5	7	7		–
1887	*Scilla siberica*	Oosterse sterhyacint	2	5	5	*	–
1621	*Scilla siehei*	Grote sneeuwroem	2	5	5	*	–
5275	*Scirpoides holoschoenus*	Kogelbies		–			*
1160	*Scirpus sylvaticus*	Bosbies	7	8	8		–
1163	*Scleranthus annuus*	Eenjarige hardbloem	9	8	8		–
1164	*Scleranthus perennis*	Overblijvende hardbloem	6	5	4		EB
1166	*Scorzonera humilis*	Kleine schorseneer	3	2	3		BE
1167	*Scrophularia auriculata*	Geoord helmkruid		+			–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	3b	zP20
i	1	1	–	3b	zP20
i	1	2	3	4d	H28 H48
i	1	1	–	9a	H22 H27 H21 H41
i	1	1	1	9b	H47
i	1	1	–	9e	–
i	1	1	–	9e	–
20.2	4	1	–	4d	H28
i	1	2	–	4d	H28 H48
i	1	1	–	9a	H27
i	1	1	–	4d	H28 H27 H47
i	1	1	1	7a	H23 H62 H43 H63 H42 H22
i	1	1	–	4d	H28 H48
i	1	1	–	4d	H28 H48 H27 H47
i	1	1	(1)	3a	bP60
i	1	1	(1)	1f	P67
i	1	2	1	6c	G47kr
i	1	2	–	1f	G47kr
19	105	2	–	1f	G47kr P67ss
19	103	1	–	4a	W16
i	1	2	–	8a	R47kr R48
i	1	2	3	8d	H69 H47 H48
i	1	2	3	8a	H42 H41 H47 H62 H61 H69
i	1	0	3	2c	P23 W13 bP20 P27
i	1	2	1	6c	G43 G63
i	1	1	1	5b	G22 G27 G42 G47
i	1	1	1	9d	H43 H42
a	105	0	–	1f	G67 G47
19	103	0	(3)	9c	H47
i	1	0	3	5a	G47
i	1	0	2	6b	P63
i	1	1	2	6c	G43
a	100	1	–	1b	P47kr
i	1	1	–	7d	G22 G21 V12 V11
i	1	2	–	4c	V18
i	1	2	–	3c	bV10 V18 bP20
i	1	2	–	4c	bV10 V18
i	1	2	–	4c	V18
i	1	1	1	7b	G23
17	113	0	–	9c	H47
i	1	0	1	9c	H42 H47
19	157	0	–	9c	H47
20.1	210	0	–	9c	H47
20.4	100	2	–	–	–
i	1	2	1	5b	R27 G27 H27
a	100	1	3	1c	P67
i	1	1	–	6b	P62 G62
i	1	1	–	7e	G42 G61
i	1	1	3	4c	R27

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1170	*Scrophularia nodosa*	Knopig helmkruid	8	8	9		–
2406	*Scrophularia umbrosa*	Gevleugeld helmkruid		+			–
1172	*Scrophularia vernalis*	Voorjaarshelmkruid	4	4	5		–
1765	*Scutellaria columnae*	Trosglidkruid	1	2	3		–
1173	*Scutellaria galericulata*	Blauw glidkruid	8	9	9		–
1174	*Scutellaria minor*	Klein glidkruid	6	5	4		BE
357	*Securigera varia*	Bont kroonkruid	5	5	5		–
1175	*Sedum acre*	Muurpeper	8	8	8		–
1176	*Sedum album*	Wit vetkruid	6	6	7		–
1177	*Sedum cepaea*	Omgebogen vetkruid	2	1	0		–
1180	*Sedum reflexum*	Tripmadam	6	5	5		BE
1181	*Sedum sexangulare*	Zacht vetkruid	6	5	6		–
1888	*Sedum spurium*	Roze vetkruid		–			*
2358	*Sedum telephium*	Hemelsleutel	8	8	8		–
1182	*Selinum carvifolia*	Karwijselie	3	3	2		BE
1183	*Senecio aquaticus*	Waterkruiskruid	8	8	8		–
1185	*Senecio erucifolius*	Viltig kruiskruid	8	8	8		–
1186	*Senecio fluviatilis*	Rivierkruiskruid	5	5	5		–
1733	*Senecio inaequidens*	Bezemkruiskruid	0	6	8		–
2290	*Senecio jacobaea*	Jakobskruiskruid	8	8	9		–
1187	*Senecio ovatus*	Schaduwkruiskruid	5	5	5		–
1189	*Senecio paludosus*	Moeraskruiskruid	7	7	7		–
1190	*Senecio sylvaticus*	Boskruiskruid	8	8	9		–
1734	*Senecio vernalis*	Oostelijk kruiskruid	2	5	5	#	–
1191	*Senecio viscosus*	Kleverig kruiskruid	7	8	8		–
1192	*Senecio vulgaris*	Klein kruiskruid	9	9	9		–
100	*Seriphidium maritimum*	Zeealsem	7	6	6		KW
1193	*Serratula tinctoria*	Zaagblad	4	2	0		VN
1194	*Sesleria albicans*	Blauwgras	1	1	0	#	VN
1195	*Setaria pumila*	Geelrode naaldaar	6	6	6		–
1196	*Setaria verticillata*	Kransnaaldaar	3	4	7		–
1197	*Setaria viridis*	Groene naaldaar	7	7	8		–
1198	*Sherardia arvensis*	Blauw walstro	6	6	6		KW
1200	*Silaum silaus*	Weidekervel	4	4	4		KW
1202	*Silene conica*	Kegelsilene	6	5	5		–
807	*Silene dioica*	Dagkoekoeksbloem	8	9	9		–
1203	*Silene gallica*	Franse silene	5	3	3		EB
805	*Silene latifolia* subsp. *alba*	Avondkoekoeksbloem	8	8	8		–
806	*Silene noctiflora*	Nachtkoekoeksbloem	5	4	4		BE
1204	*Silene nutans*	Nachtsilene	5	5	5		–
1205	*Silene otites*	Oorsilene	5	4	4		KW
1206	*Silene vulgaris*	Blaassilene	6	6	6		–
1207	*Sinapis arvensis*	Herik	8	8	9		–
1208	*Sisymbrium altissimum*	Hongaarse raket	6	7	8		–
1213	*Sisymbrium austriacum* subsp. *chrysanthum*	Maasraket	2	4	5	#	–
1210	*Sisymbrium loeselii*	Spiesraket	5	4	4		–
1211	*Sisymbrium officinale*	Gewone raket	9	9	9		–
1212	*Sisymbrium orientale*	Oosterse raket	5	5	5		–
1214	*Sisymbrium supinum*	Liggende raket	1	0	0		VN

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	0	3	9b	H47 H42
i	1	0	–	4c	R27 R28 H27
18	100	0	–	9c	H63
19	111	1	–	9c	H47
i	1	2	–	4c	H27 R27 V16
i	1	1	–	9a	H22 G22
i	1	0	–	6c	G47kr
i	1	0	3	6b	P63 P67 bP60
i	1	0	–	6c	P67
i	1	0	–	6a	–
i	1	0	–	6b	P62 G62 G67
i	1	1	–	6b	G63 G67 G62
20.4	256	0	–	–	–
i	1	0	1	8c	G67 G47
i	1	2	1	7c	G42 H42
i	1	1	1	5b	G27
i	1	1	1	5a	G47kr
i	1	1	–	4d	R28 R48
20.2	405	1	–	4d	P47 P67
i	1	1	2	6b	G63 H63 G47kr P63 G43 G67
i	1	1	1	8a	H47 H43 H42
i	1	0	–	4d	H28 R28 R27
i	1	1	3	8a	H63 H62 P62 H69 P67
20.2	104	0	1	1e	P67
i	1	1	3	1e	P67 P68
i	1	1	3	1a	P68 P48 P67 P47 bP40 bP60
i	1	1	–	3b	zG40
i	1	2	1	7c	G42
i	1	1	–	6c	P63ss H43
19	4	2	3	1c	P68
18	4	2	3	1c	P67 P47
a	100	2	3	1c	P68
a	100	2	1	1b	P47kr G47kr
i	1	1	–	5a	G47
i	1	1	–	6b	P63
i	1	1	1	8b	H47
a	110	2	–	1c	P47
i	1	1	3	1e	P47 P67 G67 G47
a	103	1	–	1b	P48
i	1	1	3	8c	G63
i	1	1	1	6b	G63
i	1	1	3	6c	G43 P47kr G47kr
a	100	0	3	1a	P48 P47kr
19	104	0	3	1f	P67 P68
20.1	153	0	–	1f	P47
19	109	0	–	1f	P67 P68
a	100	0	3	1e	P48 P68
19	105	0	–	1f	P67
19	102	0	–	2b	–

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1216	*Sium latifolium*	Grote watereppe	9	8	8		–
1217	*Smyrnium olusatrum*	Zwartmoeskervel	1	4	3	#	–
1218	*Solanum dulcamara*	Bitterzoet	9	9	9		–
1219	*Solanum nigrum* subsp. *nigrum*	Zwarte nachtschade		+			–
1738	*Solanum nigrum* subsp. *schultesii*	Beklierde nachtschade		+			–
1739	*Solanum physalifolium*	Glansbesnachtschade	4	3	5		–
1220	*Solanum triflorum*	Driebloemige nachtschade	3	5	5		–
1890	*Solidago canadensis*	Canadese guldenroede	6	7	7		–
1221	*Solidago gigantea*	Late guldenroede	5	7	8		–
1222	*Solidago virgaurea*	Echte guldenroede	7	7	6		KW
2324	*Sonchus arvensis*	Akkermelkdistel	9	9	9		–
1224	*Sonchus asper*	Gekroesde melkdistel	9	9	9		–
1225	*Sonchus oleraceus*	Gewone melkdistel	9	9	9		–
1226	*Sonchus palustris*	Moerasmelkdistel	6	7	7		–
1227	*Sorbus aucuparia*	Wilde lijsterbes	9	9	9	h	–
1742	*Sorghum halepense*	Wilde sorgo	0	4	4		–
1228	*Sparganium angustifolium*	Drijvende egelskop	4	4	3		BE
1231	*Sparganium emersum*	Kleine egelskop	8	8	8		–
1229	*Sparganium erectum*	Grote egelskop	9	9	9		**
1230	*Sparganium natans*	Kleinste egelskop	6	5	4		BE
1233	*Spartina anglica*	Engels slijkgras	6	6	6		–
1232	*Spartina maritima*	Klein slijkgras	5	2	1	#	EB
1234	*Spergula arvensis*	Gewone spurrie	9	9	9		–
1235	*Spergula morisonii*	Heidespurrie	7	7	7		–
1238	*Spergularia marina*	Zilte schijnspurrie		+			–
1236	*Spergularia media* subsp. *angustata*	Gerande schijnspurrie		+			–
1237	*Spergularia rubra*	Rode schijnspurrie	8	8	8		–
395	*Spergularia segetalis*	Korenschijnspurrie	1	0	0		VN
1239	*Spiranthes aestivalis*	Zomerschroeforchis	4	0	0		VN
1240	*Spiranthes spiralis*	Herfstschroeforchis	4	2	1		EB
1241	*Spirodela polyrhiza*	Veelwortelig kroos	8	8	9		–
1243	*Stachys arvensis*	Akkerandoorn	8	6	6		KW
1244	*Stachys officinalis*	Betonie	4	4	3		BE
1245	*Stachys palustris*	Moerasandoorn	9	9	9		–
5280	*Stachys recta*	Bergandoorn		–			*
1246	*Stachys sylvatica*	Bosandoorn	8	8	8		–
847	*Stellaria aquatica*	Watermuur	7	7	8		–
1248	*Stellaria graminea*	Grasmuur	9	9	9		–
1249	*Stellaria holostea*	Grote muur	8	8	8		–
1250	*Stellaria media*	Vogelmuur		+			–
1251	*Stellaria neglecta*	Heggenvogelmuur		+			–
1253	*Stellaria nemorum*	Bosmuur	4	4	4		–
1252	*Stellaria pallida*	Duinvogelmuur		+			–
1254	*Stellaria palustris*	Zeegroene muur	8	8	7		–
1247	*Stellaria uliginosa*	Moerasmuur	7	8	8		–
1255	*Stratiotes aloides*	Krabbenscheer	8	7	7		GE
1256	*Suaeda maritima*	Schorrenkruid	7	6	6		–
1258	*Succisa pratensis*	Blauwe knoop	9	8	7		GE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	4c	V16zt V18 R27 R28
a	102	0	–	8b	H47
i	1	2	2	4d	H27 H28 R27 R28 V16
a	100	1	(3)	1a	P68 P48
20.1	100	1	(3)	1e	P48 P68
20.1	305	1	–	1e	P48 P68
20.1	301	1	–	1f	P63 P67
19	301	1	2	1g	R48
20.1	301	1	1	4d	R47 R48
i	1	1	1	9e	H42 G42 H62
i	1	2	3	1a	P48 bP60 bR60 bR40 bP40
i	1	2	3	1a	P48 bP40
i	1	2	3	1a	P48 bP40
i	1	2	–	4d	R28 R27 bR20
i	1	2	1	9e	H42 H41 H61 H62 H47
20.3	202	0	3	1e	–
i	1	2	–	4b	W12 W11
i	1	2	–	4c	V16zt V18 W16zt W18 W15 V15
i	1	2	1	4c	V18 V16 V15
i	1	2	–	4b	W12 W15
20.1	102	1	1	3b	zP20
i	1	1	–	3b	zP20
a	100	1	3	1c	P67 P47
i	1	1	–	6d	P61
i	1	2	3	3b	bP20 bG20 zP20 zG20
i	1	1	–	3b	zG20 zP20
i	1	1	3	2c	P47 P67
i	1	1	–	1b	P47
i	1	2	–	7c	G42
i	1	2	–	6b	G42
i	1	1	0	4a	W18
a	100	1	3	1c	P48 P47
i	1	1	2	8c	G42
i	1	2	1	4d	R28 R27 H28
20.4	103	1	1	–	–
i	1	1	2	9b	H47
i	1	1	–	2b	P28 R28 H28 P48 R48 H48
i	1	1	2	5a	G67 G47
i	1	0	1	9b	H42 H43
i	1	2	3	1a	P48 P68 P47 P67
i	1	1	–	8b	H47
i	1	1	1	9a	H47
i	1	1	–	8b	P63 P67 H63 H69
i	1	1	1	7a	G27 V16
i	1	1	3	9a	P27 P28
i	1	1	–	4a	W16zt
i	1	2	1	3b	zP20
i	1	2	1	7c	G42 G22

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
2107	*Symphoricarpos albus*	Sneeuwbes	5	7	7	h	–
1259	*Symphytum officinale*	Gewone smeerwortel	9	9	9		–
2390	*Syringa vulgaris*	Sering		–			*
320	*Tanacetum parthenium*	Moederkruid	6	7	8		–
1260	*Tanacetum vulgare*	Boerenwormkruid	9	9	9		–
2430	*Taraxacum officinale*	Paardenbloem	9	9	9		+
1267	*Taxus baccata*	Taxus	5	7	7	h	–
1268	*Teesdalia nudicaulis*	Klein tasjeskruid	8	8	8		–
1184	*Tephroseris palustris*	Moerasandijvie	6	7	7		–
1419	*Tetragonolobus maritimus*	Hauwklaver	0	2	2		GE
1269	*Teucrium botrys*	Trosgamander	2	2	1	#	EB
1270	*Teucrium chamaedrys* subsp. *germanicum*	Echte gamander	2	2	1		EB
1271	*Teucrium montanum*	Berggamander	2	2	1	#	EB
1272	*Teucrium scordium*	Moerasgamander	2	2	1		BE
1273	*Teucrium scorodonia*	Valse salie	8	8	7		–
1275	*Thalictrum flavum*	Poelruit	8	8	8		–
1953	*Thalictrum minus*	Kleine ruit	6	5	5		KW
427	*Thelypteris palustris*	Moerasvaren	7	7	6		–
1278	*Thesium humifusum*	Liggend bergvlas	2	2	1		EB
1281	*Thlaspi arvense*	Witte krodde	8	8	8		–
1280	*Thlaspi caerulescens*	Zinkboerenkers	3	2	1	#	KW
1282	*Thlaspi perfoliatum*	Doorgroeide boerenkers	2	3	2		GE
1420	*Thymus praecox*	Kruiptijm		+			GE
1283	*Thymus pulegioides*	Grote tijm		+			KW
1284	*Thymus serpyllum*	Kleine tijm		+			BE
1285	*Tilia cordata*	Winterlinde		+			–
1286	*Tilia platyphyllos*	Zomerlinde		+			–
1288	*Torilis arvensis*	Akkerdoornzaad	4	2	2		BE
1289	*Torilis japonica*	Heggendoornzaad	8	8	7		–
1290	*Torilis nodosa*	Knopig doornzaad	6	6	6		KW
5190	*Tragopogon dubius*	Bleke morgenster	0	2	4		–
1293	*Tragopogon porrifolius*	Paarse morgenster	5	4	5		–
1292	*Tragopogon pratensis* subsp. *orientalis*	Oosterse morgenster		+			BE
2418	*Tragopogon pratensis* subsp. *pratensis*	Gele morgenster		+			–
1153	*Trichophorum cespitosum* subsp. *germanicum*	Veenbies	7	7	6		GE
1295	*Trientalis europaea*	Zevenster	4	5	5		–
1296	*Trifolium arvense*	Hazenpootje	8	8	8		–
1298	*Trifolium campestre*	Liggende klaver	8	8	8		–
1299	*Trifolium dubium*	Kleine klaver	9	9	9		–
1300	*Trifolium fragiferum*	Aardbeiklaver	8	8	7		–
1301	*Trifolium hybridum*	Basterdklaver	8	8	8		–
1302	*Trifolium medium*	Bochtige klaver	5	5	6	*	KW
1303	*Trifolium micranthum*	Draadklaver	3	5	5	*	KW
1304	*Trifolium ornithopodioides*	Vogelpootklaver	1	3	3		GE
1305	*Trifolium pratense*	Rode klaver	9	9	9		–
1306	*Trifolium repens*	Witte klaver	9	9	9		–
1307	*Trifolium scabrum*	Ruwe klaver	4	4	4		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
19	301	1	–	8d	H47 H48
i	1	1	–	4d	H28 H48 R48 R28
20.3	109	1	–	–	–
a	109	0	–	1e	P48
i	1	0	1	1g	R67 R47
i	1	2	2	–	G48 G47 G68 G63 G67 G62
i	1	1	–	9d	H42 H47
i	1	0	3	6d	P62 P67
i	1	2	–	2b	P28
20.2	100	1	–	6c	G43
a	103	1	–	6c	P63ss
i	1	1	–	6c	G43
i	1	1	–	6c	P63ss
i	1	2	–	2a	G23
i	1	1	3	9e	H62 H61 H42
i	1	0	2	4d	R27 R47 R28 R48
i	1	0	–	8c	G63 H63
i	1	1	–	7a	R27 H27 V16 V15
i	1	1	–	6b	G63
a	100	1	3	1a	P48
i	1	1	–	6c	G47
i	1	1	–	1b	P43 G43
i	1	1	1	6c	G43
i	1	1	3	6b	G63 G43
i	1	1	–	6d	G62
i	1	1	1	9d	H43 H47
i	1	1	–	9d	H47
a	100	1	–	5a	G47kr
i	1	1	3	8b	G47 H47
i	1	1	–	5a	G47kr bG40
20.2	103	1	3	1e	P67 P63
18	110	1	–	1g	G47
i	1	1	(2)	5a	G47
i	1	1	(2)	5a	G47 G67
i	1	1	(1)	7d	G41 G21
i	1	0	1	9e	H41
i	1	1	3	6d	G67 G62 P67 P62
i	1	1	2	6b	G67 G63 G62
i	1	1	3	5a	G47 G67
i	1	2	–	2a	bG40 G48
19	4	1	2	2a	P48 P47
i	1	2	1	8c	G47 G43 G42
i	1	1	–	6b	G67 G47
i	1	1	–	6b	G67
i	1	2	2	5a	G47 G48 bG40
i	1	1	2	2a	G48 G47 bG40
i	1	1	–	6b	G67 G63

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1308	*Trifolium striatum*	Gestreepte klaver	5	5	5		–
1309	*Trifolium subterraneum*	Onderaardse klaver	4	4	3		KW
1310	*Triglochin maritima*	Schorrenzoutgras	7	7	7		–
1311	*Triglochin palustris*	Moeraszoutgras	8	8	8		–
795	*Tripleurospermum maritimum*	Reukeloze kamille	8	9	9		–
1312	*Trisetum flavescens*	Goudhaver	8	8	7	*	GE
1313	*Tuberaria guttata*	Gevlekt zonneroosje	4	2	2		EB
1314	*Tulipa sylvestris*	Bostulp	4	4	4		–
1316	*Tussilago farfara*	Klein hoefblad	9	9	9		–
1317	*Typha angustifolia*	Kleine lisdodde	8	8	8		–
1318	*Typha latifolia*	Grote lisdodde	8	9	9		–
1319	*Ulex europaeus*	Gaspeldoorn	6	5	6	*	KW
1895	*Ulmus glabra*	Ruwe iep	4	5	6	h	–
5154	*Ulmus laevis*	Fladderiep	0	2	4	h	–
1320	*Ulmus minor*	Gladde iep	8	7	8	h	–
1321	*Urtica dioica*	Grote brandnetel	9	9	9		–
1322	*Urtica urens*	Kleine brandnetel	9	9	9		–
1325	*Utricularia australis*	Loos blaasjeskruid		+			–
1323	*Utricularia intermedia*	Plat blaasjeskruid	4	4	4		KW
1324	*Utricularia minor*	Klein blaasjeskruid	6	6	5		KW
1326	*Utricularia ochroleuca*	Bleekgeel blaasjeskruid	3	3	0		VN
1327	*Utricularia vulgaris*	Groot blaasjeskruid		+			–
5155	*Vaccinium corymbosum*	Trosbosbes	2	3	4	#	–
1329	*Vaccinium myrtillus*	Blauwe bosbes	8	8	8		–
1330	*Vaccinium uliginosum*	Rijsbes	4	3	3		BE
1331	*Vaccinium vitis–idaea*	Rode bosbes	7	7	7		–
1332	*Valeriana dioica*	Kleine valeriaan	8	7	6		KW
1333	*Valeriana officinalis*	Echte valeriaan	9	9	9		–
1334	*Valerianella carinata*	Gegroefde veldsla	4	2	3		GE
1335	*Valerianella dentata*	Getande veldsla	5	3	2		EB
1336	*Valerianella locusta*	Veldsla	7	7	7		–
1337	*Valerianella rimosa*	Geoorde veldsla	4	2	1	#	VN
2108	*Vallisneria spiralis*	Vallisneria	0	1	2		–
1338	*Verbascum blattaria*	Mottenkruid	1	4	5		–
1342	*Verbascum densiflorum*	Stalkaars	6	6	7		–
1339	*Verbascum lychnitis*	Melige toorts	3	3	4		–
1340	*Verbascum nigrum*	Zwarte toorts	6	6	7		–
1341	*Verbascum phlomoides*	Keizerskaars	4	5	6		–
1343	*Verbascum thapsus*	Koningskaars	6	7	7		–
1344	*Verbena officinalis*	IJzerhard	7	6	6		–
1345	*Veronica agrestis*	Akkerereprijs	8	7	7		–
1346	*Veronica anagallis–aquatica*	Blauwe waterereprijs		+			–
1347	*Veronica arvensis*	Veldereprijs	8	9	9		–
1364	*Veronica austriaca* subsp. *teucrium*	Brede ereprijs	5	4	4		BE
1349	*Veronica beccabunga*	Beekpunge	7	8	8		–
1350	*Veronica catenata*	Rode waterereprijs		+			–
1351	*Veronica chamaedrys*	Gewone ereprijs	9	9	9		–
1896	*Veronica filiformis*	Draadereprijs	5	7	8	#	–
1352	*Veronica hederifolia*	Klimopereprijs	8	8	9		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	1	6b	G67 G62
i	1	1	3	6b	G67
i	1	1	2	3b	zG20 bG20
i	1	1	1	2a	G27 G28 bG20
i	1	2	3	1e	bP40 P48 P47 P67
i	1	2	1	5a	G47kr
i	1	2	–	6b	G62
19	100	0	–	9c	H47
i	1	1	1	1e	P48 P47
i	1	2	–	4c	V18 V16 R28 R27
i	1	2	3	4c	V18 R28 V16 R27
i	1	0	3	7e	H62 H61
i	1	1	1	9d	H47
i	1	1	–	9c	H47
i	1	1	–	9c	H47kr H43
i	1	2	3	8b	R48 H48 R68 H69
a	100	1	3	1a	P48 P68
i	1	1	0	4b	W12 W15
i	1	1	–	4b	W12
i	1	1	–	4b	W11 W12
i	1	1	0	4b	W12
i	1	1	3	4a	W16zt
20.2	301	2	–	7d	H21 H41
i	1	2	1	9e	H61 H41 G61
i	1	2	1	7d	G21 G41 H21
i	1	2	1	9e	H61 G61 H41 G41
i	1	1	1	7c	G22 G27
i	1	1	1	5b	H28 R27 R28 H27 H47 R47
a	100	2	2	6b	P63 P47kr
a	100	2	1	1b	P47kr
i	1	2	1	6b	P47 G47 P67
i	1	2	–	1b	P47
20.2	105	1	0	4a	W18
i	1	0	–	1f	P67
i	1	0	–	1f	P67
i	1	0	2	8c	P63 P62
i	1	0	3	1f	G47 G67
i	1	0	–	1f	P67
i	1	0	3	1f	P63 P67
a	100	2	–	5a	G47kr
a	100	1	3	1a	P48 P47
i	1	1	–	4c	P28 P27
i	1	1	2	6b	P67 G63 P63 G67 P47
i	1	2	–	6c	G63 G67 G47kr
i	1	1	3	4c	P28 P27
i	1	2	3	2b	P28 W18 P27 W16
i	1	1	2	5a	G47 H47 H63 G63
20.2	210	1	–	5a	G47
i	1	1	3	1c	H47 P47 P67 H69

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1353	*Veronica longifolia*	Lange ereprijs	5	6	6		–
1354	*Veronica montana*	Bosereprijs	4	5	5		–
1355	*Veronica officinalis*	Mannetjesereprijs	8	8	8		–
1356	*Veronica opaca*	Doffe ereprijs	4	4	5	*	KW
1357	*Veronica peregrina*	Vreemde ereprijs	5	4	6		–
1358	*Veronica persica*	Grote ereprijs	8	8	8		–
1359	*Veronica polita*	Gladde ereprijs	7	5	6		–
1360	*Veronica praecox*	Vroege ereprijs	1	0	1		EB
1361	*Veronica prostrata*	Liggende ereprijs	5	3	2		EB
1362	*Veronica scutellata*	Schildereprijs	7	7	7		–
1363	*Veronica serpyllifolia*	Tijmereprijs	8	8	9		–
1365	*Veronica triphyllos*	Handjesereprijs	6	4	4		EB
1366	*Veronica verna*	Kleine ereprijs	2	1	1	*	BE
2109	*Viburnum lantana*	Wollige sneeuwbal	2	4	5	h	–
1367	*Viburnum opulus*	Gelderse roos	8	8	8	h	–
1369	*Vicia cracca*	Vogelwikke	9	9	9		–
1370	*Vicia hirsuta*	Ringelwikke	8	8	9		–
1371	*Vicia lathyroides*	Lathyruswikke	7	6	6		–
1751	*Vicia lutea*	Gele wikke	4	4	4		–
5454	*Vicia sativa* subsp. *nigra*	Smalle wikke		+			**
5455	*Vicia sativa* subsp. *segetalis*	Vergeten wikke		+			**
1373	*Vicia sepium*	Heggenwikke	8	8	8		–
1754	*Vicia tenuifolia*	Stijve wikke	3	3	3		GE
1374	*Vicia tetrasperma* subsp. *gracilis*	Slanke wikke		+			EB
1375	*Vicia tetrasperma* subsp. *tetrasperma*	Vierzadige wikke		+			–
2387	*Vicia villosa*	Bonte wikke	6	6	6		–
1377	*Vinca minor*	Kleine maagdenpalm	6	6	7		–
383	*Vincetoxicum hirundinaria*	Witte engbloem	2	1	2		KW
5158	*Vincetoxicum nigrum*	Zwarte engbloem	0	2	2	#	–
1378	*Viola arvensis*	Akkerviooltje	8	9	9		–
1380	*Viola canina*	Hondsviooltje	8	7	7		GE
1381	*Viola curtisii*	Duinviooltje	6	6	6		–
1382	*Viola hirta*	Ruig viooltje	5	6	6		–
1379	*Viola lutea* subsp. *calaminaria*	Zinkviooltje	3	2	1		EB
1384	*Viola odorata*	Maarts viooltje	7	7	7		–
1385	*Viola palustris*	Moerasviooltje	8	8	7		–
1389	*Viola persicifolia*	Melkviooltje	4	3	4		BE
1386	*Viola reichenbachiana*	Donkersporig bosviooltje		+			–
1387	*Viola riviniana*	Bleeksporig bosviooltje		+			–
1388	*Viola rupestris*	Zandviooltje	4	4	4		–
1390	*Viola tricolor*	Driekleurig viooltje	8	7	7	t	–
1391	*Viscum album*	Maretak	5	5	5	*	–
1392	*Vulpia bromoides*	Eekhoorngras	6	5	6		–
2454	*Vulpia ciliata* subsp. *ambigua*	Duinlangbaardgras		+			–
2453	*Vulpia ciliata* subsp. *ciliata*	Gewimperd langbaardgras		+			*
5159	*Vulpia fasciculata*	Dicht langbaardgras	0	2	3		–
5302	*Vulpia membranacea*	Zandlangbaardgras	0	0	3		–
1393	*Vulpia myuros*	Gewoon langbaardgras	5	7	8		–

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	1	–	5b	R27 R47
i	1	1	3	9a	H47 H42
i	1	1	3	7e	G63 H63 G62 H62
a	103	2	3	1a	P48
18	301	1	–	1a	P48 P47
19	208	1	3	1a	P48
a	100	2	3	1a	P48
i	1	2	–	6b	P67
i	1	2	–	6c	G63 G67
i	1	1	3	7a	P22 W12 G27
i	1	1	3	2a	P47 G47
a	103	2	–	1c	P67 P47
i	1	2	–	6b	P62
i	1	1	–	8d	H63
i	1	1	1	9a	H47 H43
i	1	0	1	5a	G47 R47
i	1	0	2	1a	P67 P47
i	1	0	2	6b	G63 G62
20.3	103	0	–	6b	G47
i	1	0	(1)	6b	G63
a	103	0	(1)	1a	P47 P67
i	1	0	1	8b	H47kr G47 H43
i	1	0	–	1e	G67
i	1	0	(1)	1b	P47
i	1	0	(1)	1a	P47 G47
19	113	0	1	1c	G47
a	103	0	–	9b	H42 H43 H47
i	1	1	1	8c	H43
20.3	108	1	–	8d	H63
a	100	1	3	1c	P67 P68 P47
i	1	0	2	7e	G62 G42
i	1	0	–	6b	G63 P63 G62
i	1	0	1	8c	H43 H63 G43 G63
i	1	0	–	6c	G47
i	1	0	–	9c	H47kr
i	1	0	1	7a	G22 H22
i	1	0	–	7c	G22 G27
i	1	0	1	9d	H43 H42
i	1	0	1	9b	H42 H62 H47
i	1	0	2	6b	G63
i	1	1	3	1c	P67
i	1	1	–	9d	–
i	1	1	–	6d	G67
20.4	100	1	–	6b	P63
20.4	100	1	–	–	–
20.3	100	2	1	6b	P67 P63
20.4	100	1	–	6b	–
i	1	1	2	1e	P67

Tabel 1 Annex. Alfabetische standaardlijst (vervolg)

nr.	wetensch. naam	Nederlandse naam	KFK 30	80	95	noot	RL2000
1394	*Wahlenbergia hederacea*	Klimopklokje	2	1	1	#	BE
1395	*Wolffia arrhiza*	Wortelloos kroos	6	7	7		–
2469	*Xanthium strumarium*	Late stekelnoot	4	5	6		–
1542	*Zannichellia palustris* subsp. *major*	Brede zannichellia		+			VN
1396	*Zannichellia palustris* subsp. *palustris*	Zittende zannichellia		+			–
1397	*Zannichellia palustris* subsp. *pedicellata*	Gesteelde zannichellia		+			–
1398	*Zostera marina*	Groot zeegras	5	5	4		BE
1399	*Zostera noltii*	Klein zeegras	5	4	3		BE

indig.	herkomst	dispersie	zaadbank	ecologische groepen (ARN)	ecologische groepen (RUN)
i	1	2	–	7d	G22
i	1	1	0	4a	W18
20.2	4	2	–	1e	P48
i	1	1	(3)	3b	bW10 W18
i	1	1	(3)	4a	W18 bW10
i	1	1	(3)	4a	bW10
i	1	1	–	3b	zW10
i	1	1	–	3b	zW10

Tabel 2. Combinatietaxa KFK

Legenda

1. taxonnummer (afkorting: nr.)
2. wetenschappelijke naam of namen (g = genus)
3. KFK voor de perioden 1902–1950 (KFK30), 1975–1988 (KFK80) en 1988–2000 (KFK95)
4. KFK noot

   # = KFK's zijn bijgesteld op basis van deskundigenoordeel

5. nummers van de taxa waaruit het combinatietaxon is samengesteld

nr.	wetenschappelijke naam of namen	KFK			
		30	80	95	noot
16	*Agrostis canina + A. vinealis*	8	8	8	
5200	*Agrostis gigantea + A. stolonifera*	9	9	9	
6016	*Alchemilla* (g)	6	7	6	
6017	*Alisma* (g)	9	9	9	
1652	*Amaranthus hybridus*	3	4	6	#
2308	*Anagallis arvensis*	8	8	8	
6043	*Aphanes arvensis + A. inexpectata*	8	8	8	
2334	*Arenaria leptoclados + A. serpyllifolia*	8	8	8	
2392	*Artemisia campestris*	5	5	5	
1904	*Asparagus officinalis*	6	7	8	
2336	*Blackstonia perfoliata*	4	4	5	
5375	*Brassica napus + B. rapa*	7	8	8	
2432	*Bromopsis ramosa*	4	3	3	
6097	*Callitriche* (g)	8	9	9	
2338	*Caltha palustris*	9	8	8	
2210	*Carex acutiformis + C. riparia*	8	9	9	
2213	*Carex oederi*	7	7	7	
5359	*Carex otrubea + C. vulpina*	8	8	8	
2314	*Cerastium fontanum*	9	9	9	
2433	*Cochlearia officinalis*	7	6	6	
1616	*Dactylorhiza fuchsii + D. maculata*	7	6	6	
1637	*Dactylorhiza majalis*	7	7	7	
5376	*Doronicum pardalianches + D. plantagineum*	5	5	5	
5207	*Dryopteris carthusiana + D. dilatata*	8	9	9	
6183	*Echinodorus* (g)	7	5	5	
1914	*Eleocharis palustris + E. uniglumis*	8	9	9	
445	*Elytrigia arenosa + E. atherica*	7	8	7	
5308	*Epilobium* spec. excl. *E. hirsutum & E. parviflorum*	8	9	9	
518	*Festuca cinerea + F. filiformis + F. ovina*	9	9	9	
2222	*Galeopsis bifida + G. tetrahit*	9	9	9	
2383	*Glyceria declinata + G. notata*	6	7	7	
2342	*Hypericum dubium + H. maculatum*	8	8	8	
1929	*Juncus alpinoarticulatus*	6	6	6	

samenstellende nummers
1544, 1545
17, 18
1452, 1453, 1454, 1455, 1456, 1647, 1648, 1649
26, 27, 28
5311, 5318
52, 1659
74, 75
89, 1459
98, 99
104, 105
145, 1855
1802, 1804
155, 163
179, 180, 181, 182, 183, 184, 185, 2460, 5315
187, 1460
212, 259
220, 261
245, 268
296, 1465
341, 343
883, 885
886, 890
413, 414
419, 426
429, 430
437, 440
2462, 5463
448, 453, 454, 455, 456, 458, 1642
1472, 1473, 1474
540, 543
583, 586
647, 1482
672, 682

Tabel 2 Annex. Combinatietaxa KFK
(slot)

nr.	wetenschappelijke naam of namen	KFK 30	80	95	noot
1930	*Juncus ambiguus + J. bufonius*	9	9	9	
5469	*Lamiastrum galeobdolon + L. g.* 'Florentinum'	6	8	8	
2396	*Lamium hybridum + L. purpureum*	9	9	9	
5475	*Lamium maculatum + L. m.* 'Variegatum'	6	6	7	
5309	*Lotus corniculatus*	9	9	9	
2344	*Luzula campestris + L. multiflora*	9	9	9	
5198	*Mentha aquatica + M. ×verticillata*	9	9	9	
5377	*Mentha ×rotundifolia + M. suaveolens*	6	6	6	
1936	*Montia fontana*	6	7	7	
1922	*Myosotis laxa + M. scorpioides*	9	9	9	
2319	*Odontites vernus*	8	7	7	
5202	*Oenothera biennis + O. erythrosepala*	7	8	8	
2434	*Ononis repens*	8	8	7	
5102	*Panicum dichotomiflorum + P. schinzii*	0	1	5	
5466	*Pastinaca sativa*	8	8	8	
2385	*Phleum pratense*	9	9	9	
2435	*Phyteuma spicatum*	5	6	5	
2320	*Plantago major*	9	9	9	
2321	*Poa angustifolia + P. pratensis*	9	9	9	
5203	*Polypodium interjectum + P. vulgare*	8	8	8	
5193	*Potamogeton berchtoldii + P. pusillus*	7	8	8	
2400	*Puccinellia distans*	7	7	7	
1946	*Ranunculus aquatilis + R. peltatus*	8	8	8	
1052	*Ranunculus polyanthemos*	3	3	2	
5201	*Rorippa microphylla + R. nasturtium-aquaticum*	8	9	8	
1643	*Rosa canina* agg.	8	9	9	
1645	*Rosa rubiginosa* agg.	6	7	7	
1644	*Rosa villosa* agg.	5	5	4	
2263	*Rumex maritimus + R. palustris*	7	8	8	
6455	*Ruppia* (g)	5	6	5	
1109	*Sagina apetala*	5	6	7	
6458	*Salicornia* (g)	7	6	6	
2265	*Salix aurita + S. cinerea*	9	9	9	
2356	*Salsola kali*	6	6	6	
1136	*Sanguisorba minor*	7	6	6	
1949	*Schoenoplectus lacustris + S. tabernaemontani*	8	8	8	
2266	*Scrophularia auriculata + S. umbrosa*	7	7	7	
2323	*Solanum nigrum*	9	9	9	
2270	*Spergularia marina + S. media* subsp. *angustata*	7	7	7	
2271	*Stellaria media + S. neglecta + S. pallida*	9	9	9	
6526	*Thymus* (g)	8	7	6	
5206	*Tilia* (g)	6	7	7	
1954	*Tragopogon pratensis*	8	8	8	
2282	*Utricularia australis + U. vulgaris*	6	7	7	
5199	*Veronica anagallis-aquatica + V. catenata*	7	8	8	
1960	*Vicia sativa*	9	9	9	
2408	*Vicia tetrasperma*	7	7	7	
1966	*Viola reichenbachiana + V. riviniana*	8	7	7	
2452	*Vulpia ciliata*	0	1	3	
1964	*Zannichellia palustris*	6	8	8	

samenstellende nummers
671, 675
702, 1898
703, 706
704, 2464
761, 2465
766, 1933
813, 820
818, 1772
835, 2427
841, 844
509, 1496
872, 873
876, 877
5338, 5461
922, 5340
932, 1411
935, 936
945, 947
958, 1500
978, 1415
987, 1002
1023, 1027
1041, 1055
1512, 2404
859, 860
5420, 5421, 5422, 5423, 5424, 5425, 5430, 5431, 5432
5419, 5426, 5427, 5471
5428, 5433, 5434
1100, 1102
1107, 1108
1522, 1523
1635, 1636, 2428
1117, 1417. 2468
1127, 1524
(5449), 5450
1155, 1161
1167, 2406
1219, 1738
1236, 1238
1250, 1251, 1252
1283, 1284, 1420
1285, 1286, (2277)
1292, 2418
1325, 1327
1346, 1350
(1372), 5454, 5455
1374, 1375
1386, 1387
2453, 2454
1396, 1397, 1542

Tabel 3 Annex. Veranderingen in wetenschappelijke namen (legenda + tabel)

Tabel 3. Veranderingen in taxonnummers en wetenschappelijke namen.

Legenda

1. taxonnummer (afkorting: nr.)
2. oude wetenschappelijke naam (volgens de Standaardlijst 1996; afkorting: wetensch. naam oud)
3. nieuwe wetenschappelijke naam (afkorting: wetensch. naam nieuw)
4. noot:

a = aanpassing schrijfwijze;
f = fout in oude Standaardlijst (vergeten, verkeerd nummer, schrijfwijze);
l = samenvoeging van taxa van oude Standaardlijst;
n = opnieuw/nieuw voor de Standaardlijst;
s = splitsing in meer dan één (onder)soort op Standaardlijst en/of lijst wachtkamersoorten
t = taxonomische verandering
w = verwijderd van Standaardlijst (onvoldoende bewijs of uitgestorven vóór 1900)

nr.	wetensch. naam oud	wetensch. naam nieuw	noot
9	*Adonis vernalis*	–	w
5001	–	*Acer negundo*	n
1850	–	*Acer platanoides*	f
1851	–	*Aesculus hippocastanum*	n
1652	***Amaranthus hybridus***	–	**s**
5311	–	***Amaranthus hybridus* subsp. *bouchonii***	**s**
5318	–	***Amaranthus hybridus* subsp. *hybridus***	**s**
5313	–	*Anisantha diandra*	n
5323	–	*Asclepias syriaca*	n
108	*Asperula cynanchica*	–	w
5212	–	*Berberis thunbergii*	n
1801	*Beta vulgaris* subsp. *vulgaris*	–	w
149	*Botrychium matricariifolium*	–	w
160	–	*Bromus lepidus*	n
5315	–	*Callitriche truncata*	n
190	*Camelina sativa*	–	f
190	–	*Camelina sativa* subsp. *alyssum*	f
241	–	***Carex ligerica***	**s**
257	–	***Carex reichenbachii***	**s**
2455	–	*Carex crawfordii*	n
226	–	*Carex divisa*	n
5314	–	*Centaurea stoebe*	n

nr.	wetensch. naam oud	wetensch. naam nieuw	noot
2477	–	*Chenopodium ambrosioides*	n
309	–	*Chenopodium chenopodioides*	n
5328	–	*Conyza sumatrensis*	n
5172	–	*Cotoneaster integerrimus*	n
5307	–	*Crassula helmsii*	n
381	–	*Cuscuta gronovii*	n
1616	*Dactylorhiza maculata*	–	s
883		*Dactylorhiza fuchsii*	s
885		*Dactylorhiza maculata*	s
391	–	*Dactylis polygama*	n
1490	*Diphasiastrum complanatum*	–	w
2483	–	*Dittrichia graveolens*	n
434	*Elatine triandra*	–	w
445	*Elytrigia atherica*	–	s
5463	–	*Elytrigia atherica*	s
2462	*Elytrigia repens* subsp. *arenosa*	*Elytrigia arenosa*	t
464	–	*Equisetum hyemale*	l
2420	*Equisetum hyemale*	–	l
2424	*Equisetum* ×*moorei*	–	l
2485	–	*Erigeron karvinskianus*	n
1917	–	*Erodium cicutarium*	l
480	*Erodium cicutarium* subsp. *cicutarium*	–	l
482	*Erodium cicutarium* subsp. *dunense*	–	l
2379	–	*Falcaria vulgaris*	n
1614	–	*Helianthus tuberosus*	n
2489	–	*Helleborus foetidus*	n
1860	–	*Hesperis matronalis*	n
657	*Iberis amara*	–	w
2303	–	*Juglans regia*	n
683	*Juncus gerardi*	*Juncus gerardii*	f
702	*Lamiastrum galeobdolon*	*Lamiastrum galeobdolon* s. str.	a
1898	*Lamiastrum galeobdolon* cv. 'Florentinum'	*Lamiastrum galeobdolon* 'Florentinum'	a
705	–	*Lamium confertum*	n
704	*Lamium maculatum*	*Lamium maculatum* s. str.	a
2464	*Lamium maculatum* cv. 'Variegatum'	*Lamium maculatum* 'Variegatum'	a
5362	–	*Lemna turionifera*	n
1700	–	*Lepidium densiflorum*	n
5335	–	*Ludwigia grandiflora*	n
1866	–	*Lunaria annua*	n
1899	–	*Lupinus polyphyllus*	n
2326	–	*Lychnis coronaria*	n
5089	–	*Malva parviflora*	n
791	–	*Malva pusilla*	n
2232	–	*Matteuccia struthiopteris*	n
5255	–	*Melissa officinalis*	n
863	–	*Nicandra physalodes*	n

Tabel 3 Annex. Veranderingen in wetenschappelijke namen (vervolg)

nr.	wetensch. naam oud	wetensch. naam nieuw	noot
864	*Nigella arvensis*	–	w
1496	–	*Odontites vernus* subsp. *vernus*	n
1713	–	*Oenanthe pimpinelloides*	n
5337	–	*Oxalis dillenii*	n
1715	–	*Panicum capillare*	n
5102	*Panicum dichotomiflorum*	–	s
5461	–	*Panicum dichotomiflorum*	s
5338	–	*Panicum schinzii*	s
922	*Pastinaca sativa*	–	s
922	–	*Pastinaca sativa* subsp. *sativa*	s
5340	–	*Pastinaca sativa* subsp. *urens*	s
1820	–	*Phacelia tanacetifolia*	n
5114	–	*Pontederia cordata*	n
5369	–	*Potamogeton filiformis*	n
5116	–	*Potamogeton ×sparganifolius*	f
5117	–	*Potentilla indica*	n
5120	–	*Prunus mahaleb*	n
735	*Pseudorchis albida*	–	w
2259	–	*Pseudotsuga menziesii*	n
1643	*Rosa canina*	–	s
5421	–	*Rosa canina*	s
5420	–	*Rosa caesia*	s
5422	–	*Rosa columnifera*	s
5423	–	*Rosa corymbifera*	s
5424	–	*Rosa dumalis*	s
5425	–	*Rosa elliptica*	s
5430	–	*Rosa subcanina*	s
5431	–	*Rosa subcollina*	s
5432	–	*Rosa tomentella*	s
1645	*Rosa rubiginosa*	–	s
5471	–	*Rosa rubiginosa*	s
5419	–	*Rosa agrestis*	s
5426	–	*Rosa micrantha*	s
5427	–	*Rosa pseudoscabriuscula*	s
1644	*Rosa villosa*	–	s
5434	–	*Rosa villosa*	s
5428	–	*Rosa sherardii*	s
5433	–	*Rosa tomentosa*	s
2009	–	*Rubus corylifolius*	n
1829	–	*Rubus laciniatus*	n
5132	–	*Rubus phoenicolasius*	n
1109	*Sagina apetala*	–	s
1522	–	*Sagina apetala* subsp. *apetala*	s
1523	–	*Sagina apetala* subsp. *erecta*	s
1136	*Sanguisorba minor*	–	s
5450	–	*Sanguisorba minor* subsp. *minor*	s
1144	*Saxifraga granulata*	*Saxifraga granulata* s. str.	a
1627	*Saxifraga granulata* cv. 'Plena'	*Saxifraga granulata* 'Plena'	a
1145	*Saxifraga hirculus*	–	w
5275	–	*Scirpoides holoschoenus*	n

nr.	wetensch. naam oud	wetensch. naam nieuw	noot
1418	*Sedum forsterianum*	–	w
1888	–	*Sedum spurium*	n
2334	*Sonchus arvensis*	–	f
2324	–	*Sonchus arvensis*	f
1229	–	*Sparganium erectum*	l
1533	*Sparganium erectum* subsp. *erectum*	–	l
1535	*Sparganium erectum* subsp. *neglectum*	–	l
1242	*Stachys annua*	–	w
5280	–	*Stachys recta*	n
1257	*Subularia aquatica*	–	w
2390	–	*Syringa vulgaris*	n
2430	–	*Taraxacum officinale*	l
1262	*Taraxacum celticum*	–	l
1261	*Taraxacum laevigatum*	–	l
1263	*Taraxacum obliquum*	–	l
1264	*Taraxacum officinale*	–	l
1265	*Taraxacum palustre*	–	l
1525	*Trichophorum cespitosum* subsp. *cespitosum*	–	w
1368	*Vicia sativa* subsp. *nigra*	–	s
5454	–	*Vicia sativa* subsp. *nigra*	s
5455	–	*Vicia sativa* subsp. *segetalis*	s
2453	–	*Vulpia ciliata* subsp. *ciliata*	n

Tabel 4 Annex. Veranderingen in Nederlandse namen (legenda + tabel)

Tabel 4. Veranderingen in Nederlandse namen.

Legenda

1. taxonnummer (afkorting: nr.)
2. wetenschappelijke naam (afkorting: wetensch. naam)
3. Nederlandse naam oud
4. Nederlandse naam nieuw

nr.	wetensch. naam	Nederlandse naam oud	Nederlandse naam nieuw
4	*Achillea millefolium*	Gewoon duizendblad	Duizendblad
43	*Althaea officinalis*	Echte heemst	Heemst
1965	*Aronia* ×*prunifolia*	Zwarte appelbes	Appelbes
104	*Asparagus officinalis* subsp. *officinalis*	Tuinasperge	Asperge
118	*Astragalus glycyphyllos*	Wilde hokjespeul	Hokjespeul
200	*Capsella bursa-pastoris*	Gewoon herderstasje	Herderstasje
2455	*Carex crawfordii*	Amerikaanse hazenzegge	IJle hazenzegge
226	*Carex divisa*	Waardzegge	Kustzegge
271	*Carum carvi*	Echte karwij	Karwij
1465	*Cerastium fontanum* subsp. *holosteoides*	Glanzende hoornbloem	Glanzige hoornbloem
1759	*Ceratochloa carinata*	Platte dravik	Gekielde dravik
338	*Claytonia perfoliata*	Witte winterpostelein	Winterpostelein
345	*Colchicum autumnale*	Wilde herfsttijloos	Herfsttijloos
406	*Digitalis purpurea*	Gewoon vingerhoedskruid	Vingerhoedskruid
428	*Echinochloa crus-galli*	Hanenpoot	Europese hanenpoot
2462	*Elytrigia arenosa*	Kweek (subps. *arenosa*)	Zandkweek
1917	*Erodium cicutarium*	Gewone en Duinreigersbek	Gewone reigersbek
485	*Eryngium campestre*	Echte kruisdistel	Kruisdistel
531	*Fraxinus excelsior*	Gewone es	Es
1866	*Lunaria annua*	Tuinjudaspenning	Judaspenning
2101	*Mahonia aquifolium*	Mahonia	Mahonie
922	*Pastinaca sativa* subsp. *sativa*	Gewone pastinaak	Pastinaak
696	*Petrorhagia prolifera*	Mantelanjer	Slanke mantelanjer
5116	*Potamogeton* ×*sparganifolius*	Drijvend × Ongelijkbladig fonteinkruid	Zwaardfonteinkruid
1019	*Prunus padus*	Vogelkers	Gewone vogelkers
1083	*Rosa pimpinellifolia*	Duinroosje	Duinroos
1829	*Rubus laciniatus*	Gewone braam (*R. laciniatus*)	Peterseliebraam
1522	*Sagina apetala* subsp. *apetala*	Tengere vetmuur (subsp. *apetala*)	Donkere vetmuur
1523	*Sagina apetala* subsp. *erecta*	Tengere vetmuur (subsp. *erecta*)	Uitstaande vetmuur

nr.	wetensch. naam	Nederlandse naam oud	Nederlandse naam nieuw
1229	*Sparganium erectum*	Grote en Blonde egelskop	Grote egelskop
2390	*Syringa vulgaris*	Gewone sering	Sering
1284	*Thymus serpyllum*	Wilde tijm	Kleine tijm
1153	*Trichophorum cespitosum* subsp. *germanicum*	Gewone veenbies	Veenbies
1336	*Valerianella locusta*	Gewone veldsla	Veldsla

Curriculum vitae

Wil Tamis werd op 29 oktober 1956 geboren te Alkmaar. In 1975 behaalde hij het Atheneum B diploma aan het Petrus Canisius College te Alkmaar. Gedurende de middelbare schooljaren werd hij lid van de Christelijke Jeugdbond voor Natuurstudie (CJN, nu JNM), alwaar hij actief was bij het inventariseren en tellen van vogels, planten, insecten en zeefauna.

De studie biologie aan de Vrije Universiteit te Amsterdam was een logisch vervolg op deze hobby. In 1979 werd het kandidaatsexamen Biologie behaald. De doctoraal vakken waren Diersystematiek en zoögeografie (trek van de Tureluur, *Tringa totanus*, op Schiermonnikoog), Plantenoecologie (botanische evaluatie van de ruilverkaveling Assendelft) en theoretische biologie. Hij behaalde het doctoraal diploma in 1982.

Na enige tijdelijke aanstellingen, o.a. als inventarisatiemedewerker broedvogels bij Provinciale Waterstaat Noord-Holland, werd in 1983 een tweede studie Plantenziektenkunde aan de Landbouwhogeschool (nu Wageningen Universiteit) gestart. Met een verkort programma werd daar in 1985 het kandidaatsexamen behaald. Hij was in die periode studentenassistent bij het practicum "Herkenning Plantenziekten in het veld". In 1985 was voor hij voor een jaar werkzaam bij het Hydrobiologisch Adviesbureau Klink, waar hij onderzoek deed naar nematoden (aaltjes) als mogelijke indicatoren voor verzuring.

In 1986 kreeg hij een aanstelling bij het Centrum voor Milieukunde Leiden (nu Centrum voor Milieuwetenschappen Leiden) aan de Universiteit Leiden (CML). Tot op heden is hij daar met één korte onderbreking werkzaam geweest. Hij is daar betrokken bij diverse ecotoxicologische, bodembiologische en landschapsecologische projecten, zoals bijvoorbeeld Ecologisch herstel van gereinigde grond, Landschapsecologische Kartering van Nederland (LKN), Modellering van het biotisch herstel van natte en vochtige vegetaties (DEMNAT) en de bestrijdingsmiddelenatlas. Hij is in 1996 gedetacheerd geweest bij de Gezondheidsraad (GR) te Den Haag als secretaris van de GR-commissie Ecotoxicologie bij het advies over de voedselweb-benadering in de ecotoxicologische risicobeoordeling. Gedurende 1998 en 1999 is hij gedetacheerd geweest bij het Instituut voor Plantenziektenkundig Onderzoek (IPO) in Wageningen, voor een analyse van monitoringgegevens van graanziekten in relatie tot een gangbare, biologische en geïntegreerde bedrijfsvoering. In 1997 werd hij gedetacheerd bij het Nationaal Herbarium Nederland te Leiden in een project van het Nationaal OnderzoeksProgramma mondiale luchtverontreiniging en klimaatverandering, tweede fase (NOP-II) in een onderzoek naar de lange termijn effecten van klimaatsverandering op de biodiversiteit. De combinatie met een daaropvolgend project in 2000 in het kader van het Stimuleringsprogramma Biodiversiteit van NWO vormde de basis van dit proefschrift.

Nawoord

De afgelopen jaren heb ik met veel plezier gewerkt aan de totstandkoming van dit proefschrift. Zonder de hulp van vele mensen was dit nooit gelukt. Het is bijna onmogelijk iedereen te bedanken, die een bijdrage heeft geleverd. Mijn waardering is er echter niet minder om!

Dit proefschrift zou nooit tot stand hebben kunnen komen, zonder de niet aflatende inzet van honderden vrijwillige, vaak zeer bekwame floristen die jaar in jaar uit verspreidingsgegevens verzamelden en verzamelen van de wilde flora in Nederland. Hun inzet is van onschatbare waarde. Vanaf 1975 zijn de vrijwillige floristen georganiseerd in de stichting FLORON. In samenwerking met het Nationaal Herbarium Nederland bracht FLORON alle verzamelde verspreidingsgegevens bij elkaar. Ik ben FLORON zeer erkentelijk, in het bijzonder Kees Groen, Theo Peterbroers en Baudewijn Odé, voor de levering van de gegevens, alsmede voor de discussies over valkuilen in de verzamelde gegevens.

Het werk is uitgevoerd bij het Nationaal Herbarium Nederland (NHN) en deels ook bij het Centrum voor Milieuwetenschappen Leiden (CML). Ik wil waardering uitspreken voor mijn collega's van het NHN en CML voor de stimulerende werksfeer, met name Joop van Heeswijk voor de vele (ont)spannende schaakpartijen tijdens de lunch. Maarten van 't Zelfde (CML) was een belangrijke mede-uitvoerder van mijn onderzoek. Maarten, zonder jouw altijd vriendelijke en consciëntieuse inzet was dit proefschrift niet gelukt. Ook Edith Roos (CML-bibliotheek) en Joke van der Peet (CML-secretariaat) verzorgden belangrijke ondersteuning.

Met veel plezier heb ik samengewerkt met de programma-coördinatoren Harmke van Oene en Renée Dekker binnen respectievelijk het Nationaal Onderzoeks-Programma Klimaatsverandering (Fase II) en het Stimuleringsprogramma Biodiversiteit, waarbinnen mijn onderzoek is uitgevoerd.

Bij de productie van dit proefschrift werd ik geholpen door Connie Baak, Wout Holverda, Ben Kieft, Hans Kruijer en André Schuiteman. Nigel Harle leverde een grote bijdrage aan de vertaling en/of correctie van het Engels.

Het promotieregelement van de Leidse universiteit staat niet toe dat begeleiders van het onderzoek in het nawoord worden bedankt. Ik vind dat een goede regel, immers als de dankbaarheid voor hen pas in dit stadium van het onderzoek wordt getoond, dan is dat geen goede zaak.

Mijn ouders gaven mij enkele belangrijke bouwstenen voor het leven: doorzettingsvermogen, vertrouwen en liefde voor de natuur, zonder welke dit proefschrift niet tot stand zou zijn gekomen.

Lieve Hetty en kinderen, mede dankzij jullie is er dit proefschrift. Jullie zijn er inmiddels gelukkig aan gewend dat ik tijdens onze tochtjes plotseling de bosjes of berm induik voor een mooie of bijzondere plant, vogel of insekt.