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Waterbirds in the international Rhine Valley: numbers, distribution and trends

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This report is based on census data covering a timespan of mearly 40 years! In recent years alone, about 700 dedicated birdwatchers have contributed (see annex 1). They are largely skilled volunteers, carrying out the field work in their spare time, supplemented with professionals from research institutes and nature management organizations. Coordination at the regional, national and international level is essential to run such a large-scale network for bird monitoring successfully. The waterbird census in Switzerland is coordinated by Vogelwarte Sempach by Nicolas Strebel and supported by the Federal Office of the Environment (Bundesamt für Umwelt BAFU, Switzerland). The regional coordination for the Bodensee is done by Harald Jacoby, Ornithologische Arbeitsgemeinschaft Bodensee. The waterbird census in France is coordinated by Ligue pour la Protection des Oiseaux (LPO), Regional coordination at the French side of the "Oberrhein" (called Rhin supérieur in France) is done by Ligue pour la Protection des Oiseaux d'Alsace.
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Summary

This report provides the third review of wintering waterbirds in the international Rhine Valley in the framework of the working programme of the International Commission for the Protection of the Rhine (ICPR). Counts of waterbirds have a long tradition along the Rhine, being part of national census schemes in Switzerland, France, Germany and The Netherlands. Already in the 1950s and 1960s, migratory and wintering birds were systematically recorded in selected areas within the Rhine Valley. Reliable data on population numbers and distribution of wintering waterbirds of the whole Rhine Valley have become available from the beginning of the 1980s onwards. Monitoring of waterbirds is important as they represent internationally regarded nature values and information about their conservation status is required by international treaties or directives (e.g. EU Bird Directive, RAMSAR, African-Eurasian Waterbird Agreement). Moreover, waterbirds are well-visible and good biological indicators of the ecological quality of their habitats and thus inform about the general state and developments in the ecosystems they use.

The compilation of data for this report focusses on the current status of waterbirds in the international Rhine Valley in the period 2016–2018 (winter seasons 2015/16–2017/18) and presents population trends since 1981. The review has been compiled by the national NGOs that co-ordinate waterbird counts in the different Rhine countries being the Schweizerische Vogelwarte (Sempach) in Switzerland, Ligue pour la Protection des Oiseaux (LPO) in France, Dachverband Deutscher Avifaunisten (DDA) in Germany and Sovon Vogelonderzoek Nederland (Sovon) in The Netherlands. The counts are supported by skilled volunteers, carrying out the fieldwork in their spare time. In recent years alone, about 700 dedicated birdwatchers have contributed to the counts. Locally, their efforts are supplemented with professionals from research institutes and nature management organizations.

On average, maxima of over 1.1 million native waterbirds were present at the Rhine Valley in the winters 2015/16 – 2017/18. They represent 70 bird species of which 25 species occurred in internationally relevant numbers (i.e. >1% of the flyway population). In 1999/2000 these were 21 species, expressing not only genuine increases (see below) but also improved coverage in some species. When comparing the number of birds between the six river stretches distinguished, it becomes clear that about half of the numbers of waterbirds is supported by the lake ecosystems of Bodensee IJsselmeer, Markermeer and Randmeren (Borderlakes) and half by the branches of the river Rhine itself. The phenology of single species varies considerably, due to different wintering strategies and the different geographical situation of the separate parts of the Rhine Valley. Generally speaking, largest numbers are present in the months November – February. In September – October and partly November as well, also species and numbers occur which will continue their migration to sites further south to winter. After February large numbers of wintering birds depart towards the breeding grounds.

The most common species group along the Rhine consist of ducks and Eurasian Coot, followed by swans and geese. In the Southern Rhine ducks and Coot dominate the waterbird community, in the North this position is shared between ducks/Coot and swans and geese. Other species groups as gulls, waders and grebes and herons (and allies) are much less numerous compared to the other groups but involve many species. In addition to native waterbird species, also 14 non-native waterbird species have been found in the Rhine Valley in the wild. This group is clearly increasing, both in number of individuals and partly also in the number of species. For most non-native bird species, no overall negative effects on other species have been reported but the more common ones, Greater Canada Goose, Egyptian Goose and feral Greylag Goose are locally causing crop damage and nuisance in parks and leisure areas.

When comparing trends in numbers in the international Rhine Valley since 1981 with those at the level of entire flyways (20 common species considered), there is a large

overlap in developments at both levels. Overall increases are found among species like Red-crested Pochard, Black-necked Grebe, Great Cormorant, Greylag Goose and Gadwall whereas Mallard, Common Pochard, Common Goldeneye, Eurasian Coot and Tufted Duck are in decline and Smew and Common Merganser stable with a tendency for decline. Many of these trends can be linked to changes in local conditions, but global patterns like climate change may also cause range shifts among migratory bird species visiting the Rhine Valley. We do not find much evidence for major differences in local trends with global trends. However, in Smew, Common Merganser and Common Goldeneye it has been shown that climate change and warmer winters have initiated range shifts in northeast-ward direction. Hence, flyway trends in these species are more positive than the local Rhine trends.

To investigate the relation between changes in waterbird numbers and ecological changes within the Rhine Valley, we labelled the species according to their preferred food type and the preferred foraging habitat. The aggregated results across species with the same food and habitat preferences show large increases in waterbirds foraging on waterplants while grassland-feeders are stable or have even decreased in recent years. Waterbird species largely foraging on freshwater mussels have declined. Foragers of pelagic fish in deeper water do not show a clear trend. Foragers of small fish, aquatic insects, benthos and plant seeds in floodplain marshes and shallow water have increased. As already shown by other studies, these trends can be attributed to the improvement of the water quality along the Rhine. This initiated a return and subsequent expansion of large areas of submerged macrophytes, especially in the lake ecosystems of Bodensee, IJsselmeer/Markermeer and Randmeren. Birds feeding on submerged macrophytes have responded accordingly and have shown overall increases. On the contrary, decreasing eutrophication levels (and also changes in species-composition) have negatively affected standing stocks of especially filter-feeding freshwater mussels, and thus also numbers of mussel- eating waterbirds. Recently, these declines tend to stabilise, as most of the mussel-eating ducks seem to diversify their diet and prey on other macrobenthos species. Another major development is that parts of the floodplain areas have been subject to ecological restauration projects (e.g. lowering of forelands, excavation of side-channels), at the expense of farmland. These measures have especially been taken in The Netherlands and primarily aim to lower the risk of flooding events (giving space to the river) and provision of clay material, but they also intend to increase the natural characters of the floodplain area and promote a more diverse and dynamic ecosystem at the same time. These renaturation measures have had positive effects on waterbird species of marshes, shallow water and muddy shores, by providing increased food stocks and feeding opportunities. The forelands are also very important for grass-eating waterbird species and internationally important numbers of swans, geese and ducks are wintering there. Overall, the numbers using these grasslands have remained stable since 1981, albeit at flyway level many have shown increases until recently. Especially in The Netherlands, even some decreases have occurred in the recent 10 years, likely as a result of the reduction in area of improved grassland in areas where renaturation projects have been carried out.

In comparison with the former reports, further improvements of the ongoing waterbird monitoring have been implemented. There is now an overall countrywide coordination, which especially improved the situation in Germany. Furthermore, the availability of data on smallest counting unit level increased and therefore we can use new statistical methods for estimations of missing counts and calculations of smoothed trends. However, to improve coverage over the annual cycle in waterbirds, counts in other months than January are recommended for the Hochrhein and southern part of the Oberrhein, as is the inclusion of all wader species in the waterbird counts in Switzerland. Even so, the counting scheme would still only cover the period from September to April, thus leaving out large gatherings of e.g. (Black) terns and moulting congregations of waterbirds in late summer and early autumn. These are especially important in Bodensee and IJsselmeer/ Markermeer areas, and it is recommended that for a next report it is investigated if this period can be included in the analyses as well. Present monitoring is focused on the occurrence of non-breeding waterbirds. They show already important relations with environmental conditions. However, it is recommended to investigate if results on breeding bird developments along the Rhine can be brought together as well. For certain colony breeding species and especially some common species these results will be powerful for the monitoring of habitats in the forelands, as they show more direct links to that semi-terrestrial environment. At many sites, breeding bird surveys already take place, but there is no harmonized system and shared databank in The Rhine Valley yet, as established in waterbird counts long time ago.

Zusammenfassung

Rund 20 Jahre nach dem Erscheinen des 2. Rhine Valley Reports wird in vorliegendem Bericht zum dritten Mal eine zusammenfassende Übersicht zum Vorkommen der Wasservögel im gesamten Rheinverlauf dargestellt. Erstellt wurde der Bericht im Rahmen des Arbeitsprogramms der Internationalen Kommission zum Schutz des Rheins (IKSR). Wasservogelzählungen haben entlang des Rheins bereits eine lange Tradition und sind Teil des nationalen Vogelmonitorings in der Schweiz, Frankreich, Deutschland und in den Niederlanden. Bereits in den 1950er- und 1960er-Jahren wurden die Wasservögel an gewissen Abschnitten des Rheintals systematisch gezählt. Für das gesamte Rheintal liegen seit den 1980er-Jahren verlässliche Daten über die Bestände und die Verteilung der überwinternden Wasservögel vor. Das Monitoring der Wasservogelbestände ist wichtig aus naturschutzfachlicher Sicht und wird auch zur Überwachung internationaler Übereinkommen benötigt (z.B. EU-Vogelschutzrichtlinie, Ramsar-Konvention, Afrikanisch-Eurasisches Wasservogelabkommen), die Informationen über den Erhaltungszustand der Vogelarten verlangen. Darüber hinaus sind Wasservögel sichtbare und gute Indikatoren für die ökologische Qualität ihrer Lebensräume und zeigen so den allgemeinen Zustand und die Entwicklungen in den von ihnen genutzten Lebensräumen.

Vorliegender Bericht gibt einen Überblick über Zustand (Wintersaison 2015/16-2017/18) und Bestandsentwicklung (1981–2018) der Wasservögel im internationalen Rheintal. Er wurde von den nationalen Fachverbänden erstellt, die die Wasservogelzählungen vom Bodensee bis zur Mündung koordinieren: die Schweizerische Vogelwarte (Sempach) in der Schweiz, die Ligue pour la Protection des Oiseaux (LPO) in Frankreich, der Dachverband Deutscher Avifaunisten (DDA) in Deutschland und Sovon Vogelonderzoek Nederland (Sovon) in den Niederlanden. Die Zählungen werden überwiegend von qualifizierten Ehrenamtlichen durchgeführt. Allein in den letzten Jahren haben etwa 700 engagierte Vogelbeobachterinnen und -beobachter daran mitgewirkt. In mehreren Gebieten werden sie von Hauptamtlichen aus Forschungsinstituten oder staatlichen Naturschutzeinrichtungen unterstützt.

Im Durchschnitt beherbergte das Rheintal in den Wintern 2015/16 bis 2017/18 über 1,1 Millionen einheimische Wasservögel aus 70 Arten, von denen 25 Arten in international bedeutenden Beständen (d.h. >1 % der biogeographischen Population) vorkamen. Im Bericht über den Winter 1999/2000 wurde dieses Kriterium von 21 Arten erfüllt. Diese Zunahme ist teilweise auf tatsächliche Bestandsanstiege (siehe unten) und teilweise auf die Erfassung weiterer Arten zurückzuführen. Vergleicht man die Bestandszahlen zwischen sechs Flussabschnitten, so wird deutlich, dass die See-Ökosysteme Bodensee, IJsselmeer, Markermeer und Randmeren sowie die Flussabschnitte des Rheins jeweils etwa die Hälfte der Wasservögel beherbergen. Das jahreszeitliche Auftreten der einzelnen Arten variiert beträchtlich, was auf unterschiedliche Überwinterungsstrategien und die unterschiedliche geographische Lage der einzelnen Teile des Rheintals zurückzuführen ist. Im Allgemeinen sind die Zahlen in den Monaten November - Februar am höchsten. In den Monaten September - Oktober und teilweise November wird das Rheintal auch von rastenden Durchzüglern genutzt, die ihre Wanderung anschließend Richtung Süden

fortsetzen. Ab Februar verlassen viele Wasservögel das internationale Rheintal wieder in Richtung ihrer Brutgebiete.

Die indviduenreichste Artengruppe entlang des Rheins sind die Enten und Blässhühner, gefolgt von den Schwänen und Gänsen. Im südlichen Teil des Rheins dominieren Enten und Blässhuhn die Wasservogelgemeinschaft, im Norden sind Enten/Blässhuhn sowie Schwäne und Gänse ähnlich häufig. Andere Artengruppen wie Möwen, Limikolen und Lappentaucher sowie Reiher (und Verwandte) sind im Vergleich zu den anderen Gruppen viel weniger zahlreich, umfassen aber viele unterschiedliche Arten. Zusätzlich zu den einheimischen Wasservogelarten wurden im Rheintal auch 14 nicht-einheimische Wasservogelarten (Neobiota) erfasst. Diese Gruppe nimmt deutlich zu, sowohl in der Anzahl der Individuen als auch in der Artenzahl. Für die meisten dieser Arten wurden keine nennenswerten negativen Auswirkungen auf das Vorkommen anderer Arten festgestellt. Allerdings können insbesondere die häufiger vorkommenden, neozoischen Arten (Kanadagans, Nilgans und Hausgans) lokal Schäden an landwirtschaftlichen Kulturen und Konflikten in Parks und Freizeitanlagen verursachen.
Die Bestandsentwicklung der einzelnen Arten im internationalen Rheintal gleicht in vielen Fällen der Bestandsentwicklung der gesamten biogeographischen Population (20 Arten berücksichtigt). Zugenommen haben die Bestände von Kolbenente, Schwarzhalstaucher, Kormoran, Graugans und Schnatterente, während die Zahlen bei Stockente, Tafelente, Schellente, Blässhuhn und Reiherente rückläufig sind. Zwerg- und Gänsesäger zeigen stabile Bestände (jedoch mit Tendenzen zu einer Abnahme). Viele dieser Trends können mit Veränderungen der lokalen Bedingungen in Verbindung gebracht werden, aber auch großräumige Veränderungen durch den Klimawandel beeinflussen die Wasservogelbestände im Rheintal. So zeigen sich bei Zwergsäger, Gänsesäger und Schellente Arealverschiebungen in nordöstlicher Richtung bedingt durch wärmere Winter.

Um den Zusammenhang zwischen Veränderungen der Wasservogelzahlen und ökologischen Veränderungen im Rheintal zu untersuchen, haben wir die Arten zudem nach ihrer bevorzugten Nahrungsart und dem bevorzugten Nahrungslebensraum differenziert betrachtet. Die aggregierten Ergebnisse für Arten mit den gleichen Nahrungs- und Habitatpräferenzen zeigen eine starke Zunahme der Wasservögel, die Wasserpflanzen fressen, während die Arten, die auf Grünland äsen, stabil sind oder in den letzten Jahren abgenommen haben. Wasservogelarten, die hauptsächlich Süßwassermuscheln fressen, haben abgenommen. Bei den größeren fischfressenden Arten ist kein klarer Trend zu erkennen. Zugenommen haben Arten, die im Flachwasser nach Nahrung suchen und sich von kleinen Fischen, Wasserinsekten, Benthos und Pflanzensamen ernähren. Diese Entwicklungen lassen sich auf die Verbesserung der Wasserqualität entlang des Rheins zurückführen. Hiervon profitierten vor allem unter Wasser wachsende Pflanzenarten (v.a. Armleuchteralgen), die insbesondere in den See-Ökosystemen Bodensee, IJsselmeer und Markermeer sowie in den Randmeren wieder großflächige Bestände aufweisen. Vogelarten, die sich von diesen Wasserpflanzen ernähren, haben entsprechend deutlich zugenommen (z.B. Kolbenente). Im Gegensatz dazu führte die verbesserte Wasserqualität (geringere Eutrophierung) zu Abnahmen insbesondere bei filtrierenden Süßwassermuscheln, und in der Folge auch zu Abnahmen in der Anzahl muschelfressender Wasservögel. In den letzten Jahrzehnten haben sich durch Einwanderungsprozesse auch die Häufigkeitsverhältnisse bei den Muscheln verändert. Allerdings zeigt sich in den letzten Jahren tendenziell eine Stabilisierung der Bestände von muschelfressenden Enten, die sich diese durch eine Diversifizierung ihrer Nahrung an die Veränderungen angepasst haben. Eine weitere wichtige Entwicklung entlang des Rheins vollzog sich in den Vorländern, die vor allem in den Niederlanden großflächig renaturiert wurden (z.B. Absenkung der Vorlandflächen, Entwicklung von Nebenrinnen, Aufgabe der landwirtschaftlichen Nutzung). Diese Maßnahmen wurden in erster Linie zur Reduzierung der Auswirkungen von Hochwasserereignissen ergriffen, sie zielen aber auch darauf ab, den typischen Charakter der Flussaue und damit die natürliche Dynamik dieses Lebensraums wiederherzustellen. Diese neu eingerichteten Gebiete hatten positive Auswirkungen auf die Wasservogelarten, die Flachwasserzonen und Schlammflächen bevorzugen. Die Vorländer beherbergen international bedeutende

Anzahlen von Schwänen, Gänsen und Enten, die im Grünland nach Nahrung suchen. Insgesamt weisen diese Vogelarten im Rheintal seit 1981 stabile Bestände auf. Auf Ebene ihrer biogeographischen Populationen zeigten viele dieser Arten hingegen bis vor kurzem Anstiege. Besonders in den Niederlanden ist bei diesen Arten in den letzten zehn Jahren sogar ein Rückgang zu verzeichnen, wahrscheinlich als Folge der Reduzierung der Grünlandfläche in den renaturierten Vorländern in den letzten Jahren.

Im Vergleich zu den früheren Berichten über die Wasservögel im Rheintal kam es zu zahlreichen Fortschritten bei der Erhebung und Auswertung von Wasservogeldaten. Es gibt mittlerweile in allen Ländern eine hauptamtliche Gesamtkoordination, wodurch sich insbesondere die Situation in Deutschland verbessert hat, die Daten sind inzwischen weitgehend auf Zählgebietsebene verfügbar und neue statistische Verfahren ermöglichen verlässliche Schätzungen von Trends und Beständen. Um die Erfassung des Jahreszyklus bei den Wasservögeln zu verbessern, werden jedoch für den Hochrhein und den südlichen Teil des Oberrheins Zählungen in weiteren Monaten empfohlen (derzeit November und Januar, auf französischer Seite nur Januar), ebenso wie die Einbeziehung aller Limikolenarten bei den Zählungen in der Schweiz. In wichtigen Rastgebieten wären überdies Zählungen zwischen Mai und August wünschenswert. Diese wurden zur Erfassung von mausernden Wasservögeln in ausgewählten Gebieten am Bodensee bereits eingeführt. Auch für das IJsselmeer/Markermeer werden diese empfohlen. Für den nächsten Bericht schlagen wir vor, auch die Monate Mai bis August einzubeziehen, da während dieser Zeit bei vielen Wasservögeln die Schwingenmauser stattfindet. Das aktuelle Wasservogelmonitoring konzentriert sich auf das Vorkommen von nicht-brütenden Wasservögeln. Für künftige Berichte sollte geprüft werden, ob auch Daten aus der Brutzeit entlang des Rheins zusammengeführt werden können. Für bestimmte koloniebrütende Arten und insbesondere für einige häufige Arten dürften sich dadurch wichtige weitere Erkenntnisse ergeben, da die Vogelarten während der Brutzeit besonders direkte Beziehungen zu ihrem Lebensraum aufweisen. In vielen Gebieten finden bereits Brutvogelerfassungen statt, bislang gibt es jedoch kein mit den Wasservogelzählungen vergleichbares, harmonisiertes System.

Résumé

Le présent rapport constitue le troisième relevé synthétique sur les oiseaux d'eau hivernant dans la vallée du Rhin réalisé dans le cadre du programme de travail de la Commission Internationale pour la Protection du Rhin (CIPR). Les recensements d'oiseaux d'eau ont une longue tradition sur le Rhin et sont partie intégrante de programmes nationaux appliqués en Suisse, en France, en Allemagne et aux Pays-Bas. En effet, les oiseaux d’eau ont fait l’objet de recensements réguliers sur des tronçons sélectionnés du fleuve dès les années 1950 et 1960. Des données fiables sur les effectifs et leur répartition sur tout le cours du fleuve sont disponibles depuis le début des années 1980. Le suivi des oiseaux d'eau est important car ceux-ci représentent une richesse naturelle internationalement reconnue, dont l’état de conservation nous renseigne sur l’efficacité de la mise en œuvre des traités ou directives internationaux (directive Oiseaux de l’Union européenne, Ramsar, Accord sur la conservation des oiseaux d'eau migrateurs d'Afrique-Eurasie). De plus, les oiseaux d’eau sont des espèces aisément reconnaissables qui constituent de bons indicateurs de l'état de conservation de leurs habitats. Ils nous renseignent ainsi sur la qualité des écosystèmes qu'ils fréquentent et sur l’évolution de ceux-ci au fil du temps.

Pour le présent rapport, la collecte des données s’est focalisée sur le statut actuel des oiseaux d'eau hivernants dans la vallée internationale du Rhin au cours de la période 2016-2018 (hivers 2015/16 à 2017/18), ainsi que sur les tendances démographiques constatées depuis 1981. Il a été réalisé par les ONG nationales qui coordonnent le recensement des oiseaux d'eau dans les différents pays rhénans : la Schweizerische

Vogelwarte (Sempach) en Suisse, la Ligue pour la Protection des Oiseaux (LPO) en France, le Dachverband Deutscher Avifaunisten (DDA) en Allemagne et la Sovon Vogelonderzoek Nederland (Sovon) aux Pays-Bas. Au cours de cette période, environ 700 ornithologues amateurs ont contribué à la collecte des données. Ce sont la plupart du temps des bénévoles qualifiés qui effectuent les relevés de terrain pendant leur temps libre, épaulés par des professionnels d'instituts de recherche et d'organismes de protection de la nature.

En moyenne, plus de 1,1 million d'oiseaux d'eau autochtones se rapportant à 70 espèces, dont 25 en effectifs d'importance internationale (c.à.d. > 1% de la population d'Europe occidentale), ont séjourné dans la vallée rhénane au cours des trois hivers 2015/16 à 2017/18. En 1999/2000, 21 espèces avaient été comptées. L'augmentation est en partie réelle (voir plus loin), mais aussi liée au meilleur recensement de quelques espèces. En comparant les effectifs d'oiseaux d'eau sur les six tronçons sélectionnés sur l'ensemble du fleuve, il apparaît qu'environ la moitié des peuplements se concentre dans les écosystèmes lacustres du Lac de Constance, de l'IJsselmeer, du Markermeer et des lacs de bordure néerlandais, tandis que l'autre moitié est répartie sur le linéaire du fleuve même. Compte-tenu des différentes stratégies d'hivernage des espèces et de la variété des conditions géographiques des divers tronçons du Rhin, la phénologie de chaque espèce diffère considérablement. En général cependant, le pic d'effectif est atteint de novembre à février. Plus tôt en saison - en septembre/ octobre, ainsi que début novembre -, certaines espèces et peuplements présents sont des oiseaux en transit qui poursuivront leur migration vers des sites d'hivernage plus méridionaux. Après le mois de février, une forte proportion d'entre eux repart vers les sites de reproduction.

Les canards de surface et la Foulque macroule sont les espèces les plus communes sur l'ensemble du Rhin, suivies par les cygnes et les oies. Pour les premiers, c'est notamment le cas dans la portion sud du fleuve où ils dominent largement la communauté des oiseaux d'eau, tandis que dans le Nord ils partagent cette position dominante avec les cygnes et les oies. D'autres groupes d'espèces, tels que les laridés, les limicoles, les grèbes et les hérons (et espèces apparentées), présentent les effectifs les plus faibles, mais également les espèces les plus diversifiées. Outre les espèces autochtones, 14 espèces d'oiseaux d'eau exotiques sont présentes à l'état sauvage dans la vallée du Rhin. Ce groupe est en nette augmentation en effectifs et, en partie aussi, en nombre d'espèces. Mais pour la plupart d'entre elles, aucun effet négatif réel sur les espèces autochtones n'a été signalé. Toutefois, les plus abondantes, à savoir la Bernache du Canada, l'Ouette d'd'Égypte et l'Oie cendrée, occasionnent des dommages aux cultures et des nuisances dans les parcs urbains et les zones de loisirs.

Globalement, la majorité des espèces pour lesquelles une tendance à la hausse a été mesurée sur tout l'axe de vol migratoire (n = 20, dont la plupart des espèces d'importance internationale), ont augmenté dans la vallée internationale du Rhin depuis 1981. Une augmentation globale des peuplements est notamment constatée chez la Nette rousse, le Grèbe à cou noir, le Grand Cormoran, l'Oie cendrée et le Canard chipeau. En revanche, un déclin est noté chez le Canard colvert, le Fuligule milouin, le Garrot à œil d'or, la Foulque macroule et le Fuligule morillon. Le Harle piette et le Harle bièvre sont quant à eux stables, avec une tendance à la baisse. Une partie de ces évolutions peut être due à des facteurs locaux. D'autre part, d'importants changements planétaires sont également en cours – tel le changement climatique - et peuvent entraîner des modifications de l'aire de répartition des migrateurs séjournant dans la vallée du Rhin. En comparant les tendances d'effectifs sur la voie de migration de l'Europe de l'Ouest avec celles relevées sur le Rhin, on ne note pas de grandes différences. Cependant, pour le Harle piette, le Harle bièvre et le Garrot à œil d'or, il est certain que les hivers plus chauds résultant du changement climatique provoquent un déplacement des zones d'hivernage vers le nord-est. Chez ces espèces, la tendance globale d'augmentation des effectifs sur tout l'axe de migration est plus marquée que sur le Rhin.

Pour étudier la corrélation entre les modifications d'effectifs des oiseaux d'eau le long du Rhin et les changements écologiques, les espèces ont été classées en fonction de leur alimentation préférentielle et de leur habitat d'alimentation principal. Les résultats cumulés de toutes les espèces partageant une même nourriture et un même habitat permettent de déceler les tendances d'évolution respectives des différents groupes. Les oiseaux d'eau qui se nourrissent de plantes aquatiques augmentent fortement ces dernières années, tandis que ceux qui broutent dans les prairies sont stables ou diminuent. À l'inverse, ceux qui s'alimentent principalement de moules d'eau douce régressent. Les espèces piscivores qui capturent des poissons en pleine eau n'affichent pas, quant à elles, de tendance claire : elles semblent globalement augmenter, avec de fortes fluctuations. Enfin, celles qui se nourrissent de petits poissons, d'insectes aquatiques du benthos et de graines de plantes dans les marais du lit majeur, le long des berges et dans les eaux peu profondes, augmentent. Comme il a déjà été démontré par d'autres études, ces tendances résultent de l'amélioration de la qualité des eaux du fleuve, ce qui a permis le retour de vastes peuplements de macrophytes immergés, en particulier dans les écosystèmes lacustres du Bodensee, de l'IJsselmeer/Markermeer et des lacs de bordure néerlandais, avec pour conséquence une augmentation des oiseaux d'eau se nourrissant de ces plantes. A l'inverse, la baisse de l'eutrophisation (et aussi un changement de la composition en espèces) a affecté négativement les populations de moules d'eau douce qui se nourrissent en filtrant les matières en suspension contenues dans l'eau, ce qui a entraîné une régression des oiseaux d'eau qui les consomment. Récemment, cette régression semble enrayée, car la plupart de ces espèces semble s'adapter en diversifiant leur alimentation et en se reportant sur d'autres espèces macrobenthiques. La deuxième évolution importante qu'a connue la vallée du Rhin est la création d'habitats naturels (c.à.d. décaissement du lit majeur du fleuve, réactivation de chenaux latéraux) sur d'anciennes terres agricoles, en particulier aux Pays-Bas. Ces mesures ont été initialement instaurées pour prévenir les risques d'inondation (augmentation de la zone d'expansion des eaux de crue) et comme source d'approvisionnement en argile, mais elles ont aussi amélioré le caractère naturel du lit majeur du fleuve et offert aux espèces un écosystème plus diversifié et plus dynamique. Ces zones riveraines restaurées ont eu un effet positif sur les oiseaux d'eau fréquentant les marais, les eaux peu profondes et les rives limoneuses en leur offrant de nouvelles ressources alimentaires et zones d'alimentation. Elles ont également été très importantes pour les oiseaux d'eau qui se nourrissent d'herbe. Des effectifs d'importance internationale de cygnes, d'oies et de canards y hivernent. Mais globalement, le nombre d'oiseaux d'eau s'alimentant dans ces prairies est resté stable depuis 1981, alors qu'à l'échelle de l'axe de migration d'Europe de l'Ouest, beaucoup d'espèces ont affiché des effectifs en hausse jusqu'à récemment. Il a été constaté certaines baisses au cours des 10 dernières années, en particulier aux Pays-Bas, probablement en raison de la réduction de la superficie de prairies fertilisées dans les zones où des projets de restauration ont été engagés.

Par rapport aux périodes d'analyse précédentes, une amélioration du suivi à long terme des oiseaux d'eau dans le lit majeur du Rhin est à noter. Il existe désormais une coordination globale à l'échelle des États, ce qui a particulièrement amélioré la situation en Allemagne. De plus, les données sont désormais disponibles à l'échelle de petites unités de recensement, ce qui consolide les méthodes statistiques permettant d'estimer les valeurs manquantes et de fournir des tendances lissées. Cependant, pour améliorer la couverture sur le cycle annuel des oiseaux d'eau, il est recommandé d'étendre les recensements à d'autres mois que janvier dans le haut Rhin et dans la partie sud du Rhin supérieur, ainsi que d'inclure toutes les espèces de limicoles dans les recensements effectués en Suisse. Les recensements entre septembre et avril ne prennent toutefois pas en compte l'importante période de fin d'été - début d'automne, au cours de laquelle se rassemblent des effectifs significatifs de sternes et d'oiseaux d'eau en mue. Ceci est particulièrement important pour le lac de Constance et l'ensemble IJsselmeer/Markermeer. Aussi est-il suggéré d'étudier la possibilité d'inclure cette période pour les prochains recensements. D'autre part, le suivi actuel se concentre sur les oiseaux d'eau non nicheurs. Il met déjà en évidence un lien étroit avec les facteurs environnementaux, mais il est recommandé d'étudier la possibilité de collecter également des données sur les oiseaux d'eau nicheurs. Pour certaines espèces nichant en colonies, notamment celles les plus fréquentes, les données seraient utiles pour la gestion des habitats dans les zones riveraines du fleuve, car les oiseaux nicheurs ont des rapports directs avec leurs habitats. Des relevés sur les espèces nicheuses ont déjà eu lieu dans de nombreux sites, mais il n'y a pas encore de suivi harmonisé à l'échelle du cours du fleuve comme c'est le cas de longue date pour le recensement des oiseaux d'eau en général.

Samenvatting

In het kader van het werkprogramma van de Internationale Rijncommissie (ICBR) wordt in dit rapport voor de derde keer een overzicht gegeven van de overwinterende watervogels in het internationale Rijndal, van de Bodensee tot en met de Rijnmond bij Hoek van Holland. Tellingen van watervogels hebben een lange traditie in het Rijnstroomgebied en maken deel uit van de nationale watervogelmonitoring in Zwitserland, Frankrijk, Duitsland en Nederland. Al in de jaren vijftig en zestig van de vorige eeuw werden de vogels systematisch geteld in diverse belangrijke gebieden binnen het Rijndal. Sinds ongeveer 1980 zijn er betrouwbare gegevens beschikbaar over de populatieomvang en de verspreiding van overwinterende watervogels in het gehele Rijnstroomgebied. Het monitoren van watervogels is belangrijk vanwege de internationale natuurwaarden en de internationale verdragen of richtlijnen (bijv. EU-vogelrichtlijn, Ramsar-conventie, African-Eurasian Waterbird Agreement) die goede informatie over hun beschermingsstatus vereisen. Bovenal zijn watervogels door hun zichtbaarheid kwantificeerbare en goede biologische indicatoren van de ecologische kwaliteit van hun leefgebieden en geven ze signalen af over veranderingen in de ecologische toestand van deze gebieden.

Bij het opstellen van dit rapport stond de huidige status van de watervogels in het internationale Rijndal in de periode 2016-2018 (winterseizoenen 2015/16-2017/18) centraal en wordt ingegaan op de ontwikkelingen sinds 1981. Het overzicht is samengesteld door de nationale NGOs die de watervogeltellingen in de verschillende Rijnlanden coördineren: de Schweizerische Vogelwarte (Sempach) in Zwitserland, Ligue pour la Protection des Oiseaux (LPO) in Frankrijk, Dachverband Deutscher Avifaunisten (DDA) in Duitsland en Sovon Vogelonderzoek Nederland (Sovon) in Nederland. De tellingen worden uitgevoerd door vakbekwame vrijwilligers die in hun vrije tijd het veldwerk uitvoeren. Alleen al in de afgelopen jaren hebben zo'n 700 toegewijde vogelaars een bijdrage geleverd. Lokaal wordt hun inzet aangevuld met professionals van onderzoeksinstituten en terreinbeheerders.

Gemiddeld waren er in het internationale Rijndal in de winters 2015/16 - 2017/18 maximaal ruim 1,1 miljoen watervogels aanwezig (exclusief exoten). Ze vertegenwoordigen 70 vogelsoorten waarvan 25 soorten in internationaal relevante aantallen voorkomen (d.w.z. >1% van de flywaypopulatie). In 1999/2000 waren dit 21 soorten, wat niet alleen een reële toename weerspiegelt (zie hieronder), maar ook een betere teldekking van enkele specifieke soorten. Bij een vergelijking van het aantal vogels tussen de zes deelgebieden langs de rivier wordt duidelijk dat ongeveer de helft van het aantal watervogels voorkomt op de Bodensee, op het IJsselmeer en Markermeer en op de Randmeren, en de helft in de Rijntakken zelf. Het seizoensvoorkomen van de afzonderlijke soorten varieert aanzienlijk als gevolg van verschillende overwinteringsstrategieën en de verschillende geografische ligging van de afzonderlijke delen van het Rijndal. Over het algemeen zijn de grootste aantallen aanwezig in de maanden november - februari. In september - oktober en gedeeltelijk ook in november komen ook soorten en aantallen voor die nog doorvliegen naar zuidelijker gelegen

gebieden, om daar uiteindelijk de winter door te brengen. Na februari vertrekken grote aantallen van de wintergasten naar de broedgebieden.

De meest voorkomende soortgroep langs de Rijn bestaat uit eenden en Meerkoet, gevolgd door zwanen en ganzen. In het zuidelijke Rijndal domineren eenden en Meerkoet de watervogelgemeenschap, in het noorden wordt deze positie gedeeld door eenden/Meerkoet en zwanen en ganzen. Andere soortgroepen zoals meeuwen, steltlopers en futen en reigerachtigen zijn veel minder talrijk in vergelijking met de bovengenoemde groepen, maar bestaan wel uit een groot aantal soorten. Naast inheemse watervogelsoorten zijn er bij de tellingen in het Rijndal ook 14 exoten gevonden. Deze groep neemt duidelijk toe, zowel in aantallen als deels ook in het aantal soorten. Voor de meeste soorten zijn geen algemene negatieve effecten op andere soorten gemeld, maar de talrijkere Grote Canadese Gans, Nijlgans en Soepgans veroorzaken plaatselijk gewasschade in de landbouw en overlast in parken en recreatiegebieden.

Wanneer de trends in aantallen in de internationale Rijnvallei sinds 1981 wordt vergeleken met die op het niveau van de hele flyway (20 soorten geanalyseerd), is er een grote overlap in de ontwikkelingen op beide niveaus. Over het geheel genomen is er sprake van een toename van soorten als Krooneend, Geoorde Fuut, Aalscholver, Grauwe Gans en Krakeend, terwijl de Wilde Eend, Tafeleend, Brilduiker, Meerkoet en Kuifeend afnemen en Nonnetje en Grote Zaagbek stabiel zijn, met een dalende tendens. Veel van deze trends kunnen in verband worden gebracht met veranderingen in de lokale leefomstandigheden, maar globale patronen zoals klimaatverandering spelen eveneens een rol. Andere studies hebben laten zien dat dit vooral opgaat voor Nonnetje, Grote Zaagbek en Brilduiker, die tegenwoordig noordelijker overwinteren. De flywaytrends zijn bij deze soorten dan ook positiever dan de trends in het Rijndal.

Om het verband tussen de veranderingen in het aantal watervogels en de ecologische veranderingen in het Rijndal te onderzoeken, hebben we de soorten toegekend aan hun geprefereerde voedselbron en het favoriete foerageerhabitat. De geaggregeerde resultaten over soorten met dezelfde voedsel- en habitatvoorkeuren laten een duidelijke toename zien van het aantal watervogels dat op waterplanten foerageert, terwijl de graslandeters stabiel zijn of de afgelopen jaren zelfs zijn afgenomen. Watervogelsoorten die grotendeels foerageren op zoetwatermosselen zijn eveneens afgenomen. De foerageerders van pelagische vissen in dieper water laten geen duidelijke trend zien, omdat ze neigen tot grote fluctuaties met doorgaans toenemende aantallen. Soorten die foerageren op kleine vissen, waterinsecten, benthos en plantenzaden in uiterwaarden, langs oevers en in ondiep water namen toe. Zoals uit andere studies blijkt, kunnen deze trends worden toegeschreven aan de verbetering van de waterkwaliteit langs de Rijn. Dit leidde tot een terugkeer en vervolgens uitbreiding van grote arealen aan ondergedoken waterplanten, met name in de Bodensee, in het IJsselmeergebied en op de Randmeren. Vogels die zich voeden met waterplanten reageerden hierop positief. Keerzijde van de afgenomen eutrofiëring (en ook veranderingen in de soortensamenstelling) is een afname van bestanden van zoetwatermosselen en dus ook het aantal mosseletende watervogels. Recent lijkt aan de afname een einde gekomen, omdat de mosseletende eenden hun dieet lijken te diversifiëren en zich nu ook op andere macrobenthossoorten richten. Een andere belangrijke ontwikkeling is de natuurontwikkeling in met name de Nederlandse rivieruiterwaarden (door verlaging van de uiterwaarden en het maken van nevengeulen), en de daarmee gepaard gaande afname van het agrarisch gebruik van de uiterwaarden. Hoewel deze maatregelen primair vanuit oogpunt van vermindering van overstromingsrisico dienen ("ruimte voor de rivier") en kleiwinning faciliteren, zijn ze ook bedoeld om het natuurlijke karakter van de uiterwaarden te vergroten en tegelijkertijd een diverser en dynamischer ecosysteem te bevorderen. Deze ontwikkelingen hebben een positief effect gehad op de watervogelsoorten die afhankelijk zijn van een moerasomgeving, ondiep water en slikkige oevers, doordat ze leiden tot een grotere voedselrijkdom en betere foerageeromstandigheden. De uiterwaarden zijn ook zeer belangrijk voor grasetende watervogelsoorten en internationaal gezien overwinteren er grote aantallen zwanen, ganzen en eenden. Over het geheel genomen zijn de aantallen in deze soortgroep sinds 1981 stabiel gebleven (ondanks veel soorten tot voor kort op de schaal van de flyway toenamen). Vooral in Nederland waren er de laatste 10 jaar enkele dalingen bij grasetende watervogels, waarschijnlijk als gevolg van de afname van het areaal aan boerenland in de uiterwaarden, daar waar natuurontwikkeling werd uitgevoerd.

In vergelijking met de vorige rapportages zijn er verdere verbeteringen van de lopende watervogelmonitoring doorgevoerd. Er is nu een algemene landelijke coördinatie, die vooral de situatie in Duitsland heeft verbeterd. Daarnaast is de beschikbaarheid van gegevens op het kleinste niveau van de teleenheden toegenomen en daarom kunnen we nieuwe statistische methoden gebruiken om schattingen voor ontbrekende tellingen te doen en gesmoothe trends te berekenen. Om de dekking van de jaarrrond cyclus bij watervogels te verbeteren, worden echter tellingen in andere maanden dan januari aanbevolen voor de Hochrhein en het zuidelijke deel van de Oberrhein, evenals het opnemen van steltlopersoorten in de tellingen in Zwitserland. Ook dan zou het telschema nog steeds alleen de periode van september tot april bestrijken, zodat grote concentraties van bijvoorbeeld (Zwarte) sterns en ruiende watervogels in de nazomer en de vroege herfst buiten beschouwing worden gelaten. Deze zijn vooral op de Bodensee en het IJsselmeergebied van belang en het is aan te bevelen om voor een volgende rapportage te onderzoeken of deze periode ook in de analyses kan worden meegenomen. De huidige monitoring is gericht op het voorkomen van niet-broedende watervogels. Ze laten al belangrijke relaties zien met andere omgevingsfactoren. Het is echter aan te bevelen om na te gaan of ook de resultaten van de broedvogelmonitoring langs de Rijn kan worden samengevat. Voor bepaalde koloniebroedvogels en vooral voor sommige talrijke soorten zullen deze resultaten belangrijke signalen opleveren voor de monitoring van habitats in de uiterwaarden, omdat ze meer directe verbanden met hun omgeving zullen laten zien. Op veel plaatsen vinden al broedvogeltellingen plaats, maar er is nog geen geharmoniseerd systeem, zoals dat al lang geleden wel voor de watervogeltellingen werd vastgelegd.

1. Introduction

Since the start of the ‘Rhine Action Programme in 1987’ (IKSR 1987) and the ‘Ecological Master Plan for the River Rhine’ in 1991 (IKSR 1991), several programs have been set up to monitor biological, physical and chemical parameters in the River Rhine. These surveys are supervised by the International Rhine Commission (ICPR), which co-ordinates policies and agreements with respect to the ecological restoration and rehabilitation of the Rhine. Within this field, much attention is paid to restore typical river biota and characteristics, such as the occurrence of Salmon *Salmo salar* and other riverine fish species and the creation of a more dynamic river floodplain. Main aim of the monitoring programs is to provide knowledge on the actual status in various biotic and abiotic river parameters, as well as changes in these over the long term. This information enables restoration management to be evaluated and points out new developments that need to be addressed by management authorities.

Since 1995, monitoring of wintering waterbirds has been included in this monitoring programme (Koffijberg *et al.* 1996, Koffijberg *et al*. 2001). In fact, bird counts are one of the oldest monitoring activities that have been carried out in the Rhine Valley. Already in the 1950s and 1960s, birds were systematically counted in selected stretches in several countries within the Rhine Valley (e.g. Suter & Schifferli 1988, Andres *et al.* 1994, van den Bergh *et al.* 1979). Reliable data on population numbers and distribution of wintering waterbirds can be collected quite accurately and at low costs. Morover, being at the top of the food chain, waterbirds are generally regarded as sensitive and effective indicators of changes at lower trophic levels, giving signals of what is going on in the ecosystem as a whole.

Photo: Harvey van Diek

The co-ordinated reporting of waterbird counts in January 1995 showed that the international Rhine system harboured nearly 1 million waterbirds of 38 species (Koffijberg *et al.* 1996). For 18 species, numbers at site-level regularly exceeded the 1% threshold, the level commonly used to assign areas of international importance, following the Ramsar Convention. The follow-up international Rhine report, published in 2001, confirmed its international importance and presented for the first time also results from other months than January (Koffijberg *et al.* 2001). In addition, this report analysed trends for the period 1981-2000, which showed increasing numbers in most species, but a large spatial variation between different sections within the Rhine Valley as well.

Recently, the International Rhine Commission asked for an updated analysis of waterbird numbers, distribution and trends in the context of the evaluation of the 'Rhine 2020' action program. This updated analysis is presented in this report. It reviews the current status of waterbirds in the international Rhine Valley in the period 2016–2018 (winter seasons 2015/16–2017/18) and presents population trends for the short-term (since 2000, i.e. the period assessed in the previous report) and long-term (since 1981). Like the previous two reviews, this report has been compiled by the national NGOs which co-ordinate waterbird counts in the different Rhine countries; the Schweizerische Vogelwarte (Sempach) in Switzerland, Ligue pour la Protection des Oiseaux (LPO) in France, Dachverband Deutscher Avifaunisten (DDA) in Germany and Sovon Vogelonderzoek Nederland (Sovon) in The Netherlands. Overall co-ordination was carried out by Sovon, under contract of Rijkswaterstaat, Ministry of Infrastructure and Water Management, The Netherlands.

The setup of the report is similar to the previous reports, but also includes an analysis of some specific themes like the occurrence of non-native waterbird species, a comparison between Rhine trends and international flyway trends, and the effects of large-scale floodplain restauration. The following chapters first describe the study area (chapter 2), and the methods to collect and analyse the data (chapter 3). In chapter 4 first a general overview of the results is given, followed by detailed species accounts, showing distribution, seasonal pattern and (regional) trends per species in more detail. A general discussion of the results in chapter 5 finally reviews the status of waterbirds in the Rhine Valley with respect to its international importance and ecological drivers of population change. In this section also recommendations for future monitoring are given.

2. Study area

The data presented in this report have been collected in the so-called 'Convention Area' of the International Rhine Commission, i.e. the stretch between Bodensee and North Sea (Figure 2.1). Within this area, the Rhine is divided according to geomorphological and hydrological characters into the following sections: Bodensee, Hochrhein (from Bodensee to Basel), Oberrhein (Basel to Bingen, also called "Rhin supérieur" for the part where it is the border between Germany and France), Mittelrhein (Bingen to Bonn) and Niederrhein (from Bonn onwards in Germany and The Netherlands). In The Netherlands it is branching off into three different trajectories: (1) IJssel, which flows into IJsselmeer that connects with the North Sea (either through the Wadden Sea or Noordzeekanaal), (2) Nederrijn/Lek, which flows through the Rijnmond/Rotterdam region into the North Sea and (3) Waal, which is the main stream and also flows through the Rijnmond/Rotterdam region into the North Sea (e.g. IKSR 1989). Outside this Convention Area, the Rhine starts as the Alpenrhein combining Vorderrhein and Hinterrhein (both originating from the spring of the river in the Alps) before flowing into the Bodensee near Bregenz. Along the mainstream, numerous tributaries exist, e.g. Aare in Switzerland and Neckar, Main, Mosel and Ruhr in Germany. The Alpenrhein and tributaries along the way are not covered by this report. Thus, the area dealt with is confined to the main floodplain of the Rhine, including the (former) delta in The Netherlands and its Rhine tributaries.

Figure 2.1. *The international Rhine Valley, marking the different stretches according to geomorphological and hydrological parameters as included in this report. See table 3.2 for explanation of coding. S20 – D10 is defined as 'Southern Rhine Valley' in this report and D20 – N80 as 'Northern Rhine Valley'.*

The various parts of the study area consist of different landscape types and subsites, briefly described below:

Bodensee: A large shallow lake at the border of Austria, Switzerland and Germany. It is one of the largest waterbodies in Central Europe (571 km^2) and also one of the most important staging and wintering areas for waterbirds in Central Europe (Werner *et al.* 2018). Within the lake three parts are distinguished: Untersee, Überlinger See and Obersee, which differ considerably in character (Heine *et al.* 1999, Werner *et al.* 2018). The latter makes up the largest part of the lake (75%) and is on average 100m deep. Especially the smaller Untersee holds large and sheltered shallow areas and has the most important stocks of submerged macrophytes (Heine *et al.* 1999, Werner *et al.* 2018). The average depth of this lake is 13m. Due to variations in annual precipitation, the area of shallow water, and thus also the number of birds present, vary considerably between years (Heine *et al.* 1999, Werner *et al.* 2018). The banks of the lake hold several extensive reed beds, especially around the so-called Rheindelta, the area where the Alpenrhein enters the Bodensee.

Photo: Ralph Martin (Agami)

Hochrhein: in this part, the Rhine constitutes the border between Germany and Switzerland, which is mainly situated in hilly country, largely in agricultural use. It still holds some natural and partly wooded banks.

Oberrhein: The Rhine between Basel and Lauterbourg, bordering France and Germany and continuing into Germany until Bingen. It flows through a rather broad floodplain. However, the original side-channels, islands and wet forests are nowadays only found as relicts due to extensive canalisation and damming works. Between Village-Neuf (near Basel) to Breisach, a complete artificial canal (le Grand Canal d'Alsace) runs parallel to the mainstream. Alongside the river several channels and gravel pits are found. Besides, the floodplain mainly consists of agricultural fields. Since the end of the 1980s, many nature rehabilitation projects were carried out both on the French and German banks of the Rhine. These largely concern a revitalization of lateral forest streams, which makes that wintering waterbirds are little concerned. It is also to highlight that the entire French/German section of the Oberrhein was designated as a transboundary wetland of international importance under the Ramsar Convention since 2008, covering 47.500 ha.

Mittelrhein: From Bingen until Bonn, the Rhine enters a rather narrow valley where the river cuts through the hilly Hunsrück-Taunus region. Only some small forelands occur here, as the river bank is characterised by steep(er) slopes that more or less directly emerge from the river. In this part extensive wineyards are found, as well as traditional agricultural fields and forested hills.

Niederrhein (Germany): After Bonn, the lowlands of the Niederrhein start. Downstream from here, the river is surrounded by a large open floodplain. From Bonn to Walsum (near Duisburg) this is dominated by the highly urbanised and industrialised Rhein-Ruhr district, including the large port facilities in Duisburg (largest in European inland). Downstream of Walsum, the floodplain is dominated by intensively used farmland (mainly grassland) and large gravel pits. Locally, some renaturation projects have taken place, including excavation of side channels. Also, some of the older gravel pits have been filled-up and are managed as nature reserves.

Niederrhein (Netherlands): In The Netherlands, along Rivers IJssel, Nederrijn and Waal land use is dominated by agriculture, both grassland (often semi-natural grassland managed as nature reserve) and crops (with an increasing amount of maize). Since the 1990s, a river rehabilitation programme ('Ruimte voor de Rivieren') has been initiated, combining management of flooding events and ecological restauration of the floodplain (see Box 3 for details). The IJssel flows into the area of IJsselmeer and Markermeer. Formerly this area was known as the Zuiderzee, but it was separated from the Wadden Sea by the Afsluitdijk dam in 1932 and has become a freshwater lake since then. In addition, large areas were embanked in the 1940s, 1950s and 1960s (Wieringermeer, Noordoostpolder, Flevoland). At present, the IJsselmeer area consists of three freshwater lake systems: IJsselmeer, Markermeer and Randmeren (also known as Borderlakes), the latter being the lakes between the old land and the reclaimed polders. IJsselmeer and Markermeer are separated by the Houtribdijk (built in 1975). IJsselmeer has mostly sandy sediments, a higher water transparency, an average depth of 4.5 m and has some shallow coastal areas (remaining from the former Zuiderzee) with extensive beds of submerged macrophytes (Noordhuis 2010). Markermeer has a more ‘artificial’ coastline, i.e. it is mainly surrounded by steep dikes and 'rocky foreshores' with few (semi-)natural coastal areas. Its water is generally highly turbid as a result of resuspension of the silty sediment by wind. The average water depth is 3.9 m (Noordhuis 2010). Recently, an extensive system of islands has been created in the northwestern part of this lake ('Marker Wadden'), leading to large areas of pioneer habitats. Randmeren have similar characteristics as IJsselmeer. On the side of the former mainland they are very shallow and characterised by extensive beds of submerged macrophytes. Since special measures were taken in the 1990s, these lakes have undergone significant improvement of water quality, which has led to the present areas of submerged macrophytes.

Nederrijn and Waal flow into the North Sea in the large port area of Rotterdam, which has similar characteristics as the Ruhrgebiet area in Germany, i.e. highly urbanised and with numerous industrial acitivities. Further south, the southern branches connect with the northern Delta area, including large former estuarine areas and the delta system of the Biesbosch area.

Table 3.2 (chapter 3) lists all areas that have been included in the analyses of waterbird counts.

3. Methods

3.1. Organisation

Waterbird counts along the Rhine have a long tradition and have been conducted since the beginning of the 1950s (see e.g. Schuster *et al.* 1983 and Werner *et al.* 2018 for the Bodensee area, Suter & Schiffeli 1988 for Switzerland, e.g. Dolich 2014 for Germany, Westermann 2015 for German and French Oberrhein, Andres *et al.* 1994 for France and van den Bergh *et al.* 1979 for The Netherlands). From 1967 onwards the January counts have been carried out partly in the framework of the International Waterbird Census (IWC), coordinated by Wetlands International. However, in most countries also national monitoring schemes have evolved, each with their own objectives, set-up and organisation. At present, national monitoring schemes are running in all countries bordering the Rhine (Table 3.1). Methods of counting are highly similar in all countries (see chapter 3.3).

Frequeny of counts vary. Several stretches of the Rhine are counted every month from September to April (Bodensee, most of The Netherlands, large part of Rhein in Germany). Besides, parts of the Niederrhein area in The Netherlands (IJsselmeer & Markermeer, Randmeren) are also surveyed from May to August (i.e. they are covered yearround), when moulting concentrations of some species occur. Along the southern Oberrhein, German and French observers carry out fieldwork in January; during November and March additional counting along the southern Oberrhein is done by German observers. Along the Hochrhein waterbirds are counted in November and January only. The gravel pits in France bordering the Oberrhein are counted only January during the IWC.

Table 3.1. *Organisation of waterbird monitoring in the Rhine Valley 2015/16 – 2017/18. For each country and subarea of the Rhine, the census scheme, species covered and a reference to more detailed information is given. Months included in the scheme are marked with x (when indicated as () it means only partial coverage), species refer to (1) divers and grebes; (2) Cormorants; (3) herons; (4) swans, geese and ducks, including Coot; (5) waders; (6) gulls and (7) additional species. The references stated refer to: (1) Werner et al. 2018; (2) Strebel 2016; (3) Andres et al. 1994; (4) Sudfeldt et al. 2012; Westermann 2015; (5) Hornman et al. 2020.*

Country/ area	**Rhine subarea**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**Species**	**Reference**
Switzerland[1]	Bodensee	x	x	x	x	x	x	x	x	1,2,3,4,(5),6,7	1
Switzerland[2]	Hochrhein			x		x				1,2,3,4,(5),6,7	2
France/Germany[3]	Oberrhein			(x)		x		(x)		1,2,3,4,(5),(6),(7)	3
Germany[4]	Oberrhein	x	x	x	x	x	x	x	x	1,2,3,4,5,6,(7)	4
Germany	Mittelrhein	x	x	x	x	x	x	x	X	1,2,3,4,5,6, (7)	4
Germany	Niederrhein	x	x	x	x	x	x	X	x	1,2,3,4, 5,6, (7)	4
Netherlands	Niederrhein	x	x	x	x	x	x	x	x	1,2,3,4,5,6,7	5

[1] shared by Austria, Switzerland and Germany
[2] shared by Switzerland and Germany
[3] gravel pits and channels in France only counted in January, Germany here refers to section Basel to Murg river mouth (Rhine km 315)
[4] Germany here refers to section north of Murg river mouth (Rhine km 315).

3.2. Census areas

For this study, the Rhine Valley is divided into 17 main survey areas (Table 3.2., Figure 3.1, taken from Koffijberg *et al.* 2001). These are subdivided into smaller counting units, generally the units used by the national co-ordinators to collect the data. During fieldwork, the counting units are more or less defined by single floodplain areas, thus having well-marked borders. Some of the gravel pits and reservoirs along the river are also covered, as they often provide good roosting opportunities for birds feeding on the river. For Bodensee and Hochrhein the borders of the counting units are mostly defined by the natural bank of the lake or the river. Along Oberrhein also side-channels, gravel pits, reservoirs and the Grand Canal d'Alsace are included (i.e. the historical floodplain, up to approximately 5 km distance of the river). At the Mittelrhein the counting units are following the natural river bank (as the Rhine Valley is very narrow here). In the Niederrhein the entire area between the winter dikes is covered, including forelands, (new) side-channels, former river branches and numerous gravel- and sand pits. Most of the Rijnmond canals, Amsterdam-Rijnkanaal, Noordzeekanaal as well as Randmeren and the IJsselmeer area are clearly defined by dikes. In IJsselmeer these include some smaller forelands, mainly at the coast of the province Friesland. In the Rijnmond, the Biesbosch and Oude Maas extensive forelands, floodplains and renaturated areas are included. Tributaries were not regarded as part of the census area (although mostly covered by counts, e.g. Schmolz & Wahl 2007).

Table 3.2. *System of main survey areas and counting units to process waterbird counts in the Rhine Valley in 2015/16 - 2017/18. Situation of main survey areas is depicted in Figure 2.1.*

Subarea	Country	Area	Site	Count units
Bodensee	Switzerland / Germany / Austria	S20	Bodensee / Untersee	103
Hochrhein	Switzerland/ Germany	S30	Rheinklingen - Aare junction, km 32-103	12
		S40	Aare junction - Basel, km 103-165	11
Oberrhein	Germany/France	F10	Basel-Lauterbourg, km 165-349	107
	France	F10	gravelpits, reservoirs, channels	99
	Germany	D10	Lauterbourg-Bingen, km 349-530	219
Mittelrhein	Germany	D20	Bingen-Bonn, km 530-654	29
Niederrhein	Germany	D30	Bonn-Walsum, km 654-791	25
		D40	Walsum-German/Dutch border, km 791-864	71
	Netherlands	N10	Nederrijn/Lek Arnhem - Krimpen a/d Lek, km 879-989	45
		N20	Waal Lobith - Woudrichem[1], km 864-985	48
		N30	Rijnmond/Rotterdam[2], km 989-1006	99
		N40	IJssel Westervoort - Ketelhaven, km 879 - 1006	43
		N50	Randmeren	33
		N60	IJsselmeer & Markermeer	160
		N70	Amsterdam Rijnkanaal	13
		N80	Noordzeekanaal	15

[1] including Gelderse Poort (Pannerdens Kanaal)
[2] including Boven Merwede, Beneden Merwede, Noord, Dordtse Kil, Oude Maas, Spui, Nieuwe Maas, Nieuwe Waterweg, Calandkanaal, Hartelkanaal, Sliedrechtse Biesbosch, Dordtse Biesbosch, Brabantse Biesbosch & Nieuwe Merwede.

3.3. Fieldwork

Due to their gregarious behaviour, most waterbirds are relatively easy to count. Furthermore, as most stretches along the Rhine are rather well accessible, large parts of the river and floodplain can be surveyed accurately by using binoculars and telescopes. Most counts are made by individual observers or small groups of observers, usually already involved in the counts for a long series of years. Often, higher observation points (e.g. from a bridge or a dike) are chosen to get a better overview of waterbird concentrations. Nearly all areas are counted from the ground. Only in the Dutch part of the Niederrhein specific areas are counted by professionals, using small boats (parts of the Rijnmond, Randmeren) or aircraft (IJsselmeer and Markermeer).

Photo: Harvey van Diek

The waterbird species included in the counts have varied considerably between the countries in the past, but there has been better harmonization in recent years. All national schemes include the most common waterbird species (Table 3.1). There are a few exceptions; coverage of waders in Switzerland only includes Common Snipe, Eurasian Curlew and Common Sandpiper. In Germany, Grey Heron and Gulls have been included by most observers only from 1987 onwards. Additional species (e.g. Common Kingfisher, Grey Wagtail, Peregrine Falcon) are systematically covered in Germany only since 2016/17 (Wahl *et al.* 2017). In The Netherlands, counts include all species, but additional species in the IJsselmeer area are only covered in January, when supplementary ground counts are made (these species cannot be detected by aerial surveys).

Although bird counts are generally accurate, smaller and less conspicuous species like Little Grebe are easier missed than gregarious flocks of geese and are thus not representing the true numbers of individuals present. However, they do represent a large and consistent sample, suitable for monitoring trends in time. The same holds for e.g. dabbling ducks hiding in reed beds. Especially large flocks, likely to occur in geese and some diving ducks, may be subject to counting errors, but most of such errors will be ruled-out when data are analysed over many areas and long time series, as has been done for this report. Observers often choose the best possible weather conditions to conduct their fieldwork, but prolonged periods of rainy weather or bad visibility sometimes force counts to be done under less favourable conditions. Especially large flocks, likely to occur in geese and some diving ducks, may be subject to counting errors. Finally, counts are conducted very concentrated around the weekend next to the 15th of the month. This has been agreed already in the 1960s when the waterbird counts were harmonized internationally (Atkinson-Willes 1969).

3.4. Data analysis

3.4.1. General aspects

At national level, all waterbird counts were available as computerised data files for this study. Data were received for the smallest counting units available and for all waterbird species included in the counts. Scientific names and common names in English, German, French and Dutch of all selected species are given in Annex 2. We carefully checked whether species which were not present in the dataset were actually included during the counts and could therefore be treated as zero counts, or were in fact not included in the counts and needed to be treated as missing values instead.

For the results in the winter seasons 2015/16 – 2017/18 results from counts in November, January and March were extracted from the database and analysed separately in order to assess the present status of waterbirds in the Rhine Valley. For a selection of common species however, this dataset was enlarged to the period September to April (see chapter 3.4.3). The results of winter seasons 2018/19 and 2019/20 were not yet available, as for the majority of sites the counts are still being collected, processed, computerized and validated. For the presentation of long- and short-term trends, data from January 1981 – 2018 were analysed. January 1981 is the first year with sufficient data available in all countries (see also Koffijberg *et al.* 1996). For all parts of the Rhine that are shared between two countries good routines are available to integrate the counts from both sides of the border, including the data for the Oberrhein as collected by German and French observers (so duplicate data is avoided).

Not all units were counted in all selected months in every year. We had to correct for these missing counts in the analyses, because the results have to reflect true changes in abundance of waterbirds instead of differences in counting effort. This is generally dealt with using 'imputing' techniques, in which missing counts are estimated using a model consisting of at least year, month and site factors (rTRIM 2.0 (Bogaart *et al* 2016) in Germany, U-index (Bell 1995 in The Netherlands). This was done at the national level by national coordinators, as they have the best knowledge of their data and sites and are thus best able to judge the coverage of the surveys and the quality of the imputing. The percentage of missing counts was highest in Germany (resulting in 52% of total numbers being imputed, averaged over all species and years), followed by The Netherlands (12% imputing, Hornman *et al.* 2020), Oberrhein (France/Germany, 8% imputing) and Switzerland (0% imputing, e.g. no missing counts). The high percentage of imputing in Germany is partly due to increased coverage, i.e. counts have only recently started at certain sites. Annex 3 gives an overview of the variation in amount of imputing per species, year and area.

For analysing general patterns in trends in relation to specific traits, such as diet and habitat selection, species were aggregated into guilds. The assignment per species to the guilds is documented in Annex 4.

3.4.2. Distribution

For all common species that are covered by a species account, a distribution map of concentrations within the Rhine Valley is presented. Values reflect the average number of all November, January and March counts in the period 2015/16 – 2017/18 in each main area (see Figure 2.1 and Table 3.2). Missing counts were imputed, so the dots in the map represent counted and imputed numbers.

3.4.3. Seasonal pattern

To show the variation in numbers during the course of the winter season (September to April) a stacked bar graph is made for all species covered by a species account. These are based on the average number per month of the 2015/16 – 2017/18 counts. Again, missing counts were imputed. The graphs show (from bottom to top), (1) IJsselmeer, Markermeer & Randmeren (N50 and N60), (2) other Niederrhein parts in The Netherlands (N10, 20, 30 en 40), (3) Mittelrhein - Niederrhein in Germany (D20, 30 and 40), (4) Oberrhein (D10, F10) mostly September- April counts, in southern part November, January, March and (5) Bodensee (S20). In addition, also the numbers along the Hochrhein (S40, S30) and in gravel pits and channels in France (F10) are presented, but these are available only for November-January and January, respectively.

3.4.4. Trends January 1981-2018

Due to large variation in monthly coverage between the different main survey areas in 1981-2018, trend analyses are based on the January counts only, representing the most complete dataset. Thus, trends shown depict the situation for the midwinter period. Smoothed trends were calculated using TrendSpotter software (Soldaat *et al*. 2004), which is commonly regarded suitable for analysing long time series and non-linear trends. Trends are calculated for the whole Rhine Valley, and for separate parts: (1) numbers for 'Southern' (Bodensee – Oberrhein) versus 'Northern' Rhine (Mittelrhein – Niederrhein), (2) indices for the different sections Bodensee (S20), Hochrhein (S30, S40), Oberrhein (F10, D10), Mittelrhein and Niederrhein in Germany (D20, D30, D40), Niederrhein in The Netherlands (N10, N20, N30 N40) and IJsselmeer, Markermeer & Randmeren (N50, N60). Classification of trends follows Soldaat *et al*. (2004) (Figure 3.1).

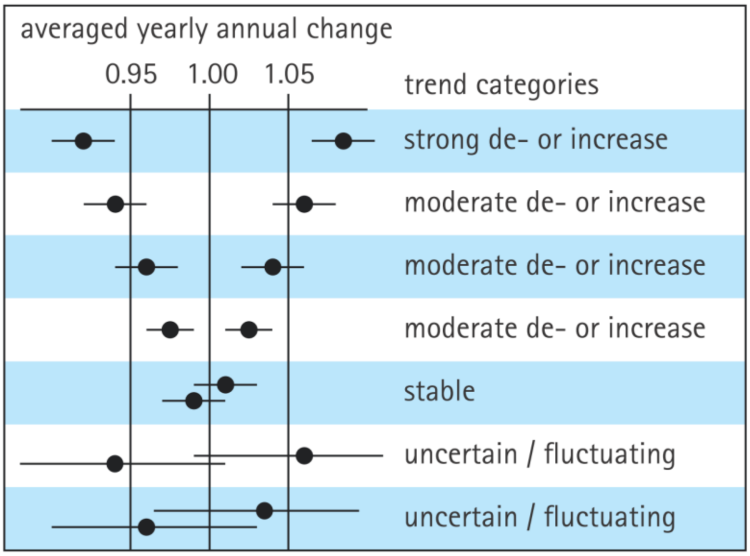


Figure 3.1. *Trend classification used to depict trends in January-numbers in this report (after Soldaat et al. 2004). Distinguished are strong or moderate significant increase in numbers, strong or moderate significant decreases, stable trends and uncertain trends (usually involving large fluctuations). The classification is derived from the slope of the trendline (average annual change, dots) and its 95% confidence interval (black line). For this report moderate and strong de- or increases have been treated as one (either decrease of increase).*

4. Results

4.1. General results

4.1.1. Status in 2015/16 – 2017/18

On average, maxima of over 1.1 million waterbirds were present in the Rhine Valley in the winters 2015/16 – 2017/18. The different winter seasons varied not that much, with maxima of 1,024,000 in 2015/16 (November), 1,152,000 in 2016/17 (January) and 1,164,000 in 2017/18 (also January). All these winters may be characterised as generally mild winters (data national weather institutes, e.g. knmi.nl and dwd.de), thus numbers counted a proxy for such weather conditions. Occurrence of more severe winter weather will cause considerable changes, but nowadays occur less and less as a result of global warming. Apart from shifts in winter distribution, the Rhine Valley may attract larger numbers of waterbirds in cold winters, as the river will not freeze over and the numerous (deep) gravel pits remain available as open water as well (see Koffijberg *et al.* 1996, 2001).

A total of almost 70 native waterbird species were counted along the Rhine during January 2016-18 (Table 4.1). In addition, 14 non-native waterbird species were recorded (Box 1). Although not exhaustively covered, also raptor species often encountered near wetlands were present (results for White-tailed Eagle and Peregrine Falcon are given as their dataset was most complete) as were other bird species mostly present along the river banks (Common Kingfisher, Grey Wagtail and White-throated Dipper). The most common species encountered in January were in order of abundance: Tufted Duck, Eurasian Coot, Greater White-fronted Goose, Eurasian Wigeon and Mallard, alltogether comprising 56% of all numbers of native species present (Table 4.1). When comparing the number of birds between the six subareas, it becomes clear that about half of the numbers of waterbirds occured at the lake systems of Bodensee, IJsselmeer, Markermeer and Randmeren and half along the stretches of the River Rhine itself. From these river stretches, largest numbers were found in the Niederrhein in The Netherlands, the Oberrhein shared between France and Germany and the Niederrhein part of Germany. This corresponds with the length of the river stretches, the extent of the floodplain and forelands bordering the main river stream and the amount of good waterbird habitat found here.

Due to different wintering strategies of the various species and the different geographical situation of the subareas within the Rhine Valley, the phenology of separate species varies considerably (see chapter 4.2 for species accounts). Largest numbers in the Rhine Valley occur in the months November – February (Figure 4.1). In addition, in September – October and partly also November, species and numbers migrate through the Rine Valley, heading for wintering areas further south or west. Such movements are sometimes also visible within the Rhine Valley itself, expressed by peak numbers (mainly ducks) in the northern subareas in December and not earlier than January in the southern parts (figure 4.1). After February, waterbird abundance quickly drops to much lower levels, indicating spring migration towards the breeding grounds.

Ducks and Eurasian Coot are the most common species group along the Rhine followed by swans and geese. In the Southern Rhine ducks and Coot dominate the waterbird community in the North this position is shared between ducks/Coot and swans and geese. Other species groups as gulls, waders and grebes and herons (and allies) are much less numerous compared to the other groups (Figure 4.1) but do represent a rather high numbers of species and thus contribute to the overall biodiversity (Table 4.1).

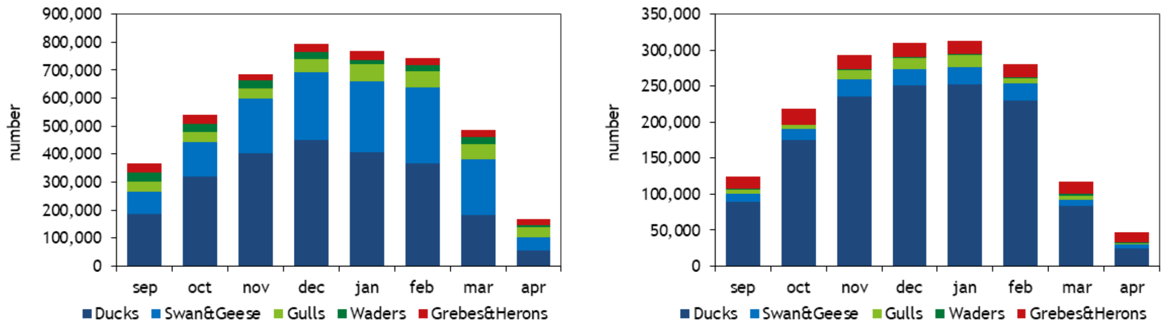


Figure 4.1. *Average numbers of waterbirds according to taxonomic group in the Northern (left) and Southern (right) half of the Rhine Valley in September – April of years 2015 - 2018. Note different scale of y-axis.*

Table 4.1. *Native waterbird species and average numbers recorded during waterbird counts in the different subareas of the Rhine Valley in January 2016-2018. BS Bodensee, HR Hochrhein, OR Oberrhein, MR & NR Mittelrhein & Niederrhein in Germany, NR-NL Niederrhein in The Netherlands, YR IJsselmeer, Markermeer and Randmeren. Method indicates counted numbers given (c) or estimated numbers including imputing for not counted counting units (e), 0 means counted but not present, empty cell means not counted.*

Species	**Method**	**BS**	**HR**	**OR**	**MR&NR**	**NR-NL**	**YR**	**Total**
Red-breasted Goose	c	0	0	0	0	1	0	1
Barnacle Goose	e	0	0	2	1,664	31,101	10,879	43,646
Greylag Goose	e	592	3	2,441	2,453	43,071	8,560	57,120
Tundra Bean Goose	e	1	0	12,216	584	237	198	13,236
Greater White-fronted Goose	e	8	0	466	19,302	115,946	3,498	139,220
Mute Swan	e	3,264	428	3,244	816	930	3,176	11,858
Tundra Swan	e	21	0	0	2	30	1,862	1,915
Whooper Swan	e	777	0	65	1	9	555	1,407
hybrid goose	c	0	0	13	1	6	1	21
Common Shelduck	e	21	5	6	44	501	389	966
Northern Shoveler	e	837	1	127	211	2,340	37	3,553
Gadwall	e	7,771	169	5,417	861	16,867	1,190	32,275
Eurasian Wigeon	e	2,045	82	1,130	4,546	30,492	62,834	101,129
Mallard	e	12,769	2,801	21,728	14,028	20,522	8,378	80,226
Northern Pintail	e	1,056	0	91	40	959	657	2,803
Eurasian Teal	e	5,599	232	1,510	1,485	10,906	620	20,352
Red-crested Pochard	e	14,165	7	152	5	2	18	14,349
Common Pochard	e	40,144	370	4,517	2,301	1,638	11,360	60,330
Ferruginous Duck	c	26	1	3	0	0	1	31
Tufted Duck	e	55,154	1,099	14,162	6,450	19,361	54,862	151,088
Greater Scaup	e	58	0	17	2	3	53,580	53,660
Common Eider	c	4	0	0	0	0	0	4
Velvet Scoter	c	21	0	15	1	1	4	42
Common Scoter	c	1	0	0	0	0	0	1
Long-tailed Duck	c	3	0	1	0	0	0	4
Bufflehead	c	0	0	0	0	0	1	1

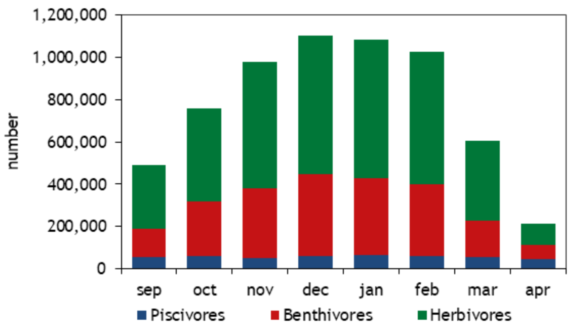
Species	Method	BS	HR	OR	MR&NR	NR-NL	YR	Total
Common Goldeneye	e	2,891	39	1,249	462	836	1,138	6,615
Smew	e	23	0	84	178	234	469	988
Common Merganser	e	788	308	1,312	493	526	2,616	6,043
Red-breasted Merganser	c	21	0	3	1	9	945	979
Red-throated Loon	c	1	0	1	0	0	0	2
Black-throated Loon	c	30	0	1	0	0	0	31
Common Loon	c	1	0	1	0	1	0	3
Little Grebe	e	1,053	265	743	169	342	39	2,611
Red-necked Grebe	c	3	0	1	0	2	1	7
Great Crested Grebe	e	6,493	167	1,698	825	1,901	3,447	14,531
Horned Grebe	c	12	0	5	0	10	0	27
Black-necked Grebe	c	1,396	0	12	4	10	0	1,422
White Stork	c			5	1	37	0	43
Eurasian Spoonbill	c	0	0	0	4	0	0	4
Eurasian Bittern	c	0	0	1	0	1	1	3
Grey Heron	e	357	106	688	276	705	99	2,231
Great Egret	e	46	23	357	139	499	100	1,164
European Shag	c	0	0	0	0	1	0	1
Great Cormorant	e	1,167	371	4,889	2,670	2,660	17,317	29,074
White-tailed Eagle	c	0	0	0	0	17	13	30
Water Rail	c			16	1	15	11	43
Common Moorhen	e	100	29	243	48	189	21	630
Eurasian Coot	e	50,955	588	11,477	12,326	23,993	43,982	143,321
Eurasian Oystercatcher	c			0	1	279	1	281
Pied Avocet	c			0	0	0	7	7
Northern Lapwing	e			3	512	10,236	1,407	12,158
European Golden Plover	c			5	0	186	27	191
Eurasian Curlew	e	818	0	0	1	2,119	305	3,243
Bar-tailed Godwit	c			0	0	1	0	1
Ruddy Turnstone	c			0	0	4	0	4
Ruff	c			0	0	18	0	18
Dunlin	c			0	0	282	33	315
Eurasian Woodcock	c			0	0	4	1	5
Jack Snipe	c			0	0	2	0	2
Common Snipe	c	36	6	1	0	67	29	139
Common Sandpiper	c	6	7	2	2	2	0	19
Green Sandpiper	c			6	1	16	6	29
Common Redshank	c			0	0	4	0	4
Black-headed Gull	e	8,452	2,742	6,543	8,969	33,714	4,200	64,620
Little Gull	c	4	0	0	0	0	1	5
Mediterranean Gull	c	1	0	0	0	0	0	1
Mew Gull	e	771	32	109	214	8,785	949	10,860
Great Black-backed Gull	c	0	0	0	0	178	57	235
European Herring Gull	e	10	1	46	104	3,090	315	3,566

Species	Method	BS	HR	OR	MR&NR	NR-NL	YR	Total
Caspian Gull	c	105	0	1	1	26	1	134
Yellow-legged Gull	c	287	78	197	6	10	0	578
Lesser Black-backed Gull	c	4	0	2	2	17	0	25
Gull spec.	c	234	19	12	54	0	0	319
Common Kingfisher	c	29	23	20	3	33	22	130
Peregrine Falcon	c			0	0	14	14	28
White-throated Dipper	c	8	18		0	0	0	26
Grey Wagtail	c	26	53		0	7	2	88
Total		220,465	10,073	97,056	82,264	386,005	300,236	1,096,072

In order to assess abundance on a broader level, each species has been classified according to its main food resource, i.e.grass, submerged macrophytes and "macro"-algae (herbivores), macrozoobenthos (benthivores) and fish (piscivores) (see Apendix 4). Herbivorous waterbirds dominate in most parts of the Rhine Valley. This is even more pronounced when the numbers are multiplied with the weight of the birds (Figure 4.2) They are abundant in regions where the river is situated in a highly productive agricultural landscape with extensive grasslands, providing excellent feeding opportunities for e.g. Greater White-fronted Goose and Eurasian Wigeon. Besides, this group consists of species which feed on submerged macrophytes, e.g. Mute Swan and Red-crested Pochard, which can be found especially in the shallow parts of the Bodensee (Heine *et al.* 1999, Werner *et al.* 2018) and at IJsselmeer and Randmeren (Noordhuis 2010).

Benthivores are especially common at the lake systems Bodensee, IJsselmeer, Markermeer and Randmeren. Species, like Tufted Duck, Common Pochard, Goldeneye and Greater Scaup, mainly relied on Zebra Mussels *Dreissena polymorpha*, which invaded the Rhine Valley in the last century (see e.g. Suter 1982) and more recently on Quagga Mussels *Dreissena rostriformis bugensis* which invaded more recently and has largely replaced Zebra Mussels (Noordhuis *et al.* 2014). Besides the lakes, benthivores also occur along the southern Oberrhein and in the Rijnmond area around Rotterdam, which also hold some stagnant waterbodies.

The floodplains and forelands of the Rhine are furthermore inhabited by another group of benthivores, waders e.g. Northern Lapwing and Eurasian Curlew. Also gulls e.g. Black-headed Gull forage extensively on macrobenthos, e.g. earthworms and other terrestrial invertebrates, especially when water in the forelands has retreated after a major flooding event.



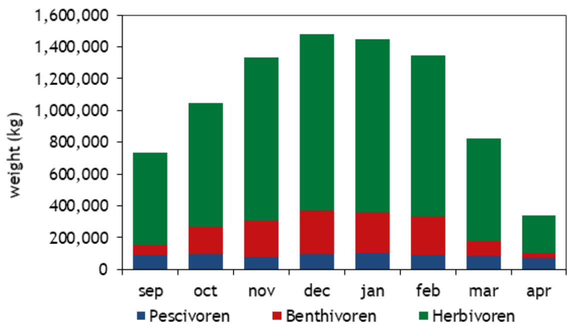


Figure 4.2. *Average numbers of waterbirds according to food preference in the Rhine Valley (left) and corrected for weight (expressed in kilogram) in September – April of years 2015 - 2018. Note different scale of y-axis.*

The group of piscivores waterbirds is much less common, Fish-eating species of open water are for instance Great Crested Grebe and Great Cormorant and typical wintering species as Smew and Merganser. In the August-September period large numbers of terns (20,000 – 50,000) make use of the Rhine Valley, especially in the IJsselmeer area, during migration (Black Tern, Common Tern and to a lesser extent Caspian Tern), but these months have not been taken info account in our study period in this report. Besides open water fish eaters several species of herons and small grebes are also among the piscivores which forage at lake shores and in marsh habitat or along side-channels in the floodplain area.

Box 1. Non-native waterbirds along the Rhine

The abundance of alien waterbirds – species native to other parts of the world, introduced in new areas as a consequence of transport by humans - in the Rhine area has increased strongly in recent decades (figure B1.1). In particular geese, swans and ducks have been popular ornamental birds and are held in large numbers in parks, zoos and private waterfowl collections. Some of these birds escaped or were released into the wild. 24 alien water bird species have recently been recorded in the Rhine Valley area during the winter season. Most of them are reported only occasionally, such as Ringed Teal and White-cheeked Pintail. So far, these birds have not yet reproduced successfully on a regular basis. However, if the number of releases/escapes is high and the species meets suitable habitat and climate conditions, permanent, self-sustaining populations can establish.

At present, about ten species occur in substantial numbers annually and do regularly reproduce along the Rhine (Table B1.1). Some species have even become 'invasive': their numbers have increased strongly, and they spread over new areas. Greater Canada Goose and Egyptian Goose have become common in Dutch and German parts of the Rhine. Ruddy Shelducks now breed in large numbers in Germany but are remarkably scarce as breeding birds in The Netherlands. Recently, it has been discovered that the central European breeding populations undertake rather 'natural' summer migration behaviour, and move to specific moulting sites areas in the Randmeren and IJsselmeer in July-August, when up to 2,000 birds have been recorded to moult (Kleyheeg *et al*. 2020). A similar moulting site is also situated in the Bodensee area (Werner *et al.* 2018) and marked birds have been recorded to switch between the two moulting sites between years (Kleyheeg *et al.* 2020).

Besides species native to other parts of the world, also domesticized forms ('feral') of Greylag Goose and Mallard are commonly observed in wintering goose and duck flocks in the Rhine Valley.

The establishment of viable populations of alien bird species has led to concerns about their potentially adverse ecological, economical and societal impacts, such as competition with native species and agricultural damage. This is why the EU developed regulation 1143/2014 on invasive alien species (IAS), which entered into force in 2015. The core of the IAS Regulation is a list of Invasive Alien Species of Union concern. These species are subject to restrictions and active management. Member States are required to take action on pathways of unintentional introduction, to take measures for the early detection and rapid eradication of these species, and to manage species that are already widely spread in their territory (EU 2014).

In 2020 the Union list included five bird species, among which two waterbirds that are present in the Rhine Valley: Egyptian Goose and Ruddy Duck. Ruddy Duck is occasionally reported from the Dutch, German and Swiss parts of the area. This species, native in North America, is closely related to the White-headed Duck, native in Southern Europe and globally endangered. Ruddy Ducks could jeopardize the latter species by hybridization. Therefore, several European countries launched eradication campaigns. Birds observed in the Rhine Valley are likely associated with the population occurring in NW-Europe, but occasionally may also refer to escapes (Werner *et al.* 2018).

Egyptian Goose is one of the most numerous waterbird species in the Rhine Valley. Indeed, when looking at its European distribution, the River Rhine has clearly functioned as a pathway for expansion into the central and southern parts of the area. This species can cause damage to agricultural grasslands and to a lesser extent also crops, as true goose species do. Egyptian Geese can show dominant/aggressive behaviour to native species on foraging grounds and nesting locations. It could for instance take over Goshawk and Buzzard nest (NVWA 2018). However, so far there have not been any indications of substantial negative impact on native species in Northwestern Europe (Gyemesi & Lensink 2010).

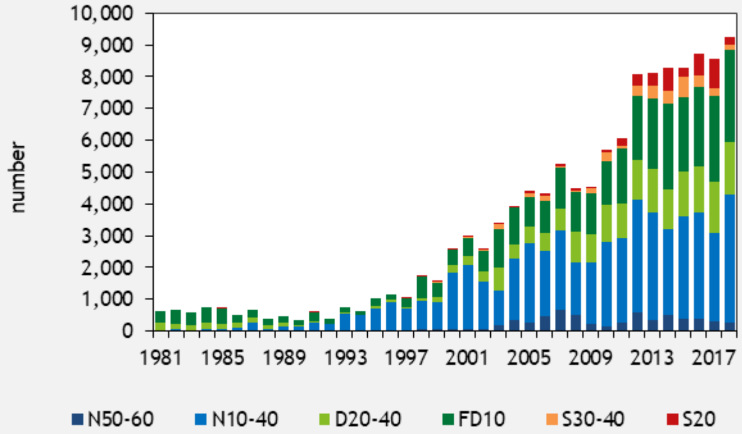


Figure B1.1*. Numbers in January of Greater Canada Goose, Egyptian Goose and Ruddy Shelduck recorded in the Rhine Valley per year.*

Table B1.1. *Average number per species for January 2016-18 of non-native waterbird species in the Rhine Valley. BS Bodensee, HR Hochrhein, OR Oberrhein, MR & NR Mittelrhein & Niederrhein in Germany, NR-NL Niederrhein in The Netherlands, YR IJsselmeer, Markermeer and Randmeren.*

Species	Counted/ estimated	BS	HR	OR	MR&NR Germany	NR NL	YR	Total
Greater Canada Goose	e	2	0	2332	888	2742	74	6038
Cackling Goose	c	0	0	0	0	2	27	29
Bar-headed Goose	c	0	0	2	0	29	0	31
Domestic Goose	c	0	0	4	4	747	229	984
Swan Goose	c	0	0	16	1	1	0	18
Black Swan	c	1	0	3	0	3	1	8
Egyptian Goose	e	2	23	525	609	1160	251	2570
Ruddy Shelduck	c	609	238	92	38	0	0	977
Muscovy Duck	c	0	0	3	1	4	0	8
Wood Duck	c	1	0	0	0	0	0	1
Mandarin Duck	c	2	1	24	6	1	0	34
Domestic Mallard	c	39	17	37	35	411	52	591
White-cheeked Pintail	c	0	1	0	0	0	0	1
Ruddy Duck	c	0	0	0	1	0	0	1

4.1.2. Trends January 1981-2018

Generally speaking, most of the waterbird species under review in this report have increased in the Rhine Valley since 1981. Increases are found among species like Red-crested Pochard, Black-necked Grebe, Great Cormorant, Greylag Goose and Gadwall (Figure 4.3). Declines are reported for Mallard, Common Pochard, Common Goldeneye, Eurasian Coot and Tufted Duck. Smew and Common Merganser are stable, but with a declining tendency. Both in the period 1981-2000 and 2000-2018 increases are dominant with even some more increases in the 2nd period, on the expense of species in decline (Figure 4.4).

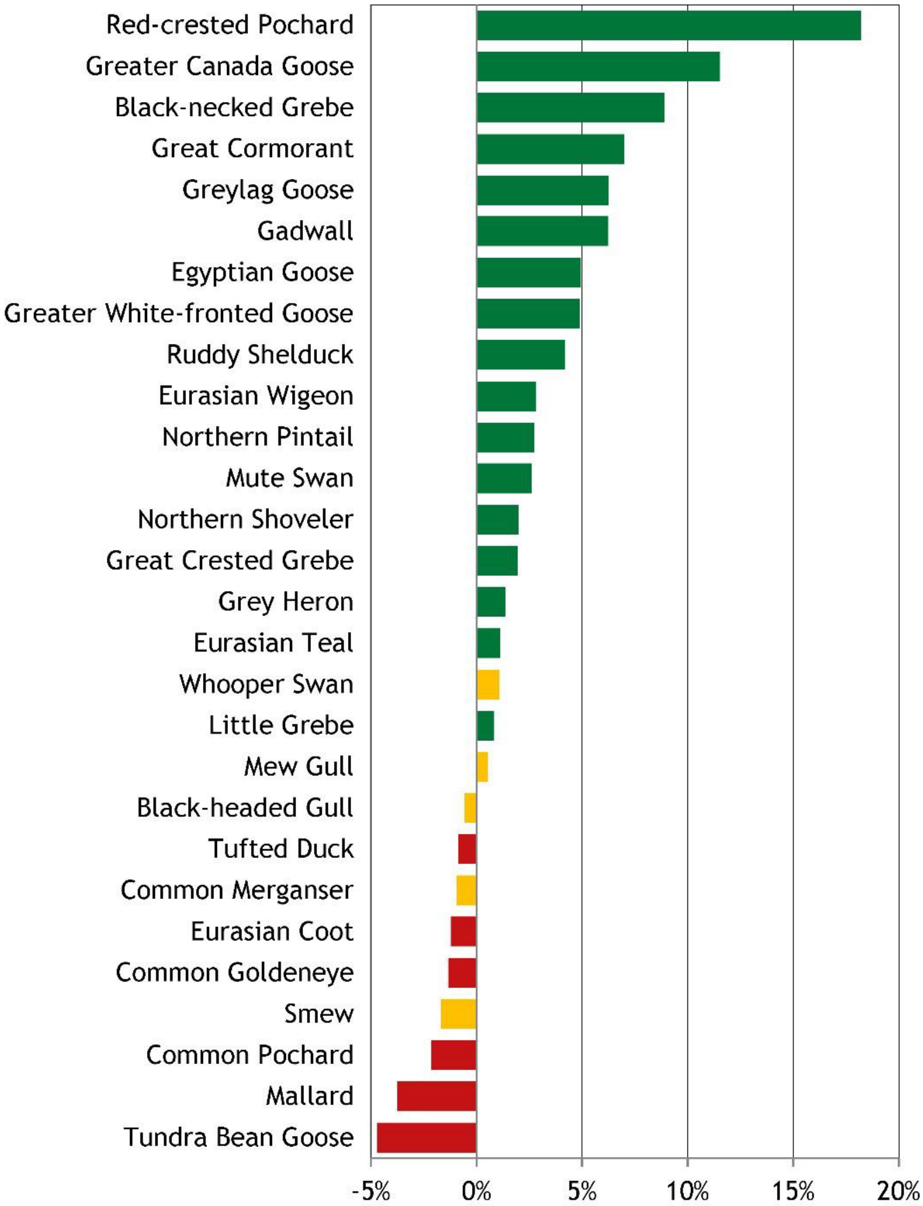


Figure 4.3. *Mean annual change in numbers of waterbird species in the Rhine Valley in January 1981-2018. Green depicts a significant increase, red a significant decrease and yellow stable trends.*

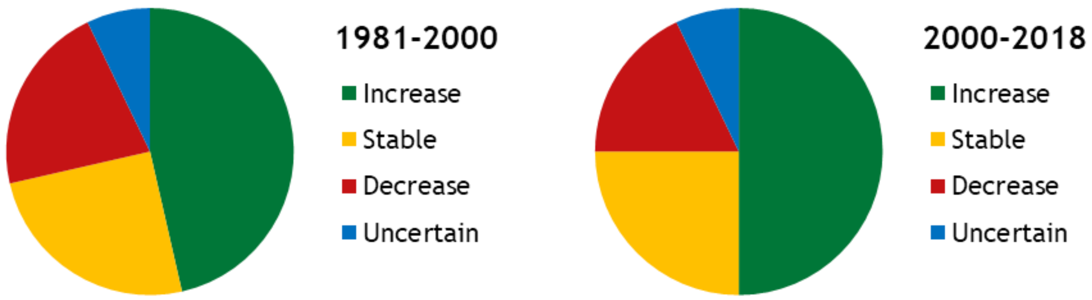


Figure 4.4. *Proportions of increasing, decreasing, stable and uncertain trend developments along the Rhine in January 1981-2000 and January 2000-2018, n=28 species.*

Trends along the Rhine (positive and negative) can be driven by local circumstances but can also be the result of more global patterns, causing increases or decreases at flyway scale or shifts in distribution within the (wintering) range. The relation between Rhine trends and the development in the whole flyway is investigated in Box 2. In the section below we investigate waterbird trends as possible indicators of development in ecological conditions along the Rhine. Numbers of waterbirds to a large extent are determined by the amount and quality of suitable feeding and roosting areas. Hence, changes in their abundance or distribution may hint at environmental changes. To investigate this further, we aggregated single species trends by labelling each species with their preferred food type and the preferred foraging habitat and calculating an overall ('mean') trend for each of these groups. As some species forage on different food types depending of the site, we differentiated between food choice in the big lakes (Bodensee, IJsselmeer, Markermeer and Randmeren) and along the river stretches (other areas, see Annex 4 for details). The results show large increases of waterbirds foraging on waterplants while numbers foraging on grassland are stable or have decreased in recent years. Waterbirds largely foraging on (Zebra) mussels have declined whereas foragers of pelagic fish in deeper water do not show a clear trend at all. Foragers of small fish, aquatic insects, benthos and plant seeds in marsh areas in the floodplain, along river banks and side-channels and in shallow water have generally increased (Figure 4.5).

These developments can indeed probably largely be linked to environmental changes in the Rhine Valley in the past 40 years that is covered by this report. From the end of the 1980s onwards, water quality in the Rhine has improved substantially. As a result especially at the Randmeren and Bodensee and later also IJsselmeer and partly also shallow areas within Markermeer, vegetation of submerged macrophytes (mainly Characeae) has expanded considerably and have attracted large numbers of feeding waterbirds, as shown e.g. by typical aquatic feeders like Mute Swan, Red-crested Pochard and Eurasian Coot (Noordhuis 1997, Heine *et al.* 1999, Werner *et al.* 2019). In fact, this process must be regarded as a recovery from the crash in the 1960s and 1970s, when increasing eutrophication and deteriorating water quality wiped out most of the submerged macrophytes and a subsequent decline in waterbirds feeding on them. This recovery of waterplants mainly occurred in the shallow lake systems within the Rhine Valley, which provide excellent settlement conditions for submerged macrophytes.

In the forelands along the Rhine, herbivore waterbird species are mainly dominated by grass-eating and other terrestrial plant-eating species, usually associated with feeding on farmland. Their abundance has been rather stable, although in the recent 10 years some decline is apparent. Especially in the Dutch Niederrhein area, larger parts of the forelands have been taken out of agricultural use and converted into wetter and more dynamic areas with natural vegetation. Many waterbirds have benefited from this conversion, but often not the species predominantly feeding on grassland, which were faced with reduced feeding opportunities (see Box 3).

Probably partly as a result of less input of nutrients, phytoplankton levels went down (mainly decrease in food quality, because of change in species-composition) along the river and at the lakes. As a result, standing stocks of water-filtering mussels responded correspondingly, causing declines in mussel-eating waterbirds as Tufted Duck, Greater Scaup, Common Goldeneye and Common Pochard (Noordhuis *et al.* 2014). In Goldeneye, also climate change plays a role (Box 2) whilst knowledge about the cause of the overall decline in Pochard still has many gaps (Fox *et al.* 2016). In contrast to other species, Common Pochard has not responded positively to the restoration of waterplant beds, so likely other constraints affect this species.

Part of the other benthos-eating species changed also to other species of benthos (which became more common especially in fields with waterplants). The development of pelagic fish-eating species is showing some increase, which is mostly driven by the increase (partly a recovery from heavy persecution in previous days) of Great Cormorant. This is not a purely pelagic fish-eater and it can respond quickly to good feeding opportunities for a wide range of different fish species. In the IJsselmeer area, populations of Smelt *Osmerus eperlanus* decreased. Also, this decrease is partly linked to lower eutrofication levels (Noordhuis *et al.* 2014). Especially species like Smew, Common Merganser and terns in late summer predominantly feed on Smelt stocks and have responded to lower abundance of this fish species. The increase of the group of species foraging on small fish, invertebrates, benthos and plant seeds in marshy areas and muddy shores is probably largely an effect of changes in the floodplain of the rivers, renaturation of former farmland areas in the (Dutch part of the) Niederrhein (see Box 3), as well as improved water quality (Bodensee).

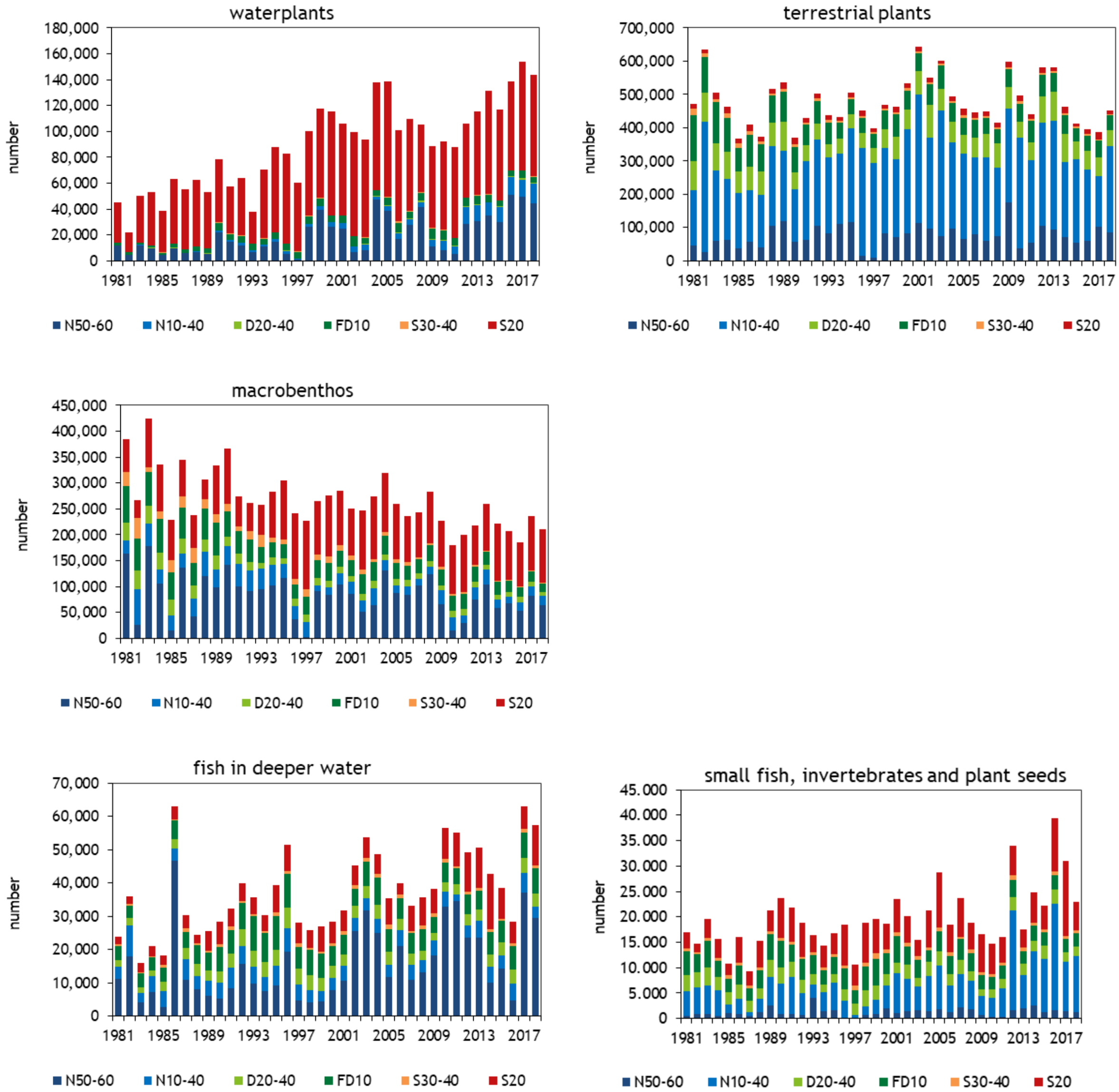


Figure 4.5. *Development of numbers of waterbirds in the Rhine Valley January 1981-2018, according to food and habitat choice (see Table 3.2 for area codes). Terrestrial plants mainly refer to farmland (grass) feeders, macrobenthos feeders mainly involve mussel-eating waterbirds (see appendix 4 for species assignment).*

Table 4.2 presents a final overall assessment for the most abundant species, combining information on trends and information on internationally relevant numbers. At species level, especially for Greater White-fronted Goose, Northern Shoveler, Gadwall, Eurasian Wigeon, Northern Pintail, Common Pochard, Tufted Duck and Eurasian Coot large proportions of the international flyway populations are found in the Rhine Valley. Sites supporting internationally relevant numbers concentrate in the lake ecosystems of Bodensee and IJsselmeer, Markermeer and Randmeren, expressing the importance of these subareas within the Rhine Valley, as well as in the Dutch part of the Niederrhein area (cf. Table 4.1). The latter is particularly obvious when compared to the German part of the Niederrhein (only 2 species exceed 1% thresholds whilst in the Dutch part this is 10 species).

When looking at trends since 2000), especially Bodensee stands out with 40% of all species increasing. A similar situation is found in the Dutch part of the Niederrhein (40% of species increasing) and in the area of IJsselmeer, Markermeer and Randmeren (44%). Negative trends (36-38% of all species) dominate along Hochrhein, Oberrhein and the stretches of Mittelrhein and Niederrhein in Germany (Figure 4.6).

Table 4.2. *Trends and occurrence of international relevant numbers per subarea (see Table 3.2, 4.1). BS Bodensee, HR Hochrhein, OR Oberrhein, MR & NR Mittelrhein & Niederrhein in Germany, NR-NL Niederrhein in The Netherlands, YR IJsselmeer, Markermeer and Randmeren. Shown is the slope of the trend (numbers, either positive + or negative -), for the period 2000 – 2018, the classification of the trend (green depicts significant increases, yellow stable trends, red decreases and blue uncertain trends, cf. Figure 4.4, empty cells indicate too small numbers or irregular occurrence to calculate meaningfull trends) and an indication (given as x) if that subarea support numbers exceeding the 1% threshold of the total flyway population.*

Transect	BS	BS	HR	HR	OR	OR	MR&NR	MR&NR	NR-NL	NR-NL	YR	YR
Species	trend	int.imp.	trend	int.imp.	trend	int.imp.	trend	int.imp.	trend	int.imp.	trend	int.imp.
Greylag Goose	16.0				3.0		4.2		5.2	x	9.8	
Tundra Bean Goose					2.5	x	0.2		-6.1		2.9	
Greater White-fronted Goose					12.6		2.9	x	-0.7	x	-1.6	
Mute Swan	3.5	x	0.6		3.6	x	2.9		-1.2		10.2	x
Whooper Swan	2.9								-12.8		27.6	
Northern Shoveler	3.6	x			2.3		3.6		10.2	x	20.5	
Gadwall	2.0	x	-4.8		-0.7	x	4.9		10.3	x	5.1	
Eurasian Wigeon	8.8		-6.5		-1.7		-1.8		-6.9	x	3.0	x
Mallard	-0.6		-2.2		-3.4		-2.7		-2.5		-4.4	
Northern Pintail	4.5	x			10.4		1.1		6.9	x	16.9	x
Eurasian Teal	-1.5		-1.0		-4.1		-1.3		6.8	x	0.5	
Red-crested Pochard	4.0	x			13.6						11.9	
Common Pochard	0.9	x	-12.7		-2.7		-3.3	x	-8.7		-2.8	x
Tufted Duck	-1.0	x	-9.8		-3.9	x	-1.7		-0.5	x	-0.3	x
Common Goldeneye	-4.7		-9.1		-1.7		-1.9		2.7		0.9	
Smew	-3.7				2.2		1.9		-2.2		-2.1	x
Common Merganser	2.0		5.7		9.7		7.7		2.2		-1.7	x
Little Grebe	1.3		-2.7		-2.3		0.7		6.9		7.5	
Great Crested Grebe	2.9	x	-0.6		-1.9		-1.4		1.7		1.7	
Black-necked Grebe	6.7				2.1				13.9			
Grey Heron	-0.4		1.8		5.0		5.1		1.3		0.5	
Great Cormorant	2.5		-1.6		0.8		-0.1		0.2		10.1	x
Eurasian Coot	-0.5	x	-6.2		-2.1		-2.7		-2.9	x	4.4	x
Black-headed Gull	-2.8		1.3		-1.7		-2.0		0.3	x	-0.4	
Mew Gull	-8.1				-0.3		-3.7		2.3		-3.6	

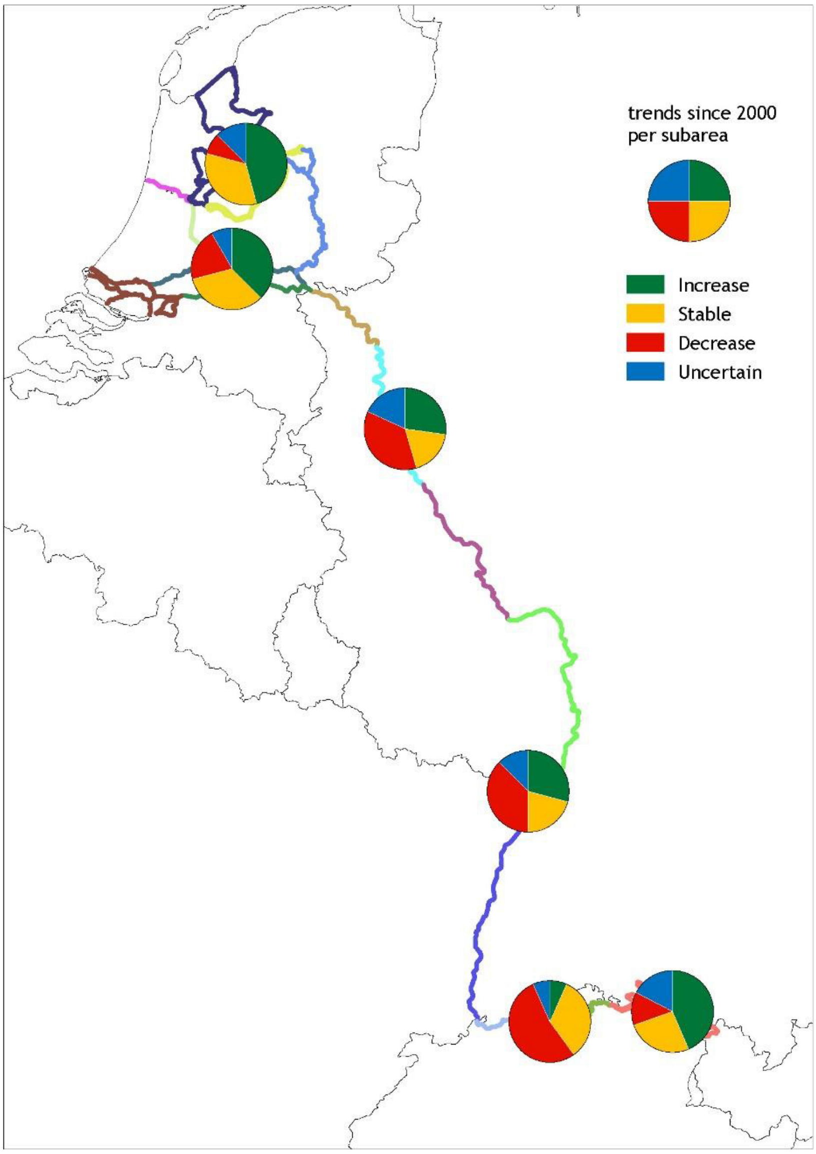


Figure 4.6. *Proportions of trends compared between the different subareas of the Rhine Valley. Given are the trends since 2000 per subarea (see Table 4.2) as percentage of the number of species with trends at that subarea.*

Box 2. Waterbird trends in the Rhine Valley compared with flyway trends

To test whether the winter population changes in the Rhine Valley are region-specific or part of a more global
pattern at flyway level, we compared the long-term trends in the Rhine Valley with the flyway population trends for 20 species (Table B2.1). This reveals a strong correspondence between Rhine and flyway trends (R^2=53.6, t=4.79, p<0.001), meaning that species that increase in the Rhine Valley tend to increase at the flyway level as well, or alternatively decrease at both levels. Moreover, the rates of population change are rather similar and hardly differ from the line y=x (Figure B2.1; y=0.954x). So overall, species population trends in the Rhine are not more or less positive than the population trends in the total flyway, at least for this selection of species.

However, at the species level, differences in trends do exist. Four species with increasing trends at the flyway level have decreased in the Rhine Valley: Smew, Common Merganser, Common Goldeneye and Eurasian Coot. For the first three species, it has been shown that warmer winters have initiated northeastward shifts in wintering range (Lehikoinen *et al.* 2013, Pavón-Jordán *et al.* 2015) and it is likely that this also has caused wintering numbers in the Rhine Valley to go down. For Eurasian Coot, regional drivers the overall decline in the Rhine Valley may have a more local origin, such as disturbance and conversion of grassland into arable land or natural vegetation (see

Box 3 and species accounts). Conversely, there are no species that increased in the Rhine Valley since 1981 but decreased at the flyway level. The majority of species has shown positive population trends in both the Rhine Valley and at the flyway level, although for some the rates of increase differ. Red-crested Pochard, Great Cormorant, Gadwall, Northern Pintail, Eurasian Wigeon and Great-crested Grebe did even fare better along the Rhine than along the flyway. Regional factors seem to play a dominant role here, such as improvement of water quality ans subsequent increase in aquatic vegetation (e.g. Red-crested Pochard), complemented by global drivers (e.g. improved protection). On the other hand, Whooper Swan, Greylag Goose and Little Grebe have increased stronger along the flyway than in the Rhine Valley, reportedly a combination of the same regional and global factors.

To conclude, the majority of waterbird species has shown long-term increases in both the Rhine Valley and along the entire flyway. Global factors (climate warming) are held responsible for some species that decline only along the Rhine, whereas probably a combination of regional and global drivers explains differences in the rates of increase for other species. For a better understanding of the relative importance of the various drivers, more data from other months of the year are needed for more sites along the flyway, in combination with more information on changes in environmental factors at the site-level.

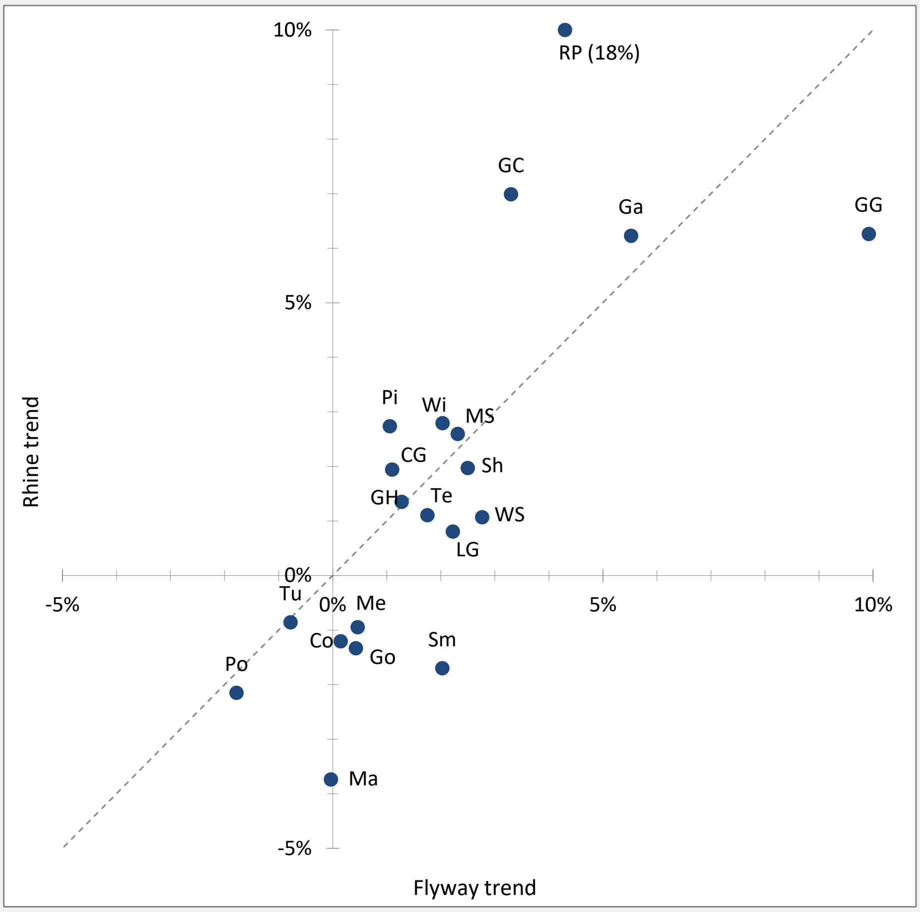


Figure B2.1 *The average rate of population change (expressed as percentage per year) within the Rhine Valley compared with the annual rate of change of the flyway population (data Wetlands International). Positive values indicate population increases; negative values indicate population decreases. Species below (i.e. to the right of) the diagonal line y=x have less favourable population trends in the Rhine Valley than in the total flyway. Species in the lower right quadrant decrease in the Rhine Valley but increase in the flyway. Dots represent separate species, for abbreviations, flyway description and trend period, see table B2.1.*

Table B2.1. *International flyway populations used for trend comparison with Rhine Valley trends. Shown are species abbreviations used in Figure B2.1, start year of flyway trend and origin of flyway population (after data Wetlands International). For six species a combination of NW-European and NE-European/Mediterranean flyway populations is used (Gadwall, Eurasian Teal, Mallard, Tufted Duck, Common Pochard, Eurasian Coot). For the flyway population trend estimate analysed here, trends of both flyways (which are very similar for four of these species) were averaged.*

Species	abb	Start flyway	Flyway population
Little Grebe	LG	1988	Europe & North-west Africa
Great Crested Grebe	CG	1987	North-west & Western Europe
Great Cormorant	GC	1988	Northern & Central Europe
Grey Heron	GH	1990	Northern & Western Europe
Mute Swan	MS	1981	North-west Mainland & Central Europe
Whooper Swan	WS	1981	North-west Mainland Europe
Greylag Goose	GG	1981	North-west Europe/North-west & South-west Europe
Eurasian Wigeon	Wi	1981	North-west Europe
Gadwall	Ga	1981	North-west Europe + North-east Europe/Black Sea & Mediterranean
Eurasian Teal	Te	1981	North-west Europe + W Siberia & NE Europe/Black Sea & Mediterranean
Mallard	Ma	1981	North-west Europe + West Mediterranean
Northern Pintail	Pi	1981	North-west Europe
Northern Shoveler	Sh	1981	North-west & Central Europe (win)
Red-crested Pochard	RP	1990	South-west & Central Europe/West Mediterranean
Common Pochard	Po	1981	North-east Europe/North-west Europe + Central & NE Europe/Black Sea & Mediterranean
Tufted Duck	Tu	1981	North-west Europe + Central Europe, Black Sea & Mediterranean
Common Goldeneye	Go	1981	North-west & Central Europe
Smew	Sm	1981	North-west & Central Europe
Common Merganser	Me	1981	North-west & Central Europe
Eurasian Coot	Co	1981	North-west Europe + Black Sea & Mediterranean

4.2. Species accounts

Below, separate species accounts give a general description of the species, its status in the Rhine Valley in 2015-2018 and information on trends in numbers since 1981. This comes with a distribution map (showing numbers per subarea, see Fig. 2.1, Table 3.2), a graph with phenology during winter (see Table 3.2 for site codes) and two type of graphs depicting trends in numbers: one with seasonal averages and their trend (dots annual figures, bold line trendline, thin line 95 % confidence intervals of the trend line, note different numbers on y-axis) and one indexed on the average of the entire data series, in order to allow a better comparison of trends between the subareas. General information in the species accounts has been mainly taken from online data sources like https://birdsoftheworld.org/bow/home and http://datazone.birdlife.org/species/search and Del Hoyo *et al.* 1996. Flyway population figures have been derived from Wetlands International 2018.

Photo: Harvey van Diek

4.2.1 Little Grebe *Tachybaptus ruficollis*

D: Zwergtaucher; F: Grèbe castagneux; NL: Dodaars

Photo: Gejo Wassink

Introduction
Little Grebes breed widespread in Europe and are only partly migratory. Eastern European populations move to Western Europe in winter. Small breeding sites on higher grounds in Western Europe are left for more open water in lowlands outside the breeding season. They mainly prey on small fish in winter and also aquatic insects, crustaceans and amphibians during the breeding period. Their typical breeding habitat consists of small swamps, ponds and reservoirs with extensive vegetation cover. They breed solitary but in good breeding habitat densities can be relatively high. In winter they usually occur solitary or in small groups on lakes, reservoirs, channels and slowly running rivers. Only few sites may hold larger numbers but never more than a few hundred birds. As the species may behave concealed, counts perhaps are lower than numbers actually present. This is even more pronounced in the IJsselmeer area, where counts are done from an airplane.

Status (distribution Figure 4.7, seasonal pattern Figure 4.8)
Most wintering Little Grebes are found in the southern half of the Rhine Valley. By far the largest numbers are found in the Bodensee area. But also the numbers along the Oberrhein are relatively high. In the Niederrhein region numbers are smaller and more or less evenly distributed over most of the subsites. Larger concentrations in the area of Rijnmond/Rotterdam are part of the core wintering area in the SW-Netherlands.
Arrival on the wintering grounds takes place during September – October and Little Grebes move to breeding grounds in March – April. In October – February the total wintering numbers are rather stable at the Rhine. This indicates that Little Grebe move to the Rhine Valley for wintering, as e.g. in Germany as a whole, overall peak numbers occur during autumn (DDA unpubl.). Some small changes in numbers at subregions between October, November and December also suggest some movements. The total number at the Rhine in winter in 2015/16 – 2017/18 was 2,300 Little Grebes of which 1,800 in the South and 500 in the North. This is only about a 0.5 % of the flyway population.

Trends (Figure 4.9)
In the past decades, declines have been reported for several breeding populations of Little Grebes in Europe. For wintering birds in the Rhine valley, this is only supported by the river branches of the Niederrhein, which showed a decrease after 1985. Obviously, this trend results from the series of severe winters in 1985-87, which also reduced numbers at e.g. Bodensee (1985, 1987). However, Little Grebes usually recover after such declines, as also expressed by Bodensee numbers in the 2nd half of the 1980s. In the Bodensee area, declines have also been associated with fluctuations in food abundance (Werner *et al.* 2018).

Overall trends 1981-2018 show a long-term increase, thus the species is nowadays more abundant as in the beginning of the data series. Apart from fluctuations in the Bodensee, numbers in the Dutch section of the Niederrhein and the IJsselmeer area show most pronounced increases. It is likely that these are associated with the improved water quality and subsequent expansion of submerged waterplants (leading to higher food stocks) and renaturation projects in the floodplains of Nederrijn, Waal and IJssel, again improving wintering habitat and food resources for the species.

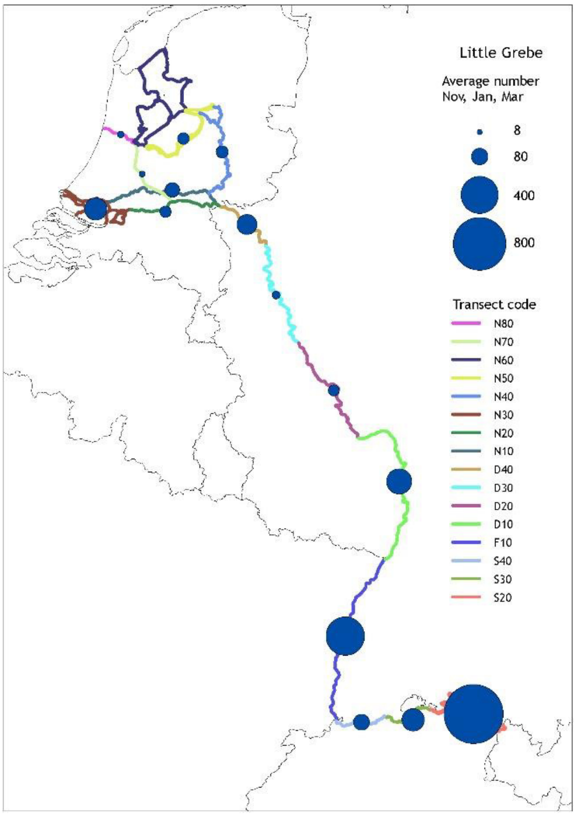


Figure 4.7 *Distribution of Little Grebe*

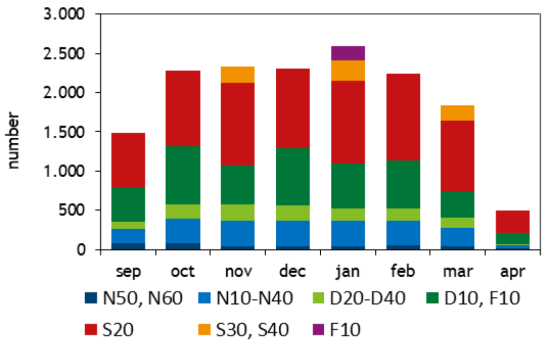


Figure 4.8 *Seasonal pattern of Little Grebe*

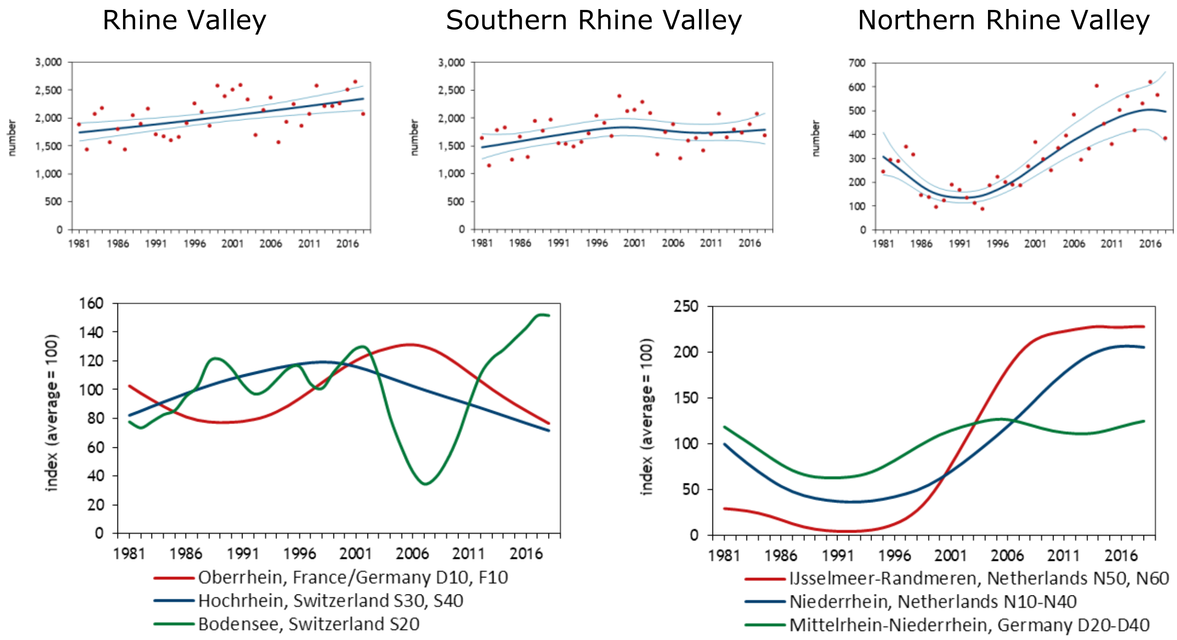


***Figure 4.9** Trends of Little Grebe. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.2 Great Crested Grebe *Podiceps cristatus*

D: Haubentaucher; F: Grèbe huppé; NL: Fuut

Introduction
Great Crested Grebe is a resident species throughout large parts of its European breeding range. Waterbodies in western and central Europe also serve as wintering areas for birds breeding in northern and eastern zones. In the Rhine Valley, Bodensee, Oberrhein and parts of the Niederrhein area (notably IJsselmeer/Markermeer) are known for their concentrations of moulting birds in July-September. Bodensee as well as sites in the Niederrhein area support numbers of international importance. The species is very susceptible to any source of disturbance, which e.g. in the Bodensee area also clearly affects the distribution pattern within the area (Werner *et al.* 2018).

Status (distribution, Figure 4.10, seasonal pattern Figure 4.11)
Most parts of the Rhine Valley do not show a distinct seasonal pattern. Generally, numbers peak in the Niederhein area in autumn (September), whereas further upstream numbers increase towards January. In January and March, overall numbers were slightly lower but showed an increase in concentrations in more southernly situated sections like Oberrhein and Bodensee. The Bodensee harboured about half of the entire population present in the Rhine Valley in January and March. In spring (April) the species is even one of the most abundant waterbird species in this area (Werner *et al.* 2018). In the Rhine Valley, Great Crested Grebes especially gather at slow-moving waterbodies with good fish stocks, such as Bodensee, IJsselmeer/Markermeer, Randmeren and water reservoirs and gravel pits along the Oberrhein. It occurs far less in the main stream of the river itself.

Trends (Figure 4.12)
Initially, Great Crested Grebes have responded positively to the increasing eutrophication and subsequent increase in fish stocks of e.g. Perch *Perca fluviatilis*, Ruffe *Gymnocephalus cernua* and Smelt *Osmerus eperlanus* (e.g. de Nie 1995), but also benefited from changing fish stocks after improvement of water quality. Trends in the Rhine Valley in 1981-2018 show large fluctuations but have clearly increased over time. Great Crested Grebe numbers at the Bodensee have shown a strong correlation with fish stocks of *cyprinid* fish (Heine *et al.* 1999, Werner *et al.* 2018). Similar relationships have been reported for IJsselmeer/Markermeer (Winter 1994, Noordhuis 2000) and Randmeren (Noordhuis 1997). The species has also benefited from renaturation projects in the floodplains in the Dutch part of the Niederrhein area (see also Box 3).

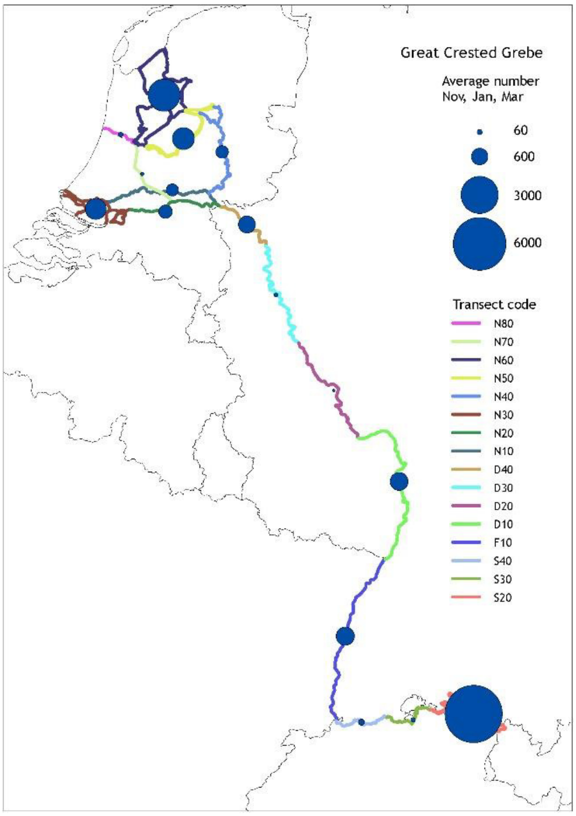


***Figure 4.10** Distribution of Great Crested Grebe*

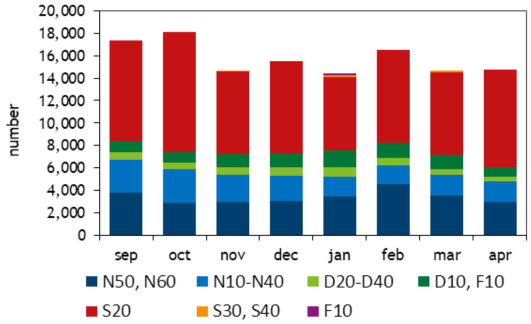


***Figure 4.11** Seasonal pattern of Great Crested Grebe*

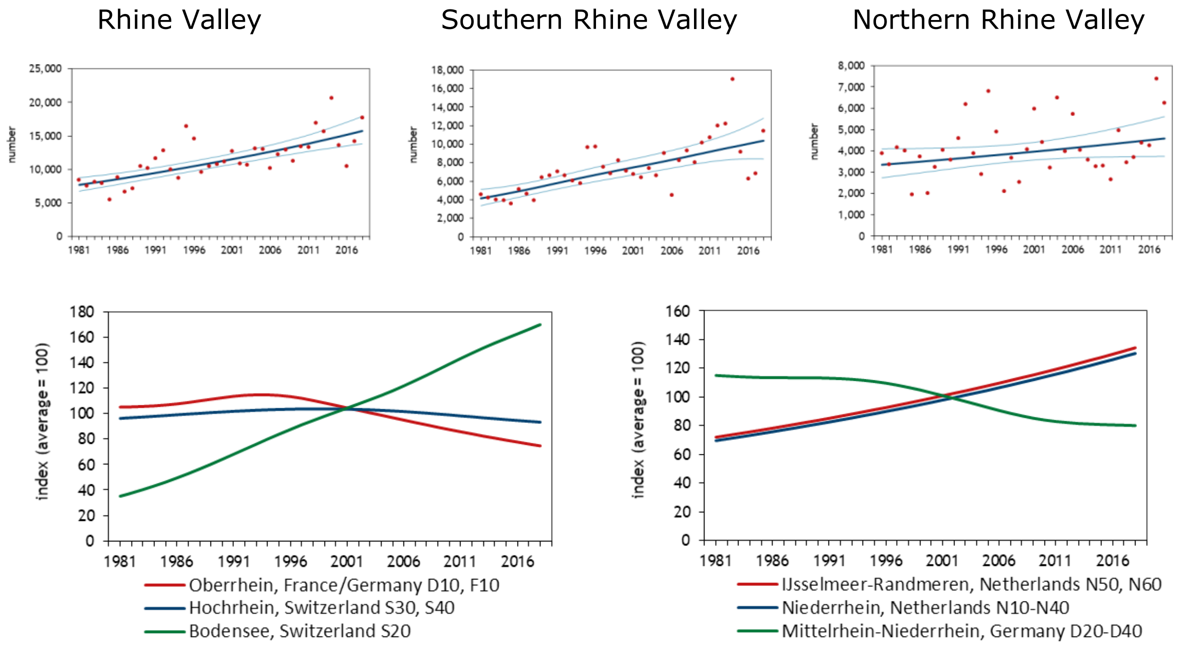


***Figure 4.12** Trends of Great Crested Grebe. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.3 Black-necked Grebe *Podiceps nigricollis*

D : Schwarzhalstaucher ; F : Grèbe à cou noir ; NL : Geoorde Fuut

Photo: Harvey van Diek

Introduction

Black-necked Grebes occurring in the Rhine Valley are part of the flyway population that breeds in Europe and winters both in southern and western Europe as well as in northern and western Africa. Small numbers breed at Bodensee, at one site along the Oberrhein and in the Dutch part of the Rhine Valley. However, it is more abundant throughout the rest of the year, particularly at Bodensee. It breeds in vegetated areas of freshwater lakes, sometimes in mixed-species colonies together with Black-headed Gulls and other species (Bochenski 1961). During the non-breeding period, Black-necked Grebes mainly occur on lakes, coasts and on large rivers where they feed on water invertebrates. The species moults in late summer and autumn; flocks of several hundred individuals in this period can be observed at Bodensee (Werner *et al.* 2018).

Status (distribution, Figure 4.13, Seasonal pattern, Figure 4.14)

With numbers of > 1000 individuals, Bodensee hosts the by far largest share of the population wintering in the Rhine Valley (>95%). In January 2018, more than 2000 individuals of the species were counted. Among them, almost 1000 concentrated on the Untersee, the part of the lake that typically hosts the most important share of the wintering population (Werner *et al*. 2018). Currently, the numbers on Bodensee usually do not reach the 1%-threshold of international importance (1800 individuals), but this might change in the next years if the current, positive trend continues. Wintering numbers in the rest of the Rhine Valley reach a few dozen individuals only, almost all of them are found in the area between Rijnmond and Rotterdam, close to the core wintering sites in the SW-Netherlands.

Trends (Figure 4.15)

Since the 1980s, the wintering population in the Rhine Valley has shown a steep increase, mainly driven by the increase at Bodensee (the increase in the Dutch Niederrhein area only involves very small numbers). This contrasts to the estimated flyway population trend that is stable on the long term, but probably decreasing on the short term. The relative popularity of Bodensee has thus increased, most likely due to climate change and to a change in the benthic fauna (see below). The Black-necked Grebe is particularly prone to energy loss when the water is cold, as it has an unfavourable surface-to-volume ratio (compared to larger species), and because it feeds on small prey objects that are captured while diving (Glutz & Bauer 1987). Avoiding cold water is also reflected by the species' wintering distribution, it mainly keeps to the coastlines of southern and western Europe and northern Africa. In the late 1980s, a shift in climate regime led to an abrupt warming of the winter surface temperatures of Swiss lakes (North *et al.* 2013). Before, the shallow and thus colder part of Untersee (lower part of Bodensee) was abandoned by the species from December to March. Since then, wintering numbers increased, particularly also in the months with the lowest water temperature (Knaus *et al.* 2019), and nowadays this part hosts the most important share of the lake's wintering population. In 2006, researchers discovered an invasive freshwater shrimp species (*Hemimysis anomala*) in the Bodensee area, which immediately colonized the lake and perfectly matches the Black-necked Grebe's food preferences. The birds responded to the new source of food not only by a population increase, but also by changing their hunting strategy, diving in a synchronised fashion in groups of up to several dozen individuals (Werner *et al.* 2018).

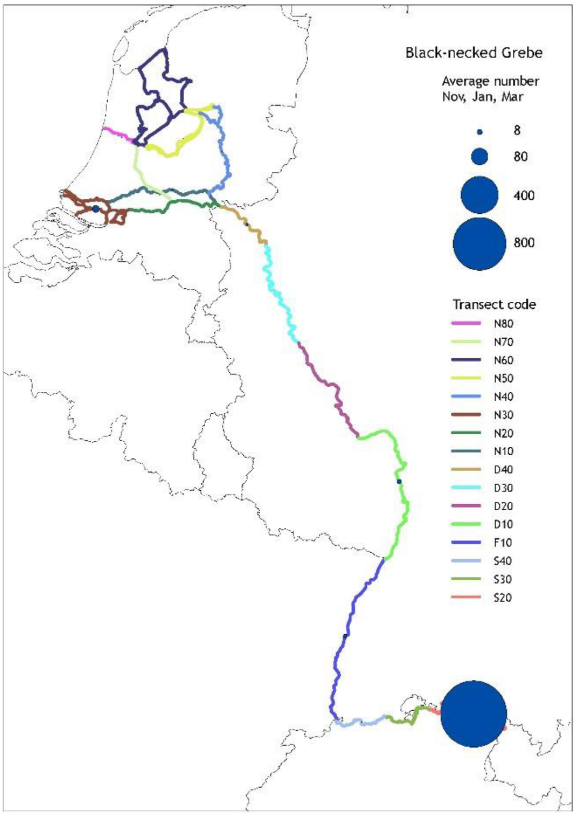


Figure 4.13 *Distribution of Black-necked Grebe*

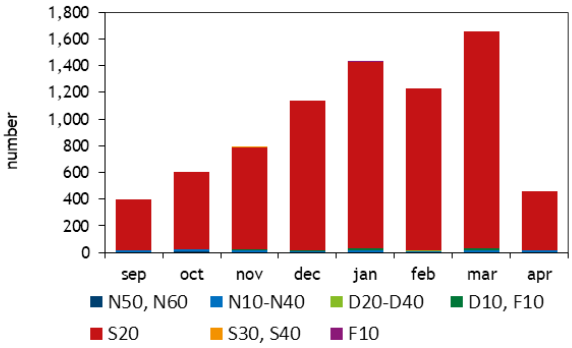


Figure 4.14 *Seasonal pattern of Black-necked Grebe*

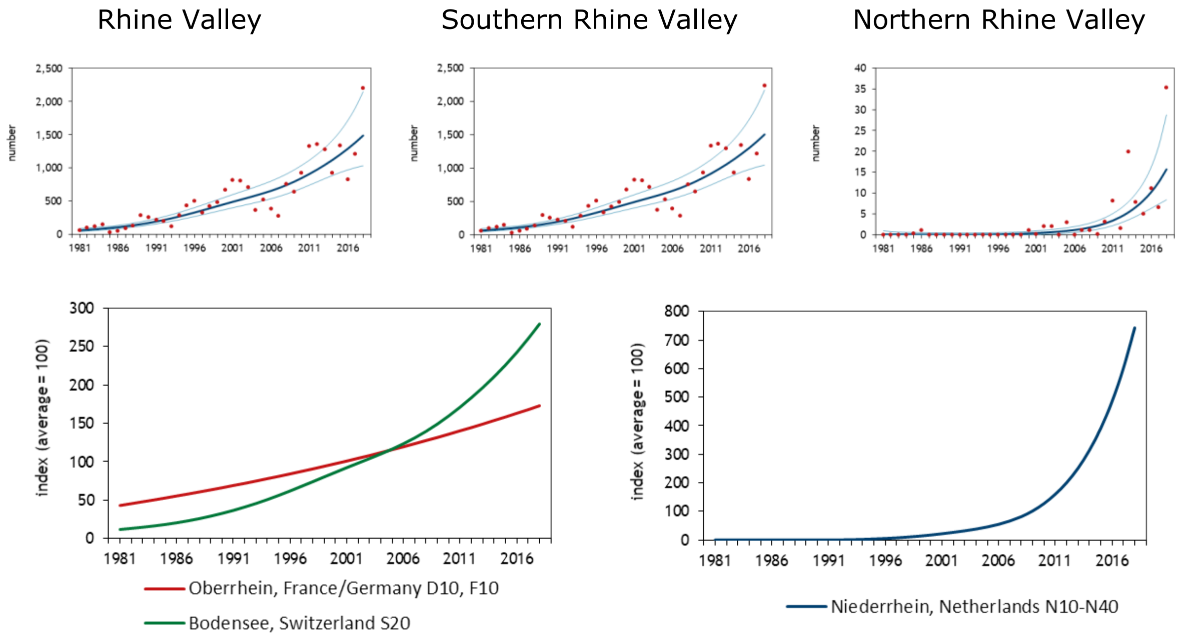


Figure 4.15 *Trends of Black-necked Grebe. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.4 Great Cormorant *Phalacrocorax carbo sinensis*

D: Kormoran; F: Grand Cormoran; NL: Aalscholver


Photo: Gejo Wassink

Introduction
Great Cormorants (subspecies *P. c. sinensis*) breed in large parts of Western, Northern and Central Europe. Germany and The Netherlands host large breeding populations of around 26,000 and 22,000 pairs, respectively (Gerlach *et al*. 2019, Boele *et al.* 2020), of which substantial numbers nest within the Rhine Valley (especially IJsselmeer area). Breeding numbers have grown considerably since the 1970s and 1980s (partly as a recovery from persecution) and breeding areas have expanded correspondingly, with a clear tendency towards more dispersed, but smaller colonies. The species is regulated by hunting in some countries (see below).
Birds breeding in the Rhine Valley are partly residents but may migrate to southern Europe and the Mediterranean or move to nearby sites. In winter, the local birds are partly replaced by birds of northern origin. In the southern Rhine Valley proportionally more birds originating from the Baltic or Northeast-Germany may occur, compared to the northern parts of the valley, where Baltic Great Cormorants dominate in wintering numbers from abroad (Bairlein *et al.* 2014, vogeltrekatlas.nl).
This piscivorous species is a generalist, with respect to its diet, targeting simply the most numerous and available fish species in attractive sizes (ideally 10-15 cm, but up to 45 cm). It may forage socially in groups of up to several hundreds or even more. Atlantic Great Cormorant (subspecies *P.c. carbo*), nesting mainly along the coasts of the United Kingdom, is probably a regular but rare winter visitor in (the northern part of) the Rhine Valley (e.g. Sovon 2018).

Status (distribution, Figure 4.16, Seasonal pattern, Figure 4.17)
Nowadays, Great Cormorant can be observed throughout the whole Rhine Valley. Total numbers exceed an average of 20,000-30,000 birds monthly in September-April (about 4-5% of the NW-European population). Major concentrations within the Rhine Valley occur in the IJsselmeer area, holding 60-70% of all birds at peak moments. Smaller but fairly good numbers are recorded along most of the German/Dutch Niederrhein and adjacent rivers and large wetlands, but numbers along Mittelrhein are relatively small (as large waterbodies do not occur in this part of the Rhine Valley). Deep inland, Bodensee is the most important wetland for this species.

Seasonal patterns in the Rhine Valley show peaks during autumn migration (September and especially October) and midwinter (January). The second peak, however, is influenced by unusually high numbers of up to 26,000 birds in the IJsselmeer area in January 2017 and 2018 (Hornman *et al.* 2019, 2020). Apart from these outliers, total numbers tend to decrease throughout winter, but remain relatively high compared to e.g. coastal waters in The Netherlands, where wintering numbers are much lower than in autumn. Different seasonal schemes do occur, e.g. fairly constant numbers in October-February along Oberrhein and a peak in April at Bodensee, but these have little influence on the general pattern.

Trends (Figure 4.18)
Total numbers have grown with an average of 7%/year in 1981-2018. The trend is heavily influenced by the large numbers in the IJsselmeer area, which experienced some

stagnation in the 1990s and recently also has fluctuated considerably from year to yeare. Regional trends sometimes differ from the general pattern, with for instance stable but lower numbers after an initial peak around 1990 (Mittelrhein), or even some decreases (Oberrhein, Hochrhein, Bodensee). In general, numbers have increased in the northern part of the Rhine Valley more strongly than in the southern part (in 1981-2018 with 8% and 6%/year, respectively).
The growth of the Great Cormorant population in the Rhine Valley is part of a long-term international phenomenon, recorded over most of Europe (Bregnballe *et al.* 2014). Factors involved are improved protection (but see below) and improved water quality (initially also euthrophication of freshwaterbodies, resulting in higher biomass of some fish species and successful adaptation to social fishing techniques). Recent decreases or fluctuations can be caused by renewed persecution (e.g. in Switzerland and Bodensee where hundreds of birds are shot annually: Werner *et al.* 2018) and ongoing changes in water quality. Increasing water transparency at Markermeer (IJsselmeer area), for instance, makes social fishing here less profitable (van Rijn *et al*. 2018). Besides, it has been reported that wintering strategies may have changed, e.g. birds from NE Germany have shortened their migration distance (Hermann *et al.* 2015) whereas earlier departures from breeding colonies locally also affect numbers present (i.e. leaving the Rhine Valley earlier in summer).

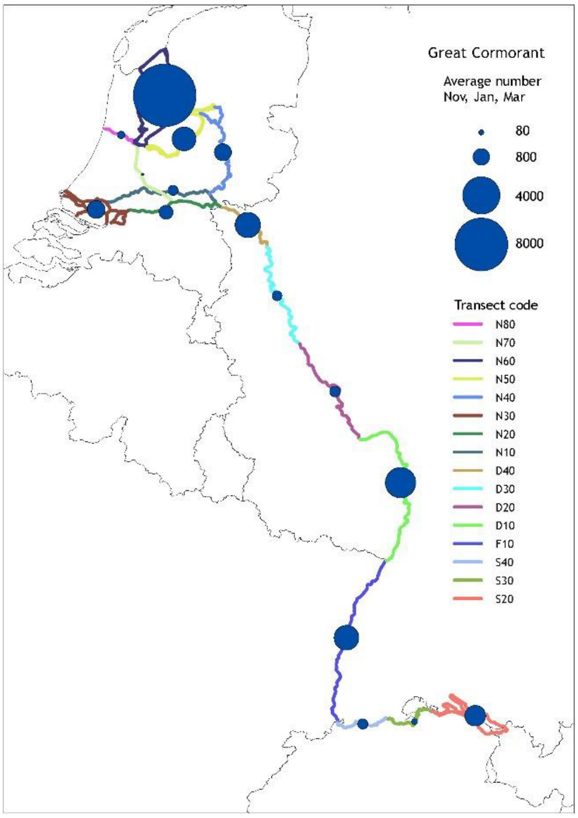


Figure 4.16 *Distribution of Great Cormorants*

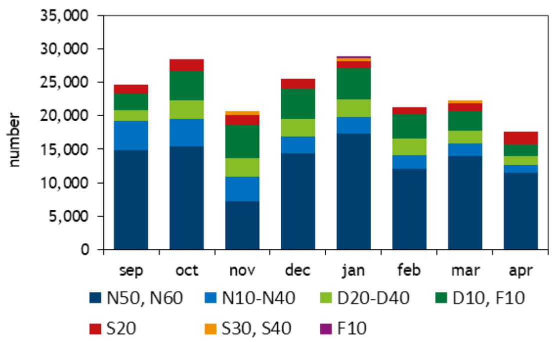


Figure 4.17 *Seasonal pattern of Great Cormorants*

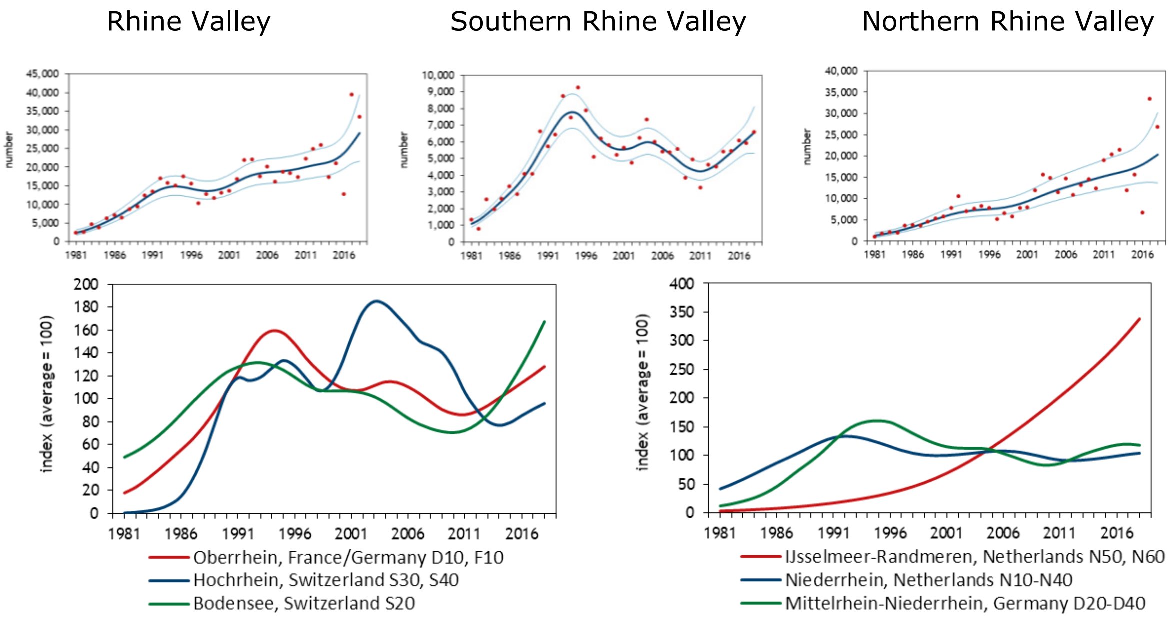


Figure 4.18 *Trends of Great Cormorants. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.5 Grey Heron *Ardea cinerea*

D: Graureiher; F: Heron cendré; NL: Blauwe Reiger

Photo: Rein Hofman

Introduction
As a European breeding bird, Grey Heron can be found especially in lowland areas. Germany and The Netherlands harbour populations of around 20-25,000 and 10,500 pairs, respectively (Gerlach *et al.* 2019, Boele *et al.* 2020). Its diet is varied, with small mammals (especially in winter) and fish (dead or alive) being most important, but additionally also comprising e.g. insects, worms, small birds and amphibians. Breeding birds start nesting in late winter, between mid-January (Netherlands; Boele *et al.* 2020) and the end of February (Bodensee; Werner *et al*. 2018)., Juveniles start to disperse from June onwards.
A substantial and growing part of the Rhine Valley breeding population is resident, the migrants leaving mostly for Southwestern Europe but into Africa as well. Local wintering birds may be accompanied by Grey Herons from northeastern countries. It is suggested that this influx is decreasing as a result of a tendency to winter further north, enabled by global warming (Bairlein *et al.* 2014, Werner *et al.* 2018, vogeltrekatlas.nl).

Status (distribution, Figure 4.19, seasonal pattern, Figure 4.20)
Grey Herons are well-distributed over the Rhine Valley, especially along the rivers, holding good numbers in some of the northernly areas (e.g. IJssel, Waal, German/Dutch Niederrhein) as well as southernly situated areas (Oberrhein). In large wetlands, the birds are confined to the shores and numbers remain relatively modest. In the whole Rhine Valley, an average of around 2500 Grey Herons may be recorded in autumn (to compare: 1% threshold of international flyway population is 5,000 birds). Higher numbers may stay in farmland areas adjacent to the river valley, especially in grassland polders intersected with many ditches. In severe ice-winters, the Rhine Valley may become more attractive for its ice-free waterbodies, but such but conditions have become rare nowadays.
The seasonal pattern shows gradually decreasing numbers from September to March, falling by about one third. Although a slight recovery is recorded in April, a clear spring migration peak is lacking. Systematic migration counts, however, reveal its existence (trektellen.nl) and 'disappearance' of birds into breeding colonies (in or outside the Rhine Valley) may obscure the passage of spring migrants. The general seasonal pattern is highly influenced by birds along the rivers; in large wetlands, numbers may not peak in autumn but in winter (Bodensee) or spring (IJsselmeer).

Trends (Figure 4.21)
Since the early 1980s, when the population was probably at a rather low level following the harsh 1978/79 winter, numbers have grown by an average of 1%/year. This growth was interrupted by two severe ice-winters in the mid-1990s and the relatively cold and snow-rich winters around 2010. These recent cold winters caused unexpectedly high losses among breeding birds, at least in The Netherlands (-30%) and at least parts of Germany (e.g. Schleswig-Holstein -35 % between 2009 and 2010; Knief & Grüneberg 2010).I It took a few years for the population to recover (Boele *et al.* 2020), resulting in correspondingly lower figures in winter (Hornman *et al*. 2020). In the southern Rhine Valley, the trend was somewhat different, with only a modest growth until 2010 and increasing and uninterrupted numbers afterwards. However, calculated over the whole

period, annual growing figures are almost the same in the northern and southern Rhine Valley.
In general, Grey Herons have benefitted from better protection (despite some recent local persecution; Werner *et al.* 2018), improved water quality, eutrophication (higher biomass of some fish species) and other factors. The tendency towards milder winters will seduce more local birds to stay in the area but may contribute to a decreasing influx from abroad as well.

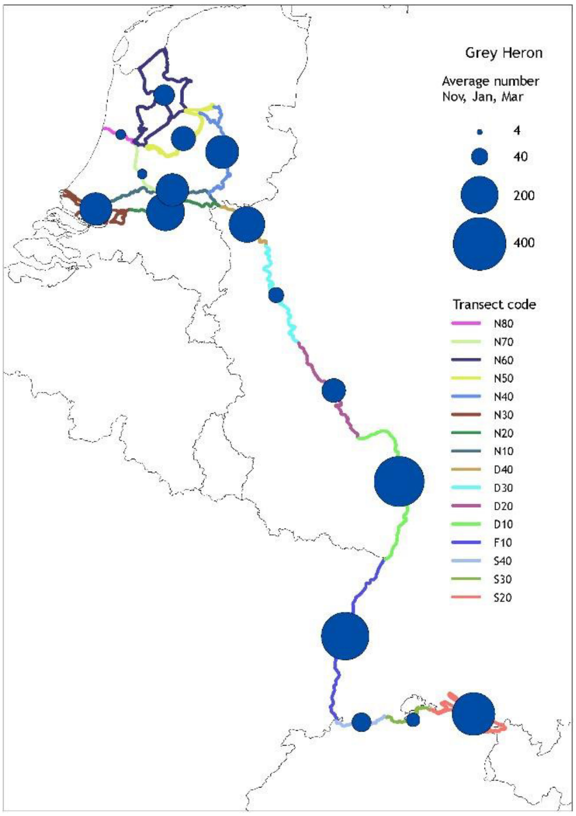


Figure 4.19 *Distribution of Grey Heron*

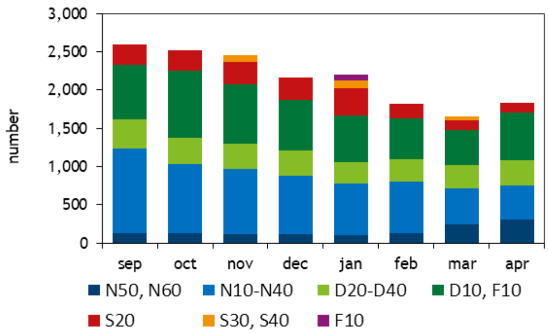


Figure 4.20 *Seasonal pattern of Grey Heron*

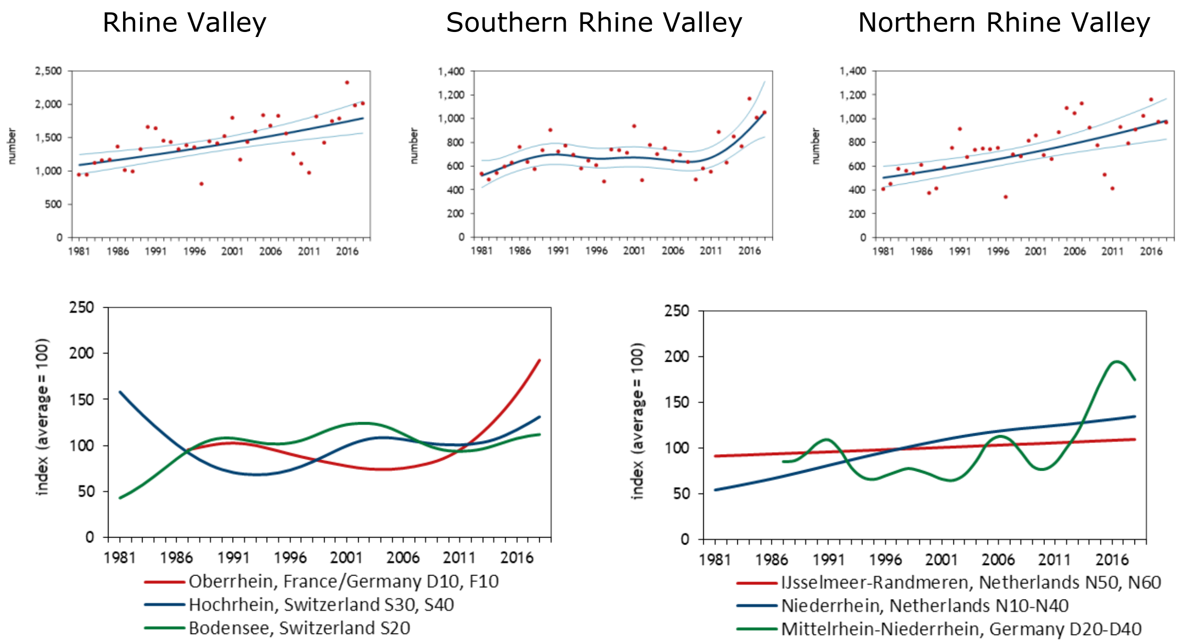


Figure 4.21 *Trends of Grey Heron. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.6 Mute Swan *Cygnus olor*

D: Höckerschwan; F: Cygne tuberculé; NL: Knobbelzwaan

Photo: Harvey van Diek

Introduction
Mute Swans breed within the temperate zones of Europe, with in the Rhine Valley relatively high densities in The Netherlands (mainly outside the floodplain of the river). Many breeding birds in Western and Central Europe originate from feral stocks. Mute Swans in the Rhine Valley generally behave as residents, but non-breeding birds migrate to large wetlands like the IJsselmeer area, Rijnmond area and Bodensee to complete primary moult in May-August, and often prolong their stay in such wetlands as long as aquatic vegetation remains available (see below). Influxes in winter involving birds of eastern origin are probably small (Bairlein *et al.* 2014).

Status (distribution, Figure 4.22, Seasonal pattern, Figure 4.23)
Outside the breeding season, the species occurs all over the Rhine Valley, with major concentrations in IJsselmeer, Markermeer, Randmeren (Niederrhein), along the Oberrhein and at Bodensee. Numbers are highest in September-November, to decline gradually to half this level by March-April. The seasonal pattern differs slightly between the northern core areas with focus on autumn and the southern core areas, with more stable numbers throughout autumn and winter. The share of IJsselmeer/Randmeren decreases from at least 50% in September to roughly 25% by April. This is driven by the availability of submerged macrophytes in the IJsselmeer area, which gradually become depleted and die off in the course of autumn, forcing the swans to disperse into grassland polders outside the river floodplain.
At peak moments in September-November an average 18,000 Mute Swans are present in the Rhine Valley, which is about 9% of the Northwest Mainland and Central European population.

Trends (Figure 4.24)
Numbers remained at a rather stable level until the mid-1990s, to increase more than twofold afterwards. Over the entire data series, there has been an annual increase of 3% during winter. Obviously, the increase rate was highest in the three core regions mentioned above, notably in the IJsselmeer area. In the northern part of the Rhine Valley, also the impact of cold winters (i.e. ice cover in lakes) is visible around the mid 1980s, mid 1990s and around 2010. Besides, at regional scale, numbers may show contrasting trends, e.g. along some Rhine branches in The Netherlands (decrease) and Hochrhein (only very slight increase). The general increase of the population has earlier been attributed to better protection and improved feeding conditions (Koffijberg *et al*. 2001). Specifically, in the Rhine Valley, improvement of water quality and subsequent increase of vegetation of submerged macrophytes have enabled Mute Swans to feed aquatically for a long period in autumn (instead of feeding on farmland). Locally, additional feeding by humans may be of importance as well (Westermann 2015). Regional decreases in The Netherlands find a parallel in some other herbivorous species (Eurasian Wigeon, Coot) and coincide with changing farming practices (crops (maize) instead of pastures) or renaturation projects (resulting into less suitable habitat, see Box 3), but are sometimes related to persecution as well (Hornman *et al*. 2018).

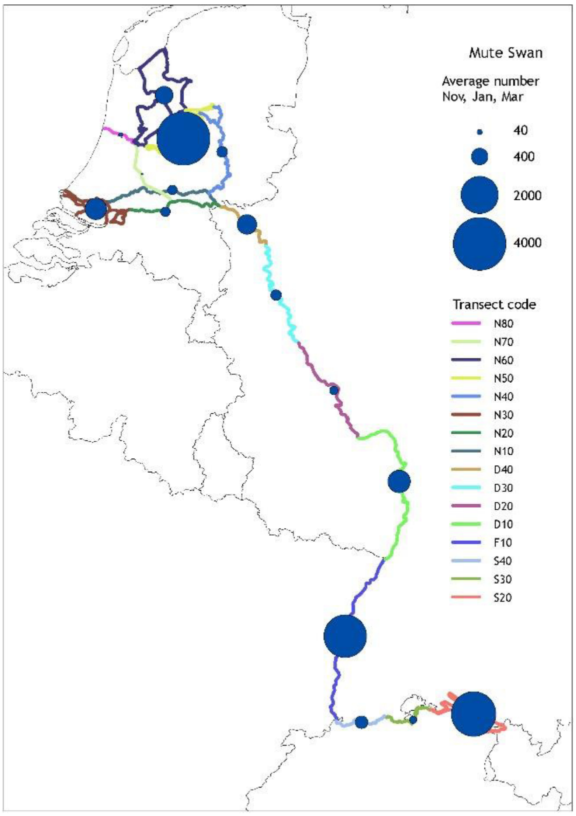


Figure 4.22 *Distribution of Mute Swan*

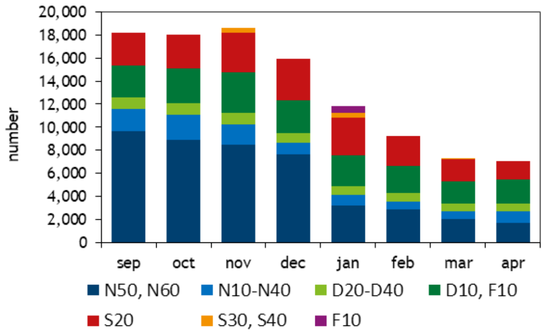


Figure 4.23 *Seasonal pattern of Mute Swan*

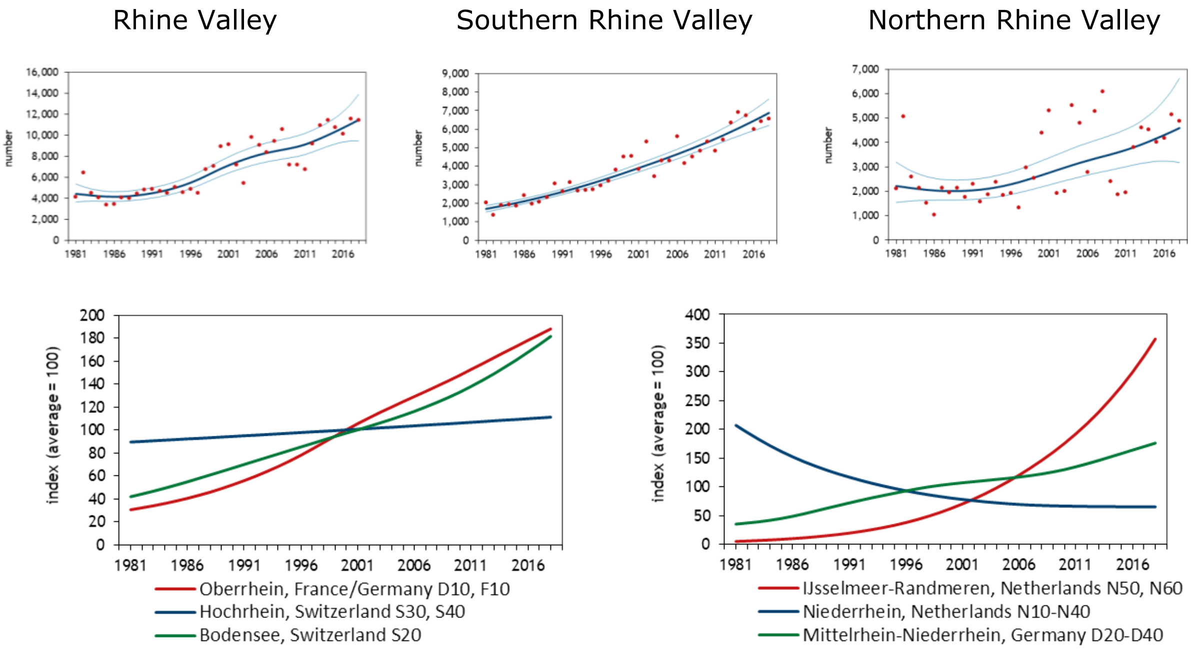


***Figure 4.24** Trends of Mute Swan. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.7 Whooper Swan *Cygnus cygnus*

D: Singschwan; F: Cygne chanteur; NL: Wilde Zwaan

Photo: Harvey van Diek

Introduction
The European breeding distribution of the Whooper Swan is mainly restricted to the Nordic countries and Russia, but in recent decades the species has expanded as a breeding bird into Central Europe as well. By now, pairs in The Netherlands (few) and Germany (mainly in northeast, 50-60 pairs, Gedeon *et al.* 2014, Gerlach *et al.* 2019) represent the southernmost edge of the breeding range. In winter, these birds are supplemented by birds of north-eastern populations. Finnish and Russian birds tend to migrate to the northern parts of the Rhine Valley while Baltic birds dominate in the southern parts (Bairlein *et al.* 2014). Movements of marked birds also show links between the northern and southern part of the Rhine Valley (Werner *et al.* 2015). Most Whooper Swans winter in the Baltic region and Eastern Europe.

Status (distribution, Figure 4.25, Seasonal pattern, Figure 4.26)
In the Rhine Valley the Whooper Swan occurs in strongly fluctuating numbers, with annual differences by factor five or more. This is mainly caused by influxes during cold spells, which initiate southbound movements from the core wintering area in the southern Baltic. Distribution has a strong emphasis on lake ecosystems of the IJsselmeer area in the north and Bodensee in the south, whereas the species is scarce elsewhere along the river. Seasonal pattern is that of a typical wintering bird and almost confined to November-February. Within the winter season, a shift in emphasis takes place towards Bodensee, holding at least 80% of all Whooper Swans in February, against some 40% in November. This is a result of swans in the IJsselmeer area, switching from feeding on submerged macrophytes in autumn to feed on farmland in winter (see Mute Swan), whereas on Bodensee the birds remain feeding on the lake. At peak moments a mean number of 1400 Whooper Swans will stay in the Rhine Valley, which is about 1% of the international flyway population.

Trends (Figure 4.27)
Trends in the entire Rhine Vally are subject to a slight increase (+1% annually), but marked annual fluctuations result in strong annual fluctuations in accordance with the character of winter weather (see above). A more pronounced increase is obvious in the southern Rhine Valley, namely Bodensee, where a continuing growth since the early 1960s has been recorded (Werner *et al.* 2018). In the northern Rhine Valley (mainly IJsselmeer area) an obvious increase has been reported only recently, caused by flocks of Whooper Swans feeding on submerged macrophytes. On the other hand, the (small) numbers in the Dutch part of the Niederrhein area have gone down, similar as other herbivorous species (see Mute Swan).
The international flyway population has grown due to better protection and increased feeding opportunities both in wetlands (improved water quality resulting in recovery of aquatic vegetations) and farmland (Laubek *et al.* 2019). Locally, banning of recreational activities is helpful as well (Werner *et al.* 2018).

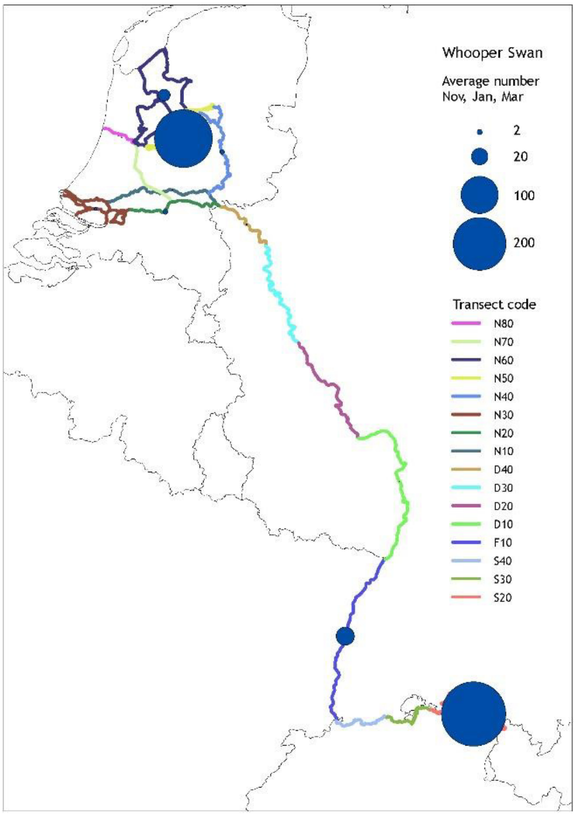


Figure 4.25 *Distribution of Whooper Swan*

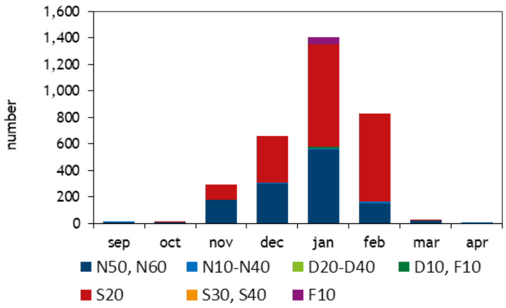


Figure 4.26 *Seasonal pattern of Whooper Swan*

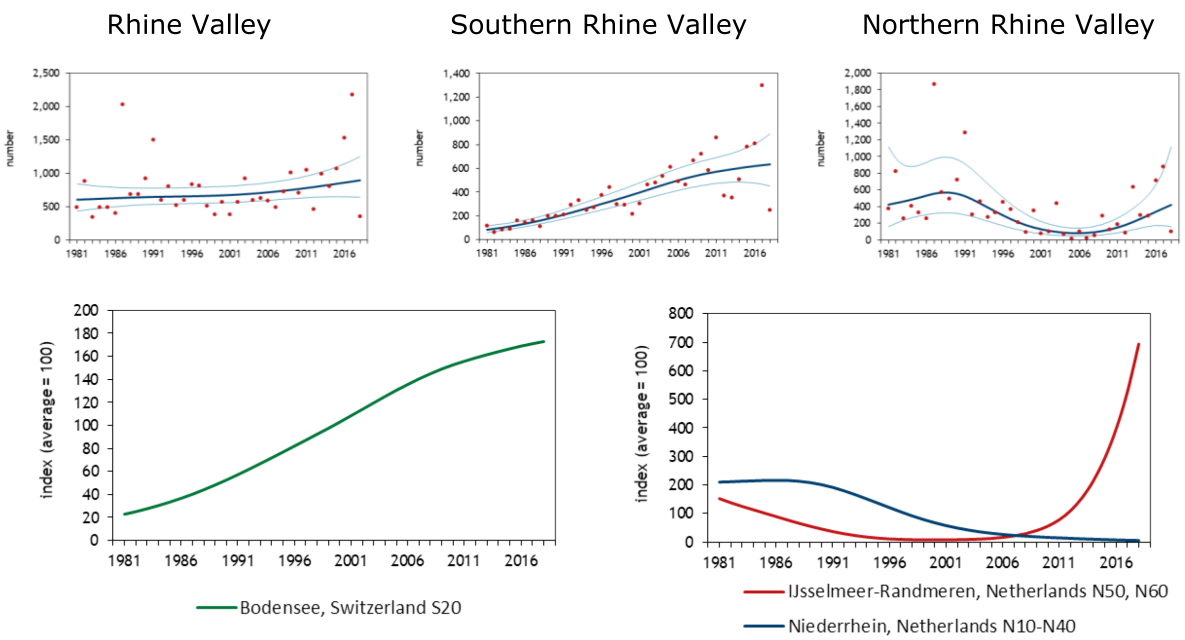


Figure 4.27 *Trends of Whooper Swan. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.8 Tundra Bean Goose *Anser serrirostris*

D: Tundrasaatgans; F: Oie des moissons de la toundra; NL: Toendrarietgans


Photo: Hans Gebuis

Introduction
Bean Geese wintering in the Rhine Valley predominantlybelong to the species Tundra Bean Goose *Anser serrirostris*, which mainly breeds in tundra areas in northern Russia. Most birds winter in eastern and southeastern Europe and numbers in the Rhine Valley represent the southwestern border of the wintering range, thus often fluctuate according to winter conditions in the core wintering areas.

Status (distribution, Figure 4.28, seasonal pattern, Figure 4.29)
Regular wintering sites of Tundra Bean Geese are found in the Niederrhein area (Koffijberg *et al.* 1997, Hornman *et al.* 2020) and along the Oberrhein (Dronneau 1998, Dietzen 2015a). Highest numbers are usually observed in December-February. Besides scattered flocks along the Niederrhein, Bean Geese mainly concentrate in the floodplain of Oberrhein. Note, however, that results of the counts along Oberrhein refer to surveys of communal night-roosts, which are visited by birds from a much larger area (also from outside the river floodplain). Such counts are not part of the waterbird monitoring carried out along the Niederrhein, thus damping potential numbers. On the other hand, distribution in The Netherlands is nowadays mainly concentrated in the northeastern part of the country, whereas in the SW and along the rivers there has been a long-term decline (Sovon 2018). In the German Niederrhein area, flocks nowadays mainly occur outside the river floodplain, feeding on harvest remains and also using more local waterbodies to roost (e.g. Wille *et al.* 2007). Both Niederrhein and Oberrhein have largest numbers found in agricultural areas, where birds feed on pastures as well as crops (Koffijberg *et al*. 1997, Dronneau 1998). The species has benefited greatly from the expansion of maize farming, providing good feeding opportunities until midwinter.

Trends (Figure 4.30)
Due to the situation that the Rhine is on the southern edge of the wintering range, the occurrence of Bean Goose is somewhat erratic and influenced by the severity of the winter. Overall, numbers have declined, and it is likely that this is especially an effect of milder winters (as the population as a whole did not decline). Long-term trends for Niederrhein show a significant decrease, but Oberrhein on the contrary, receive increasing numbers (note, however, that this involves rather small numbers). The decline in the Niederrhein area is partly a consequence of birds moving away from the river floodplain in the German part and a general shift of major winter concentrations to the northeast in The Netherlands (see above).

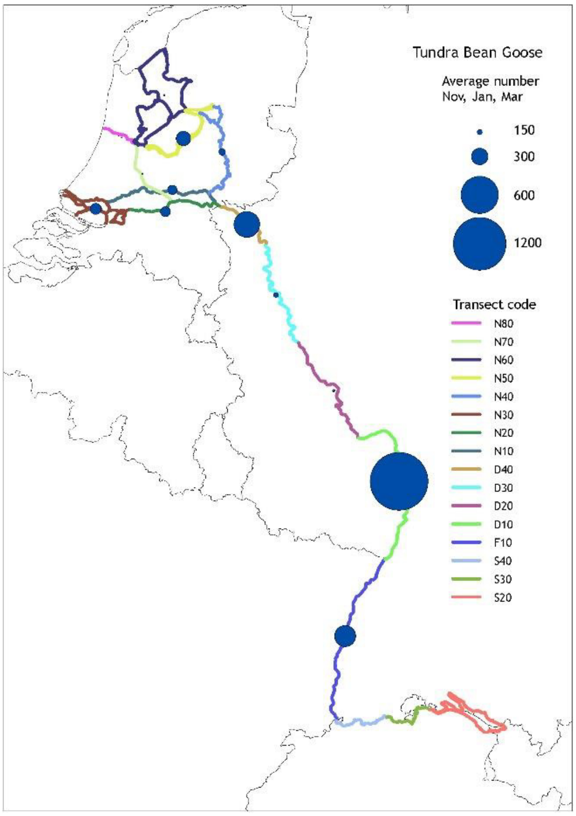


Figure 4.28 *Distribution of Tundra Bean Geese*

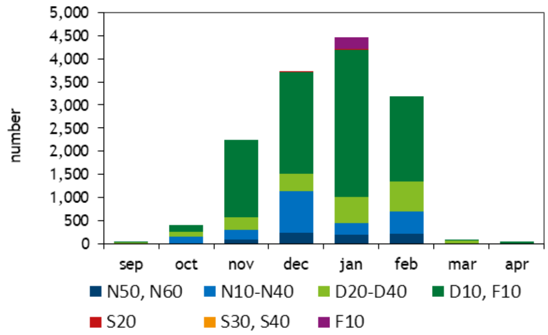


Figure 4.29 *Seasonal pattern of Tundra Bean Geese*

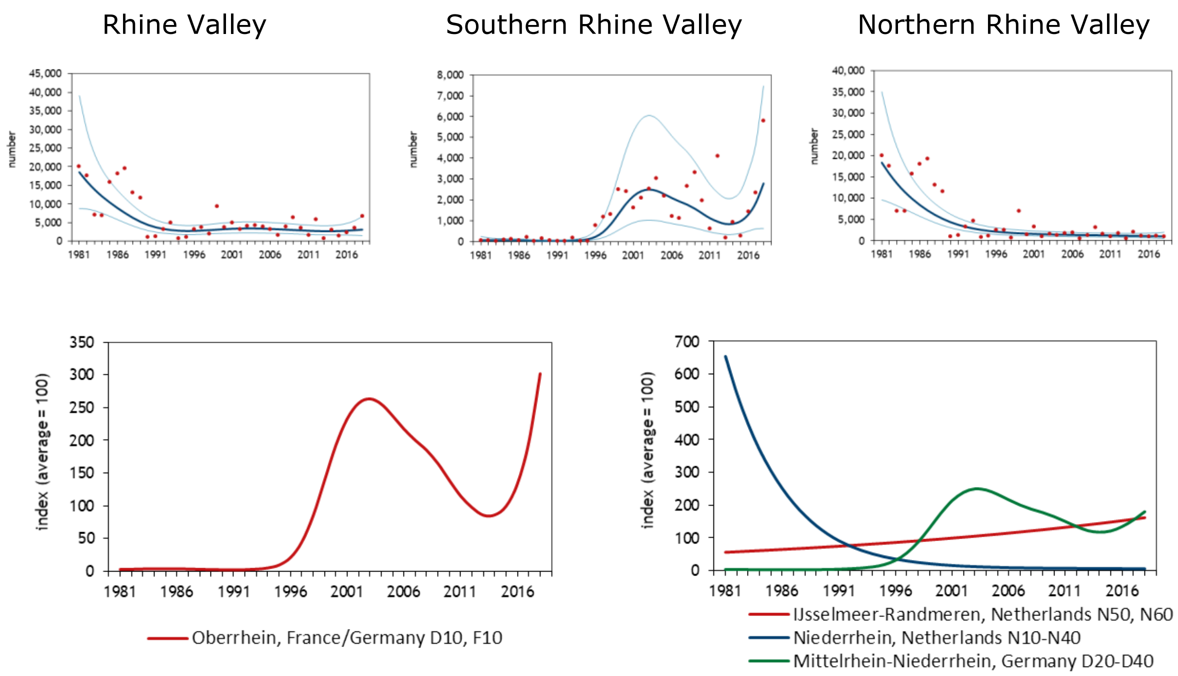


Figure 4.30 *Trends of Tundra Bean Geese. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.9 Greylag Goose *Anser anser*

D: Graugans; F: Oie cendré; NL: Grauwe Gans

Photo: Cor Fikkert

Introduction
The European breeding distribution of the Greylag Goose (nominate *A. a. anser*) is mainly restricted to lowland areas in the northwestern part. Here, the species breeds in freshwater marshes, at water bodies (especially islands), in farmland with pools and ditches and, increasingly, in urban habitat. The Netherlands (67,000-110,000 pairs; Sovon 2018) and Germany (42,000-59,000, Gerlach *et al.* 2019) have large and thriving breeding populations. A substantial part of these pairs is nesting within the Rhine Valley, especially in The Netherlands and the northern part of the German Niederrhein.
Regional breeding birds are mostly residents (95% in The Netherlands; Sovon 2018), but many non-breeders will leave the area temporarily in Mai-June to moult in specific waterbodies. Such moulting areas may be located close to the breeding area itself but may also involve movements of 100s of kilometers as well. The biggest moulting location in the Rhine Valley, Oostvaardersplassen in the IJsselmeer area, attracts large numbers (36,000 in June 2017; Hornman *et al.* 2020), mostly birds from the Low Countries, Germany and, to a lesser extent, Scandinavia. Such birds will normally return to the breeding area shortly after completing primary moult. In autumn, part of the Fennoscandian Greylag Geese migrates trough or winters in the Rhine Valley. Part of these birds nowadays tend to stay closer to their breeding areas, enabled by warmer winters (Nilsson 2013, Ramo *et al.* 2016, Bacon *et al.* 2019). Birds of the subspecies *A. a. rubirostris* nesting in Southeastern and Eastern Europe are proven to occur in at least the utmost south of the Rhine Valley (Werner *et al.* 2018), but numbers are very low. Recently, a species management plan has been endorsed by AEWA, in response to increasing conflicts between goose abundance and especially agricultural practice (Powolny *et al.* 2018).

Status (distribution, Figure 4.31 seasonal pattern, Figure 4.32)
Within the Rhine Valley, distribution is strongly biased towards the northwestern sections, although to a lesser degree than in e.g. Greater White-fronted Goose. In the northern part of the Rhine Valley, close to the large breeding populations and situated in the centre of the migration pathway, the species is one of the most common birds along all rivers and in wetland areass. From Mittelrhein further south it is much scarcer, with the exception of relatively large numbers along the northern parts of Oberrhein. In the Bodensee area, local breeding Greylag Geese have increased, but still represent rather small numbers compared to those in e.g. the Dutch part of the Rhine Valley.
Total numbers build up during autumn, when Scandinavian birds arrive, peaking in December with an average of nearly 70,000 birds, about 7 % of the NW European flyway population. Afterwards, number fall and in April they are more than halved. At that moment, most breeding birds will have begun nesting, but there is a substantial non-breeding population nowadays. Numbers using the Rhine Valley will, in fact, be much higher than shown by the daytime counts here, as there are e.g. lively movements between adjacent farmland and waterbodies (for resting, drinking, roosting).

Trends (Figure 4.33)
Few waterbird species have shown increases comparable to those in Greylag Goose. Being almost extinct as a breeding bird in The Netherlands and most of Germany in the 1950s and 1960s, a recovery started in the 1970s and 1980s and resulted in an exponential increase from the late 1990s onwards. It was fueled by reintroduction projects and the establishment of new, optimal (temporarily available) breeding habitat through reclamations in the IJsselmeer area (Zuidelijk Flevoland, including Oostvaardersplassen) (Sovon 2018). Annual increases over the whole period hardly differed between the northern and southern Rhine valley (around 6 %/year), despite the fact that the numbers involved differ by a factor ten. More recently, the growth in wintering numbers in the Rhine Valley levels off, which may indicate local saturation, but is likely also the result of increased numbers shot (Powolny *et al.* 2018). Besides, it has been reported that some Scandinavian breeding birds have shortened their migration route, and winter more closely to their breeding grounds (see above), perhaps also affecting numbers migrating through or wintering in the Rhine Valley. This phenomenon is likely to play an important role, as breeding populations in both The Netherlands and Germany have continued to increase (Gerlach *et al.* 2019, Koffijberg & van Winden 2020).
The NetherlandsThis might explain the change in peak numbers from October-November prior to 2000 (Koffijberg *et al*. 2001) to December by now. The Netherlands

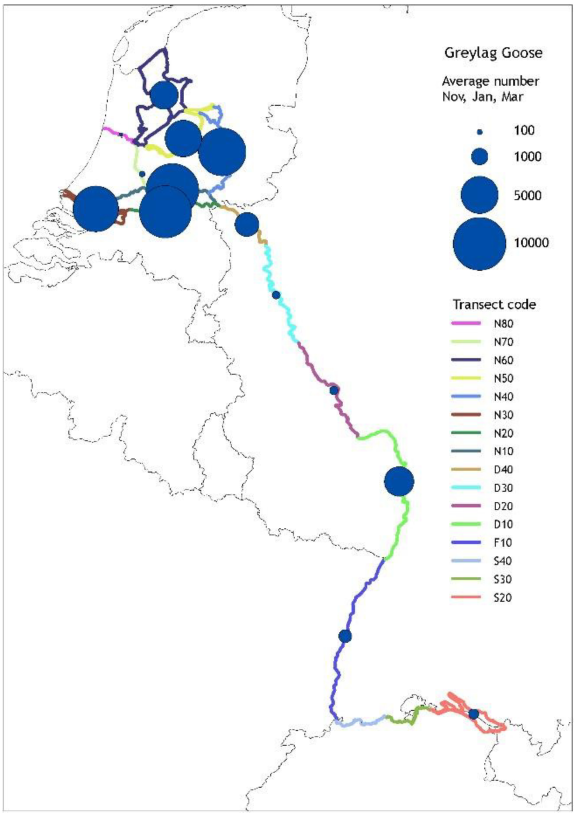


***Figure 4.31** Distribution of Greylag Goose*

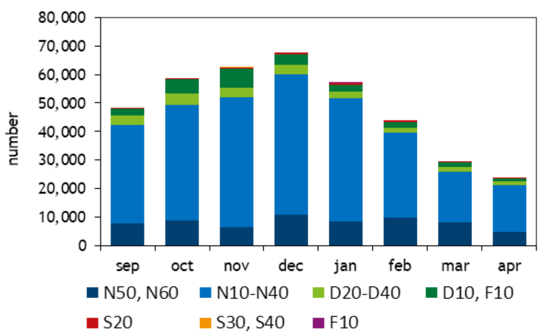


***Figure 4.32** Seasonal pattern of Greylag Goose*

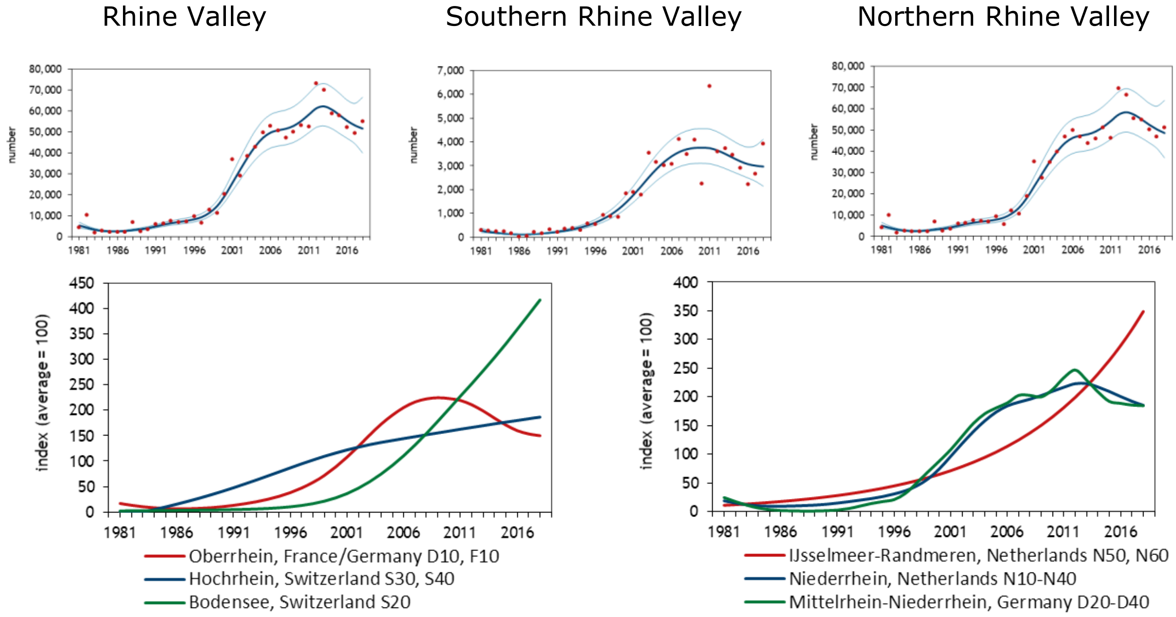


Figure 4.33 *Trends of Greylag Goose. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.10 Greater White-fronted Goose *Anser albifrons*

D: Blässgans; F: Oie rieuse; NL: Kolgans

Photo: Harvey van Diek

Introduction
The breeding distribution of Greater White-fronted Goose is almost restricted to the Eurasian tundra from the Kanin Peninsula to Kolyma. At temperate zones, only small introduced numbers breed, e.g. in The Netherlands (420-700 pairs in 2013-15, probably less by now; Sovon 2018, Boele *et al.* 2020). The northern part of the Rhine Valley is situated within the core wintering range of the species. Greater White-fronted Geese mainly feed on grassland (in autumn also harvest remains of crops) and often use gravel and sand pits for roosting. This combination of feeding and roosting sites at close range makes the Niederrhein area extremely attractive as a wintering site. In cold winters, the Rhine Valley becomes even more attractive, as it still provides open water for drinking and roosting (Sovon 2018). The NetherlandsMassive winter movements caused by heavy snowfall are a well-known phenomenon but have not been recorded since the 2009/10 winter when large numbers left the northern Netherlands and parts of Germany. Passage of up to 22,000 birds at single counting points was noticed on 30 and 31 January (Hornman *et al*. 2012).

Status (distribution, Figure 4.34, seasonal pattern, Figure 4.35)
The northern parts of the Rhine Valley are clearly the stronghold within the Rhine Valley (about 98% of numbers counted). The species is especially abundant along the tributaries of Waal and IJssel. In Germany, high numbers winter in the Niederrhein area north of Duisburg. Further south the species becomes rapidly scarcer. Largest numbers are present from November to March, but in some years mass-arrival may take place already in October (Wille *et al.* 2007, Sovon 2018).
At peak moments, an average of 160,000 Greater White-fronted Geese is recorded in the Rhine Valley, representing about 13 % of the NW European flyway population.

Trends (Figure 4.36)
Numbers in the Rhine Valley have grown considerably in the 1980s and 1990s (on average +11 %/year) but have stabilised more recently (-0.3 %/year). Overall increase in 1981-2018 was by 5 %/year. The increase in the Rhine Valley is part of the increase in the flyway population but growing abundance were influenced as well by a tendency towards earlier arrival in autumn. As moment of departure did not change, the period of presence of large numbers in the Rhine Valley was prolonged. Very recently, however, arrival was remarkably late (2017-19) and numbers did not reach usual levels until the end of winter. It is not yet clear whether this later arrival is part of a new strategy, with a prolonged stay in autumn along the Baltic (Hornman *et al.* 2020), but it contributes to the stagnating figures in recent years. Another factor in this respect is ongoing poor breeding success. In recent years, wintering groups in The Netherlands (including areas outside the Rhine Valley) hold only 12-14 % juveniles, sometimes even less (8% in 2017/18, poorest result in 60 years), whereas 25-40 % was normal during the period of sharp increases in the 1970s and 1980s (Hornman *et al.* 2020).
The recent stabilisation in the Rhine Valley is, however, still rather favourable. The international population stabilised earlier (Jongejans *et al.* 2014) and trends in some traditionally important areas such as the province of Friesland are clearly more negative than those in the Rhine Valley (Hornman *et al.* 2019).

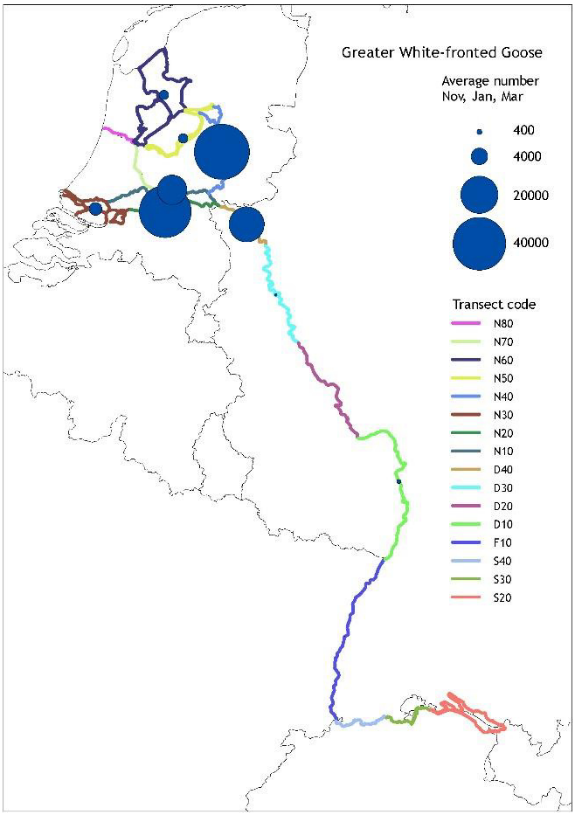


Figure 4.34 *Distribution of Greater White-fronted Goose*

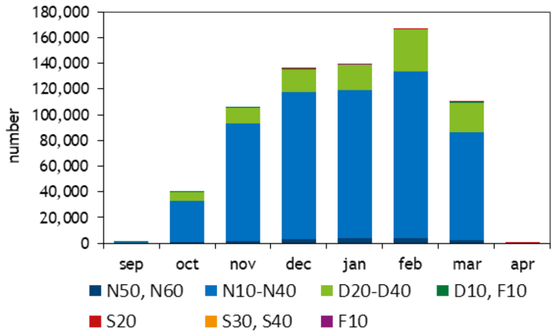


Figure 4.35 *Seasonal pattern of Greater White-fronted Goose*

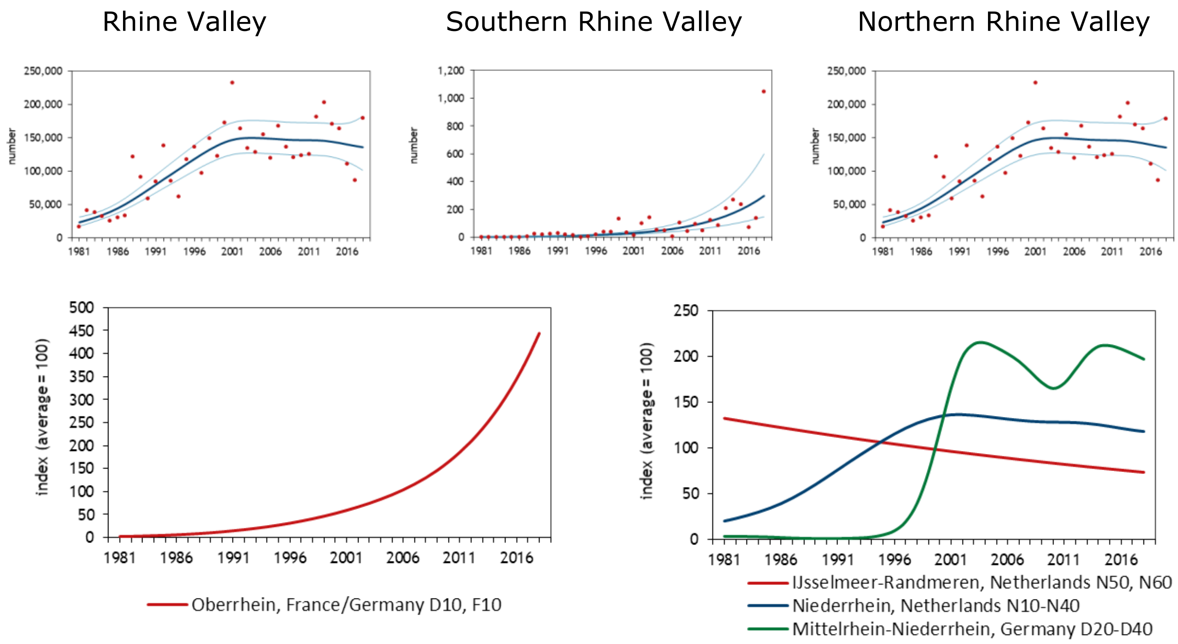


***Figure 4.36** Trends of Greater White-fronted Goose. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.11 Greater Canada Goose *Branta canadensis canadensis*

D: Kanada Gans; F: Bernache du Canada; NL: (Grote) Canadese Gans

Photo: Harvey van Diek

Introduction
Greater Canada Goose is a Nearctic species that was introduced in European waterfowl collections several centuries ago. It mainly represents Greater Canada Goose, but other subspecies and hybrids may be involved as well in a small extent (and were taken together in the analyses). Released birds and escapes established fast growing breeding populations in the United Kingdom, Sweden and, since the 1970s, in other European countries as well. In the Rhine Valley, its stronghold is situated in the Niederrhein area In The Netherlands 9,000-12,000 pairs were counted in 2013-2015, of which a substantial part in the Rhine Valley; Sovon 2018). In Germany, with an estimated 8,500-14,500 breeding pairs recently (Gerlach *et al.* 2019), the Rhine Valley is even the main stronghold of the breeding population Relatively high numbers also nest along the Oberrhein (Gedeon *et al.* 2014), but further south the species becomes increasingly scarce.Although many breeding birds tend to disperse locally around their breeding sites, long-distance movements may occur in June and July, associated with primary moult. This involves at least German birds, moving into The Netherlands (Bairlein *et al.* 2014), but there are also signs of a pronounced moult migration into the Baltic (Sovon 2018). On the other hand, influxes of Baltic birds during winter have become rare. The NetherlandsThe Netherlands In Germany such birds may reach the Baltic, but rarely make it up to the Bodensee (Werner *et al.* 2018).

Status (distribution, Figure 4.37, seasonal pattern, Figure 4.38)
Greater Canada Goose can be observed throughout the whole area along the river and its branches, although it is rather scarce along the Mittelrhein (where few feeding opportunities exist and urban populations are scarce) Concentrations are located near the most important breeding sites in the Dutch/German Niederrhein area and along Oberrhein. Most wetlands are relatively unimportant in winter, but they may function as night roosts for birds foraging in farmland (maize stubble, grassland). Numbers increase from September to November, when an average of 6,500 birds is present. Midwinter numbers are somewhat lower, to diminish quickly afterwards (as birds displace to sites outside the river floodplain) The Netherlands
Total numbers in the Rhine Valley are relatively low, compared to those distributed over farmland and some other rivers, e.g. Meuse. The wintering population in The Netherlands is estimated to comprise at least 50,000 birds (Sovon 2018).

Trends (Figure 4.39)
The species was rather scarce until the mid-1990s, with the exception of influxes of several hundreds of Nordic birds during severe winters (Sovon 2018). Starting in the mid-1990s or, in some areas, after the turn of the century (Gaudard *et al.* 2017), a steep increase was noticed, showing no clear signs of stabilisation up to 2010. Average increases in 1981-2018 of 12 %/year (hardly differing between the northern and southern Rhine valley), are even higher than those of other fast-growing populations, e.g. of Greylag Goose, Egyptian Goose and Gadwall. The increase of birds in winter parallels that of breeding populations (Gedeon *et al.* 2014, Gerlach *et al.* 2019, Hornman *et al.* 2020, Koffijberg & van Winden 2020).
Recent figures demonstrate that strong increases continue especially in areas where colonisation started rather late, e.g. along the Oberrhein (Dietzen 2015b, Mahler *et al.* 2018). Numerically, however, ongoing increases in the northern Rhine valley, holding the largest population, are more important. Substantial persecution, such as in The

Netherlands (21,000 shot/year in 2015/16-2017/18; Boele *et al*. 2020) and parts of Germany (in Northrhine-Westphalia up to 6,530 in 2015/16, Eylert 2018) have not yet substantially reduced total numbers.

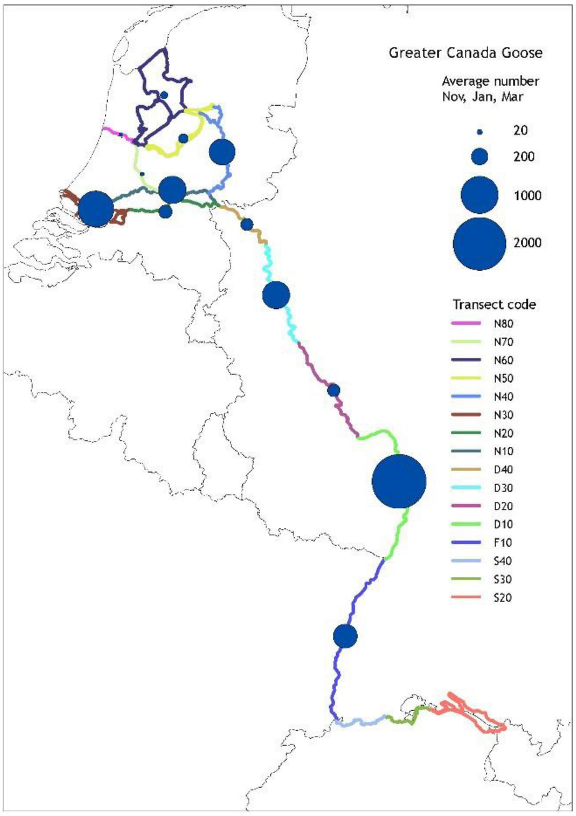


Figure 4.37 *Distribution of Greater Canada Goose*

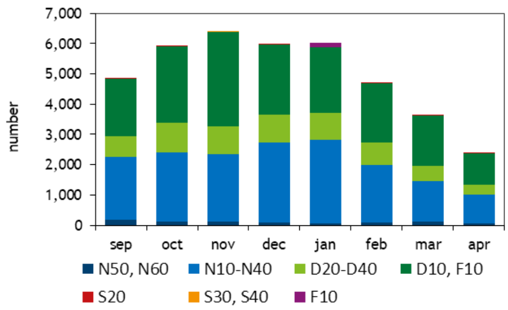


Figure 4.38 *Seasonal pattern of Greater Canada Goose*

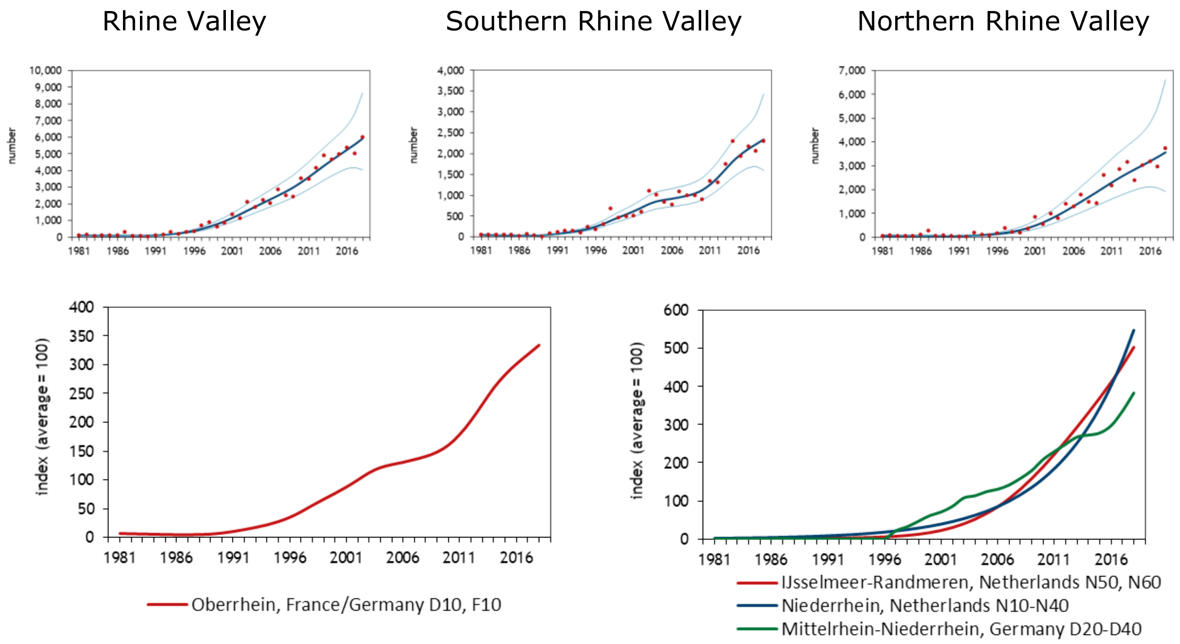


Figure 4.39 *Trends of Greater Canada Goose. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.12 Egyptian Goose *Alopochen aegyptiacus*

D: Nilgans; F: Ouette d'Egypte; NL: Nijlgans

Photo: Harvey van Diek

Introduction

The Egyptian Goose is a non-native species in the study area, originating from Africa. The river floodplains in The Netherlands were occupied from the 1970s onwards, from where it gradually colonized the upstream parts of the Rhine valley. The species has now established populations across vast parts of NW-Europe, including the larger part of the Rhine region. The European breeding population is even larger than the native African breeding population. The German population has increased hugely to 8,000–12,500 pairs and expanded into the eastern and southern parts now as well, with the western parts still being the strongholds (Gedeon *et al.* 2014, Gerlach *et al.* 2019, ornitho.de).

Egyptian Geese breed in holes (trees, buildings, nest boxes), in dense vegetation on the ground or in nests of other species (raptors), generally in close proximity to open water bodies. They are herbivorous and largely sedentary and are found year-round in the Rhine valley in floodplains with grasslands and shallow or deep stagnant waters, including large water reservoirs. Egyptian Geese generally breed close to their natal grounds, but ringed individuals have demonstrated that dispersal up to some 100s kilometres does occur (Sovon 2018). Especially young birds seem to show large natal dispersal (Dietzen 2015c), which is likely the the reason why it is increasing and spreading much quicker than e.g. Canada Goose (e.g. Mahler *et al.* 2018, Bauer *et al.* 2018).

Status (distribution, Figure 4.40, seasonal pattern, Figure 4.41)

The species is well-distributed in the Rhine region, with the largest concentrations in the lower part of the Niederrhein, particularly along the Nederrijn/Lek in The Netherlands and the adjacent main river stretch in Germany. Besides, relatively high numbers occur in the lower part of the Oberrhein. In the Hochrhein and Bodensee Egyptian Geese are still raher scarce.

The seasonal pattern shows only limited regional variation. Numbers strongly peak in early autumn (partly a result of moult concentrations) and gradually decrease in the course of winter (when birds disperse over farmland feeding sites). In spring numbers slightly increase again. Total numbers account for some 7,000 Egyptian Geese in September, around 2,500 during midwinter and 4,000 in April. Large numbers will be present as well in summer, during primary moult (Koffijberg & Kowallik 2018).

Trends (Figure 4.42)

Winter numbers of Egyptian Goose in the Rhine Valley have increased strongly, approximately fivefold since the early 1980s. The population grew most rapidly between 1995 and 2005. After 2005 the rate of increase has levelled off somewhat. A similar pattern is visible along the Oberrhein (where level off takes place later on). Contrastingly, other parts of the Rhine Valley still show increases, but numbers are still low in the Hochrhein and Bodensee area (first breeding in 2013, Werner *et al.* 2018). The stabilisation in The Netherlands has been attributed to offtake by hunting and limitations in feeding areas in the floodplain area (Sovon 2018). In the central and southern parts of the Rhine Valley, the species is likely to expand further in the coming years. At present, the species is also listed on the EU Regulation on invasive alien species. This implies that member states are obliged to manage the population and prevent further expansion.

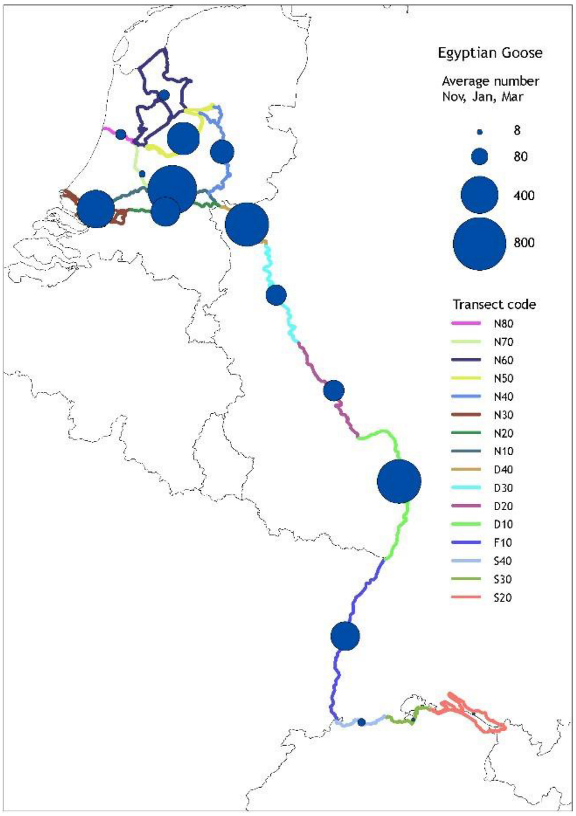


Figure 4.40 *Distribution of Egyptian Goose*

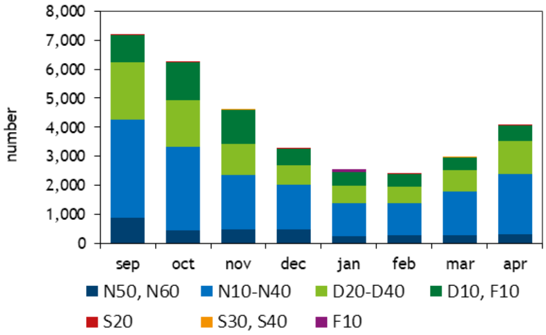


Figure 4.41 *Seasonal pattern of Egyptian Goosep*

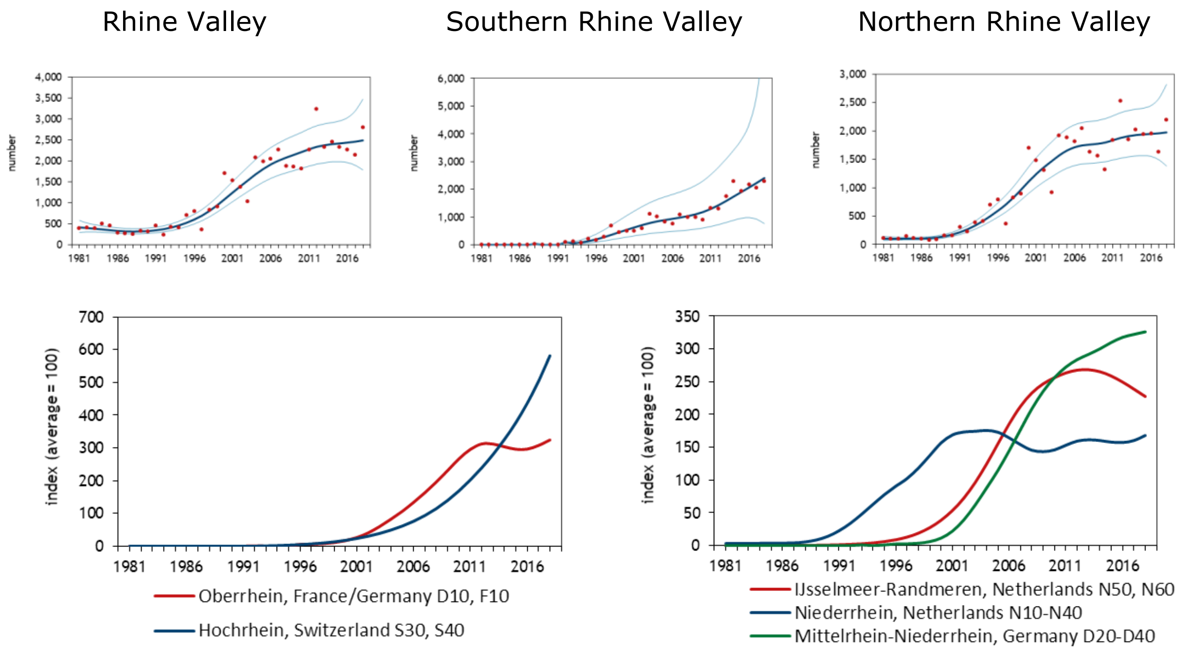


Figure 4.42 *Trends of Egyptian Goose. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.13 Ruddy Shelduck *Tadorna ferruginea*

D: Rostgans; F: Tadorne casarca; NL: Casarca


Photo: Cor Fikkert

Introduction
The Ruddy Shelduck's native breeding distribution stretches from SE-Europe to Central Asia, with scattered occurrence locally in N-Africa. Birds observed in Central and NW-Europe are assumed to have been established from escaped or released birds. Although long distance movements have been recorded from Central Asian breeding sitesthe European population is probably not connected to the wild populations further east (Kleyheeg *et al.* 2020). The German breeding population now consists of over 3,600 individuals (including non-breeders), concentrated along the Niederrhein and in southern Germany (Kleyheeg *et al.* 2020). Contrastingly, the Dutch and Swiss breeding populations consist of only 10-30 (Sovon 2018) and 10-15 pairs (Knaus *et al.* 2015), respectively. Often the birds breed close to waterbodies, but breeding pairs in small villages and other settlements (mainly breeding in buildings) may also wander considerable distances with their brood. Outside the breeding season, these birds move over large distances. Increasing numbers of moulting Ruddy Shelducks, up to almost 2,000 individuals in 2018, are found in June-August in the IJsselmeer area. A second important moulting sites has been found in the Bodensee area (Werner *et al.* 2018) and ringed birds have been reported to switch both moulting sites between years (Kleyheeg *et al.* 2020). Important wintering numbers, amounting up to 1,200 individuals, have been found in Switzerland. These concentrations consist of birds from the entire Rhine Valley and breeding, moulting and wintering populations are closely connected (Kleyheeg *et al.* 2020). Concentrations of Ruddy Shelducks mainly occur in shallow waterbodies, both lakes and side channels of the main river stream. They feed on (submerged) plants and invertebrates.

Status (Distribution, Figure 4.43, Seasonal pattern, Figure 4.44)
During winter, the largest concentrations of Ruddy Shelducks occur at the Bodensee. Smaller concentrations are present along the Hochrhein and the German Niederrhein, with even lower numbers in the floodplains in between. In the Dutch part of the Rhine Valley the species is very scarce in winter.
The seasonal pattern shows a gradual, two-fold increase between September and January, followed by a sharp decline in numbers in February and a further decrease to April (birds dispersing to breeding sites). This general pattern largely reflects the situation in Bodensee and Hochrhein. In the Dutch and German parts, the seasonal pattern is the opposite: here, numbers are highest in autumn (post-moulting concentrations) and lowest in midwinter.
Total numbers account for some 500 Ruddy Shelducks in September, around 1,000 in January and less than 200 in April.

Trends (Figure 4.45)
Winter numbers of Ruddy Shelducks in the Rhine Valley have increased strongly, particularly from 2000 onwards, with on average 19% annually. The winter population grew strongest in the southern part, up to 400 individuals along Hochrhein and to around 1,000 at the Bodensee. In the northern part the increase from 2000 onwards was more modest. It is expected that the numbers in the Rhine Valley will expand and grow further in the near future.

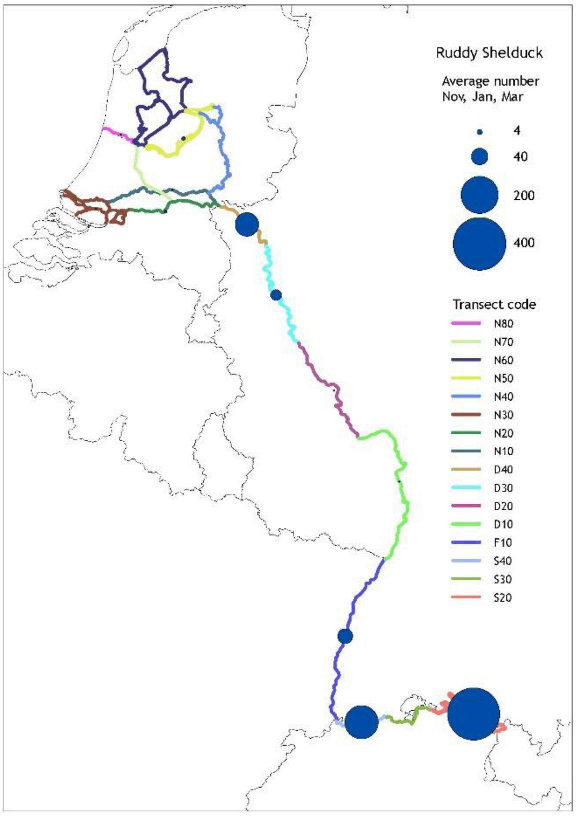


Figure 4.43 *Distribution of Ruddy Shelduck*

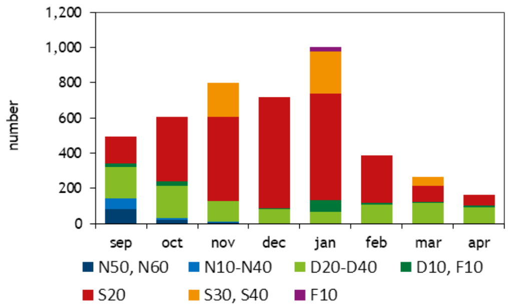


Figure 4.44 *Seasonal pattern of Ruddy Shelduck*

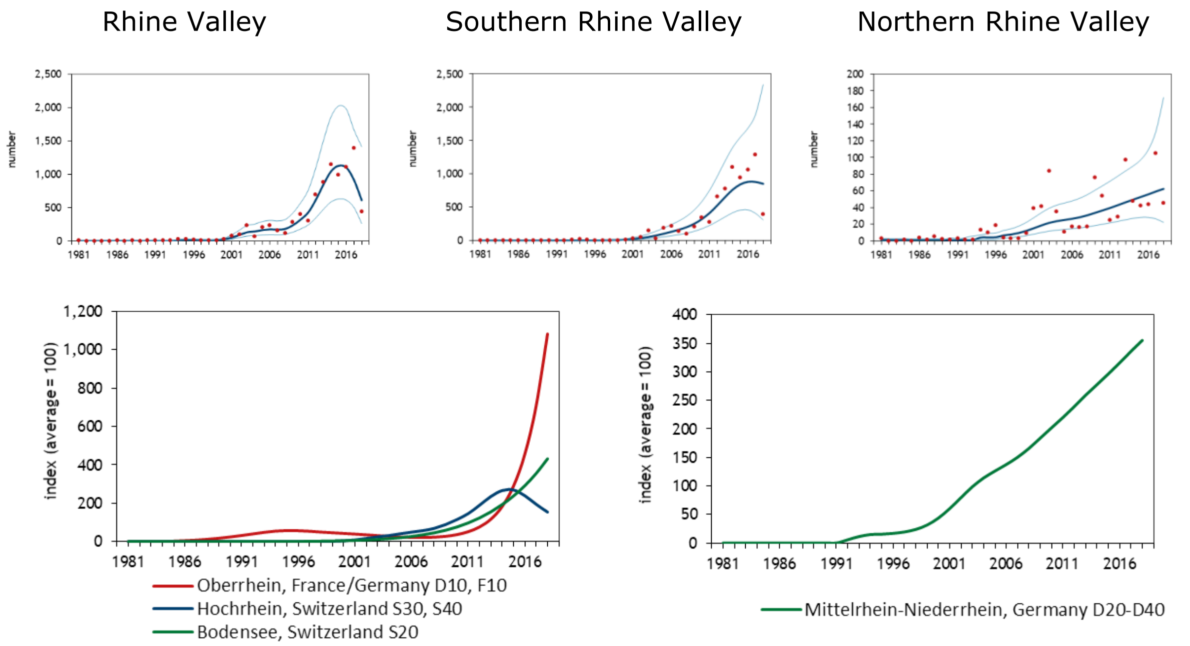


Figure 4.45 *Trends of Ruddy Shelduck. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.14 Eurasian Wigeon *Mareca penelope*

D: Pfeifente; F: Canard siffleur; NL: Smient

Photo: Theo Verstrael

Introduction
Eurasian Wigeons observed in the Rhine Valley during migration or in winter most probably belong to the Northwest-European flyway, breeding in Fennoscandia, Russia and Western Siberia. Its main wintering areas are situated in lowland areas and wetlands along the coasts of the Baltic, North Sea and the Atlantic. Small numbers normally wintering in the Black Sea or Mediterranean may pop up in the Rhine Valley as well, e.g. in Southern Germany. Wintering birds can be faithful to locations but may exchange areas (and perhaps flyways) as well (Bairlein *et al.* 2014, Werner *et al*. 2018, Hornman *et al.* 2020, vogeltrekatlas.nl). In the Rhine Valley, Eurasian Wigeons feed almost exclusively on grassland and, to a much smaller account, on aquatic vegetation in shallow waters. Severe cold spells sometimes trigger large scale movements or even an exodus but were not recorded in recent years. Breeding populations in temperate zones are marginal and in the Rhine Valley comprise only few tens of breeding pairs at most (Gedeon *et al*. 2014, Sovon 2018).

Status (Distribution, Figure 4.46, Seasonal pattern, Figure 4.47)
Distribution in the Rhine Valley is strongly concentrated (at least 90 % of all birds) in the northwest, especially the IJsselmeer area, where numbers of up to 84,000 birds were recorded (January 2017). Here, many Eureasian Wigeons rest on open water in daylight and forage in adjacent grassland polders at night. The Dutch Niederrhein area can hold good numbers as well, but further to the east and south this becomes increasingly uncommon.
Numbers gradually build up towards a peak in January, when on average 100,000 Eurasian Wigeons are counted, which is about 7% of the flyway population. After February, numbers fall sharply but departure may be halted by a cold spell. Massive evening departures of Eurasian Wigeons can be sometimes recorded in the IJsselmeer region (24,700 in 2.3 hours on 7 April 2013 at one counting point, trektellen.nl, sovon.nl).

Trends (Figure 4.48)
Numbers in the Rhine Valley increased up to the turn of the century, coinciding with the overall positive trend of the NW-European population (Delany *et al.* 1999, Fox *et al.* 2015), to fall to a substantial lower level afterwards. This pattern is mainly determined by the large numbers in the northern Rhine Valley (on average +3 %/year since 1981), although regional trends here may differ somewhat in detail (fluctuating numbers in IJsselmeer area vs. recent decreases along rivers, see below). In the southern Rhine Valley, numbers gradually increased throughout the whole period (5 %/year), at Bodensee steeper than in Oberrhein. Total numbers here, however, remained relatively small. The recent decrease in the Rhine Valley cannot be attributed to changing wintering areas, although there is some tendency to winter further north as a result of global warming. The flyway population is thought to decrease, probably because of poor breeding success caused by feeding problems (Fox *et al.* 2015). The influence of excessive mortality caused by hunters or diseases (avian influenza) needs further research. At a smaller scale, regional habitat changes may contribute to declining numbers as well. Renaturation of forelands in The Netherlands were unfavourable for Eurasian Wigeons, as improved grassland was replaced by more natural vegetation (Hornman *et al.* 2019, see Box 3).

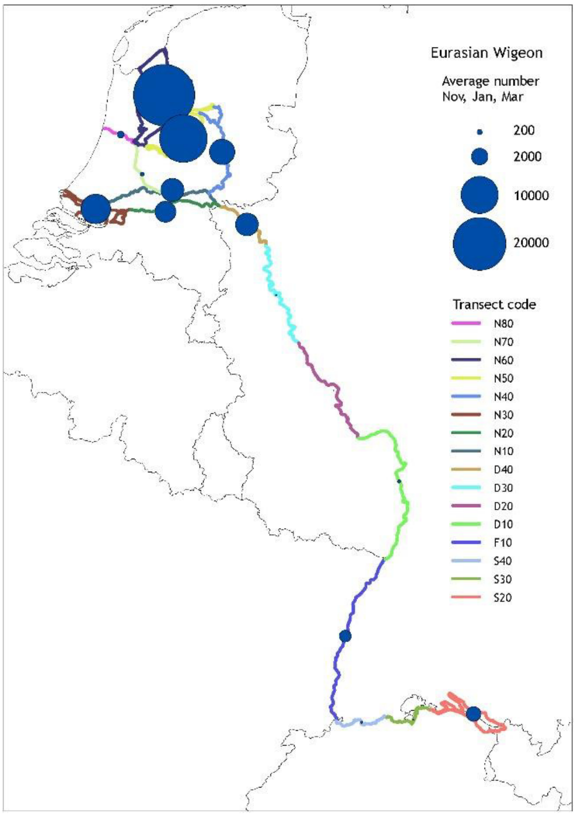


***Figure 4.46** Distribution of Eurasian Wigeons*

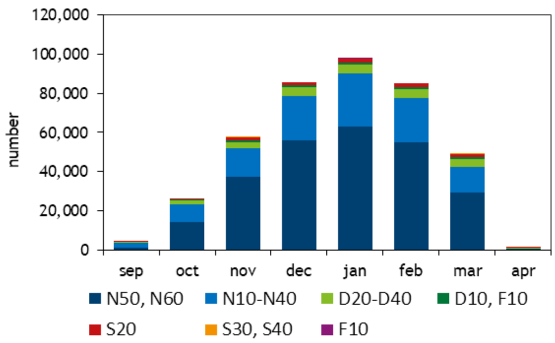


***Figure 4.47** Seasonal pattern of Eurasian Wigeons*

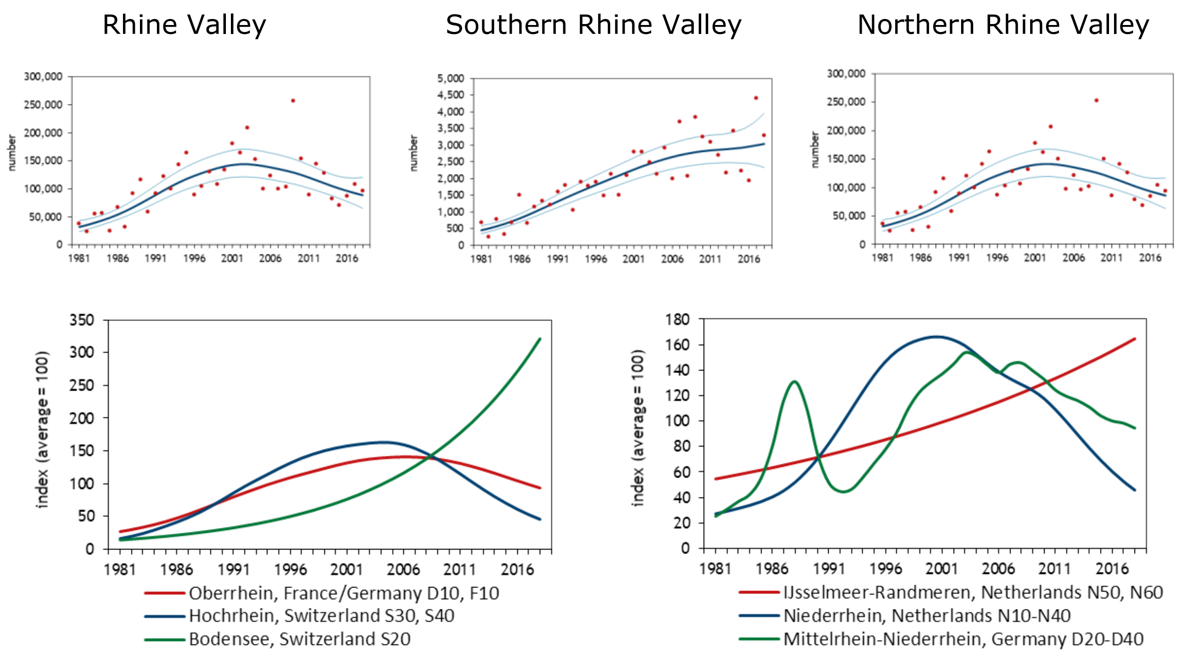


***Figure 4.48** Trends of Eurasian Wigeons. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.15 Gadwall *Anas strepera*

D: Schnatterente, F: Canard chipeau; NL: Krakeend

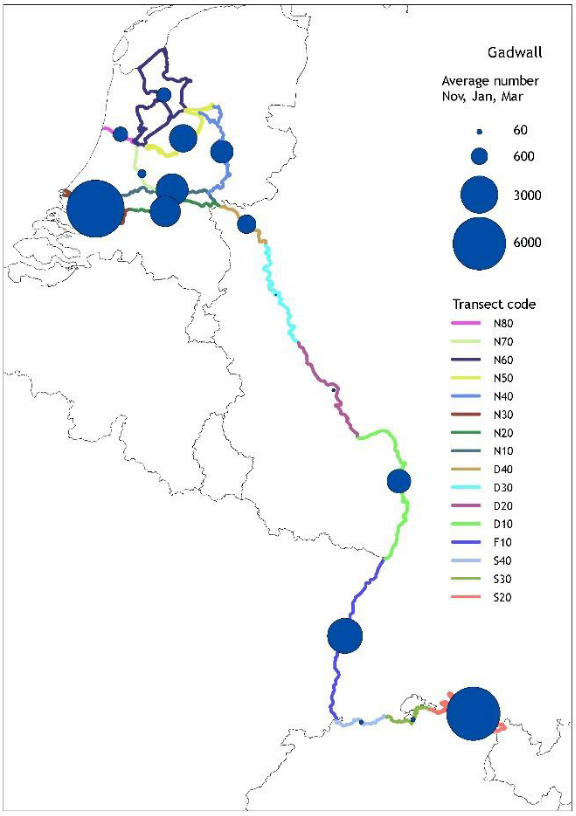
Photo: Marcel van Kammen

Introduction
Gadwalls breed in growing numbers in wetland (and sometimes farmland) habitats all over Western Europe, including the floodplains of the Rhine. Wintering birds prefer the temperate zones where they feed on water plants in shallow and stagnant eutrophic waters. But they occur as well along (artificial) banks of deeper waters, including water reservoirs, canals and docks, where they may feed on macro algae. With these feeding habits, they are less vulnerable to freezing conditions than some other dabbling ducks. Breeding Gadwalls in the Rhine Valley are probably partly residents, the migrants leaving for the United Kingdom and France (northern Rhine Valley) or Southeast-France and Italy (southern Rhine Valley). There is a suggestion that Gadwalls in the northern Rhine Valley belong to the Northwest-European flyway population and birds in the southern valley to the Central European/Black Sea/Mediterranean flyway population (Scott & Rose 1996, Koffijberg *et al.* 2001, Bairlein *et al.* 2014).

Status (Distribution, Figure 4.49, Seasonal pattern, Figure 4.50)
The species is well-distributed in the Rhine Valley, with major concentrations in the Bodensee area as well as the Niederrhein area in The Netherlands (notably the Rijnmond area around Rotterdam. In general, large numbers are already present in (late summer and) autumn. These are mostly a result of moult concentrations, arising in June and locally comprising several 1000s of birds. Despite migration to other wintering areas of part of the birds after completing primary moult, total numbers remain high well into winter. They fall sharply after February when dispersal to breeding areas starts.
This pattern experiences some regional differences, with for instance emphasis on autumn/early winter in the IJsselmeer area versus more stable numbers throughout autumn and winter in the Dutch/German Niederrhein area and a slight midwinter emphasis on Oberrhein and Bodensee. Winter weather may somewhat influence seasonal occurrence, with partial migration or redistribution of birds during cold spells, but in recent years seriously cold weather was rarely recorded. Water tables can have impact on numbers as well, as demonstrated by differences in January occurrence at the Bodensee featuring high water levels (and high numbers of Gadwalls) vs. lower levels (and correspondingly low numbers) (Strebel 2018, Werner *et al.* 2018).
Total numbers accumulate to a mean of 30,000 Gadwalls in October-January, decreasing to about 5,000 in April (1 % threshold of international flyway population is 1,200 birds for NW European population and 1,900 birds for Central/Mediterranean population).

Trends (Figure 4.51)
Numbers in the Rhine Valley have strongly increased, almost tenfold, since the early 1980s (mean annual growth 6 %/year). There is a marked difference, however, between the northern parts showing ongoing increases and the southern parts, where numbers roughly stabilised in 1995-2010. Recent numbers here vary from decreasing tendencies (Oberrhein, Hochrhein) to increases (Mittelrhein) or fluctuations (Bodensee, partly in response to varying water levels; Werner *et al.* 2018).
The general increase is in line with the growth of the breeding population in Western Europe and the flyway population. Factors involved may be higher survival due to diminished hunting and better feeding opportunities through slight euthrophication of stagnant waters. Wintering Gadwalls may have benefited from the absence of truly

severe winters since the mid-1990s and there is a suggestion that they generally winter more northerly nowadays than some decades earlier (Hornman *et al*. 2018).



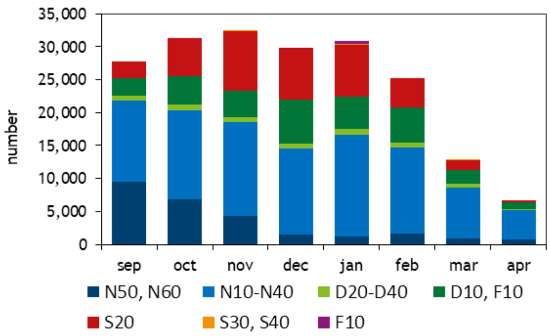


Figure 4.49 *Distribution of Gadwall*

Figure 4.50 *Seasonal pattern of Gadwall*

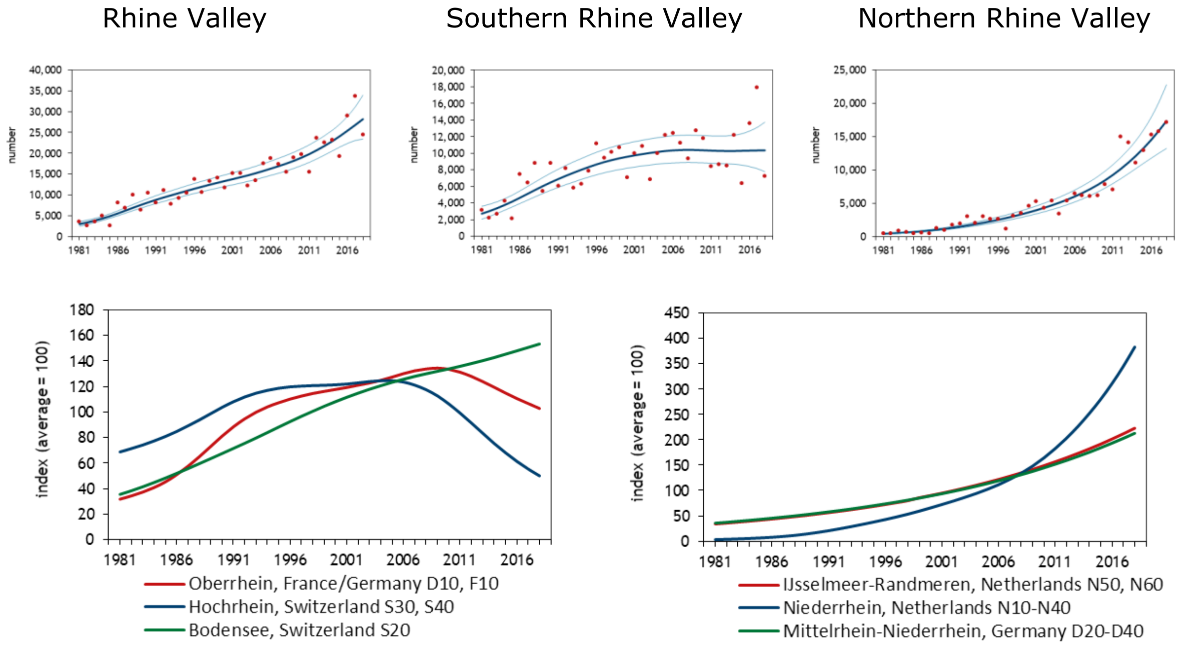


Figure 4.51 *Trends of Gadwall. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.16 Eurasian Teal *Anas crecca*

D: Krickente, F: Sarcelle d'hiver; NL: Wintertaling

Introduction
The European breeding distribution of the Eurasian Teal is mainly restricted to the northern half, the bulk nesting in the Nordic countries and Russia. Numbers in the Rhine Valley, mainly situated in the northern parts, are low and decreasing (Gedeon *et al*. 2014, Sovon 2018). Eurasian Teals winter in the temperate zones of Europe, in coastal waters as well as inland, and feed mainly on plant seeds and small invertebrates in shallow waters. Wintering birds in the Rhine Valley will be mostly of North-eastern European origin (including Russia) and may belong to the NW European flyway as well as the Central/Mediterranean flyway population. Birds wintering normally in the northern parts may travel as well to the United Kingdom and Western France, those in the south to the Mediterranean, e.g. Camargue (Koffijberg *et al.* 2001, Bairlein *et al.* 2014).

Status (Distribution, Figure 4.52, Seasonal pattern, Figure 4.53)
The distribution within the Rhine Valley shows resemblance to that of Gadwall, with major concentrations in the far south (Bodensee) as well north (Southwest-Netherlands). Total numbers peak in December-January, in some areas more pronounced (Bodensee) than in others (Dutch/German Niederrhein, IJsselmeer).
Occurrence at a local or regional level is influenced by water levels, low levels being generally more favourable than high levels (for Bodensee: Werner *et al*. 2018). Winter weather is of importance as well, as severe cold spells may lead to cold rushes, especially along the Dutch/German Niederrhein. Temporally available feeding bonanzas often attract large numbers of this highly mobile species, e.g. in the period discussed up 10,000 birds in some areas (early renaturation stages) in the west of The Netherlands (van Eerden 1997, Hornman *et al.* 2018).
At peak moments an average 20,000 Eurasian Teals are present in the Rhine Valley (1% threshold of international flyway population is 5,000 birds for NW European population and 10,000 birds for Central European/Mediterranean population).

Trends (Figure 4.54)
Total numbers fluctuate strongly, being lowest during rows of severe ice-winters in the mid-1980s and 1990s. The absence of such truly severe winter weather since 1997 initially did not result in an obvious growth of the wintering population. In recent years, however, numbers tend to increase, but this is partly due to a few boost years along the Dutch Niederrhein (Hornman *et al*. 2020). In the southern Rhine Valley, numbers keep on fluctuating, sometimes *in extremis* (Bodensee), or tend to decrease (Oberrhein, Mittelrhein).
Regarding the complete period discussed (1981-2018) numbers in the Rhine Valley increased by on average 1%/year. But as stated before, this is the result of strong annual fluctuations, caused by the species' preference for feeding in shallow water and changing water levels throughout the seasons and the years.

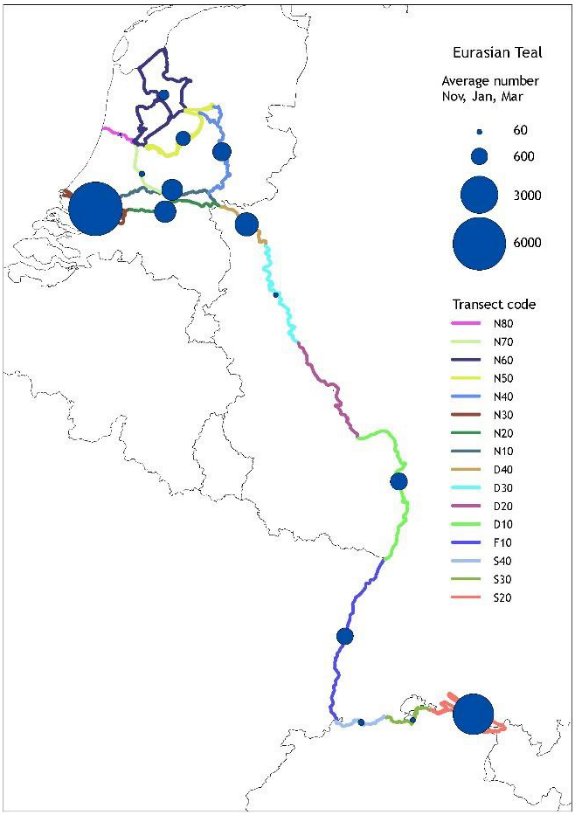


Figure 4.52 *Distribution of Eurasian Teal*

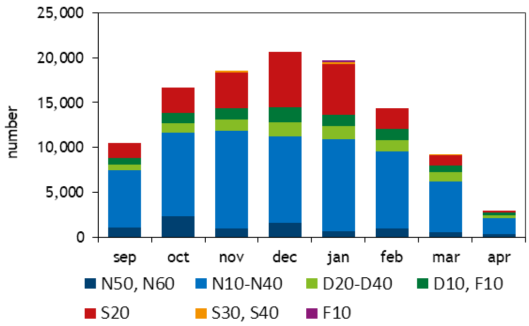


Figure 4.53 *Seasonal pattern of Eurasian Teal*

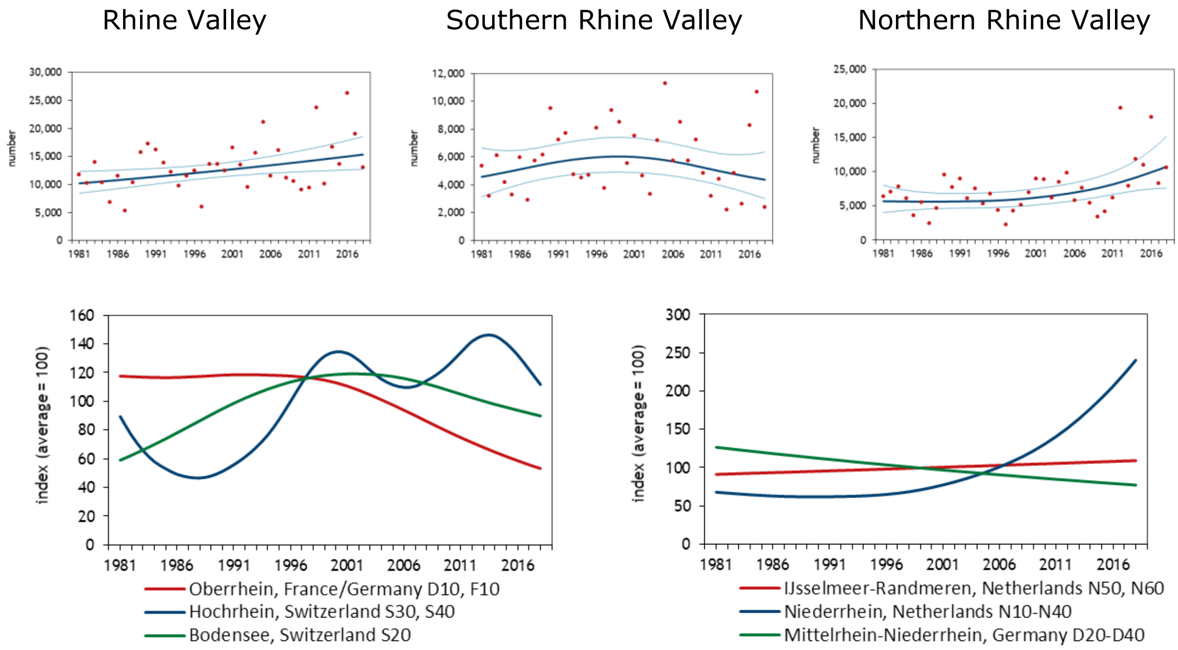


***Figure 4.54** Trends of Eurasian Teal. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.17 Mallard *Anas platyrhynchos*

D: Stockente; F: Canard colvert; NL: Wilde Eend

Introduction
The Mallard is a common breeding bird all over Europe, including the Rhine Valley. Although most pairs prefer wet conditions, breeding far away from standing water is not uncommon. Breeding numbers tend to decline in some countries, most notably in The Netherlands, holding a large population. It is thought that decreasing survival of ducklings may be a key factor in this (Schekkerman *et al.* 2018). Also the German breeding population shows a long-term decline (Gerlach *et al.* 2019).
Wintering Mallards occupy a variety of habitats, from major wetlands to farmland or urban areas. In the Rhine Valley they will comprise local birds, being residents, as well as migrants from northern and eastern origin (Bairlein *et al*. 2014). Telemetric studies have revealed that some males follow their partner to breeding grounds in Russia, only to return to moulting areas in the Rhine Valley (Bodensee) already in July (Werner *et al.* 2018).

Status (Distribution, Figure 4.55, Seasonal pattern, Figure 4.56)
Mallards occur in fairly high numbers all over the Rhine Valley. Compared to most other waterbirds, concentrations are quite evenly distributed, reflecting the broad habitat preferences of the species. The seasonal pattern of occurrence shows a strong emphasis on the midwinter period, with strongly falling numbers shortly afterwards. Regional variation on this theme is limited and a clear response to unusually mild or more severe winter weather is lacking. In truly severe winters, however, some redistribution of wintering birds may occur, with for instance an influx into urban or non-freezing areas. In January, on average some 80,000 Mallards are counted in the Rhine Valley (1% threshold of international flyway population is 53,000 birds for NW European population and 14,000 birds for Central European/Mediterranean population).

Trends (Figure 4.57)
In general, numbers have severely diminished, by perhaps 75% or more since the early 1980s (on average -4%/year). There are no signs of a recovery, although the rate of the decrease has slowed down in recent years. Little regional variation is recorded, although numbers at e.g. Bodensee developed less negatively than for instance those along the Dutch Niederrhein The Netherlands, along Oberrhein and Mittelrhein.
The decrease was in some areas well under way at the start of our data series (Westermann 2015), in others it started later, for instance at the end of the 1990s in The Netherlands (Hornman *et al.* 2018). It can be partly attributed to local breeding populations (The Netherlands and Germany, see above), but not always (the rather small Swiss breeding population increases whereas Scandinavian breeding populations are thought to be stable; Strebel 2019, Dalby 2013). Hence, a decline in wintering numbers in the Rhine Valley may also be partly the result of short-stopping of Nordic breeding birds, in response to warmer winters, as is the case in several other species (Lehikoinen *et al*. 2013, 2016). The strong increase in Swedish wintering numbers between the 1980s and the 2000s also fits in this hypothesis (Haas & Nilsson 2017). However, other findings in the Nordic countries are somewhat contradictory (Gunnarsson *et al.* 2012, Dalby 2013). Other factors involved may be hunting and recreational pressure, changing farming practices (more efficient harvesting methods on arable land) and renaturation projects in the forelands (and correspondingly unfavourable vegetation succession, although the earliest stages may temporarily provide good habitat; Hornman *et al.* 2019, see Box 3).

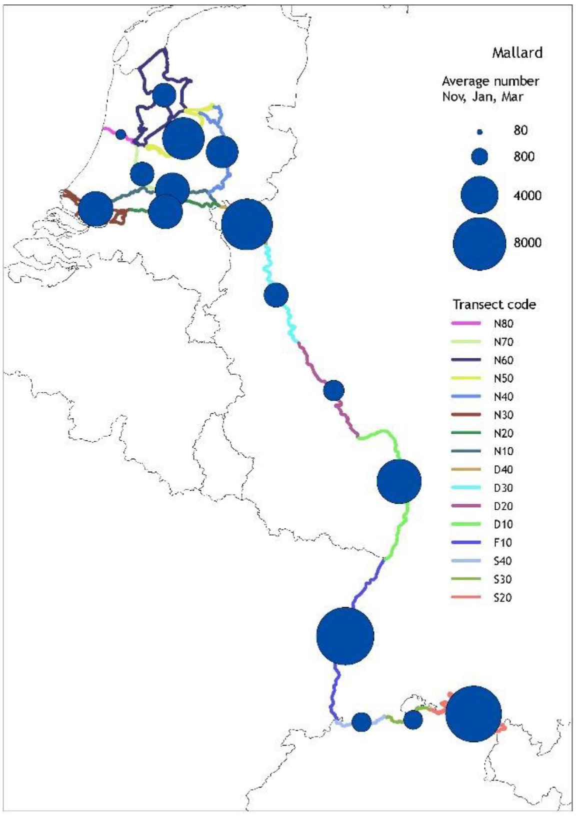


Figure 4.55 *Distribution of Mallard*

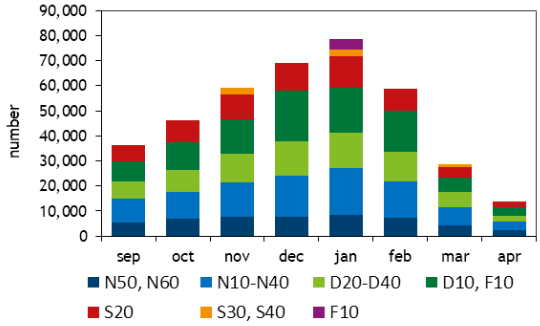


Figure 4.56 *Seasonal pattern of Mallard*

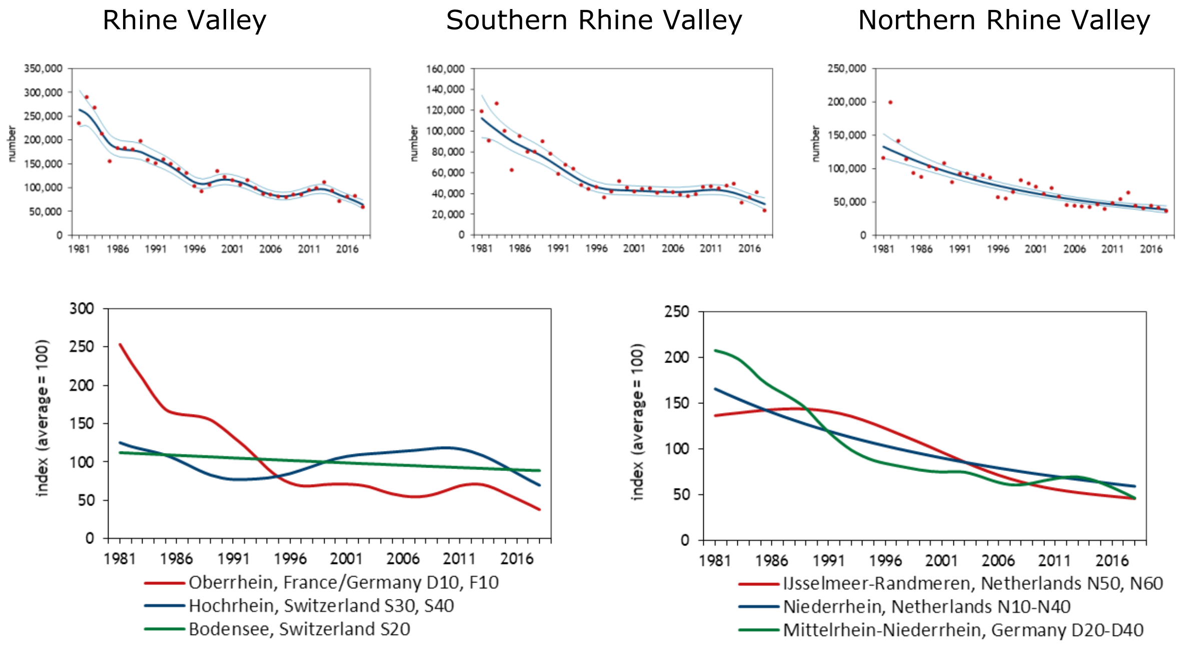


***Figure 4.57** Trends of Mallard. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.18 Northern Pintail *Anas acuta*

D: Spießente; F: Canard pilet; NL: Pijlstaart

Photo: Harvey van Diek

Introduction
The majority of the breeding population of Northern Pintails making use of Western Europe and the Rhine Valley is situated in Northeast-Europe (incl. Russia) and Western Siberia. In Western and Central Europe, it is a scarce or rare breeding bird. The main wintering areas are situated in Sub-Saharan Africa, but substantial numbers remain in Western Europe and the Mediterranean, especially along coasts with saltmarshes. Birds mainly feed in shallow waters for plant seeds but may use farmland (harvested arable fields) sometimes as well. Wintering birds in the Rhine Valley likely originate from Northeastern Europe, Russia and Western Siberia.

Status (Distribution, Figure 4.58, Seasonal pattern, Figure 4.59)
Along the Rhine, relatively low numbers winter or stop-over during migration, when compared to coastal areas like the international Wadden Sea area and the British estuaries. Total numbers in the Rhine Valley reach maximum levels in November-February, firmly concentrated in the Dutch parts (Randmeren and Rijnmond area) and, perhaps somewhat surprising (because far inland), Bodensee, especially Ermatinger Becken. The Netherlands hold 50-60% of all Northern Pintails in autumn and winter, this share increasing to more than 75% in spring when inundated forelands may offer good feeding opportunities for spring migrants.
At peak moments an average 2,500 Northern Pintails are counted in the Rhine Valley (1% threshold of international flyway population is 600 birds).

Trends (Figure 4.60)
Total numbers fluctuated until 2000, partly due to winter weather, with an exodus under harsh circumstances like in winters 1985-87 and 1997 (especially in Dutch/German Niederrhein area; Koffijberg *et al.* 2001). Recent winters were generally mild, although migration counts suggest some movements in colder periods, e.g. in January 2017 (Hornman *et al.* 2019). Since the turn of the century, numbers gradually increased in the main regions for this species. In areas of less importance, trends sometimes differed, e.g. along Mittelrhein and the German part of the Niederrhein (decreasing tendency) and Oberrhein (recovery after initial decrease). Compared to the situation in the 1990s, the emphasis on migration periods is less pronounced nowadays (for Bodensee: Werner *et al*. 2018, for Netherlands: Hornman *et al.* 2018).
Over the whole 1981-2018 period, numbers in the Rhine Valley showed a moderate increase by on average 3%/year, being more pronounced in the southern Rhine Valley (5%) than in the northern Rhine Valley (+1%). The increase, especially in recent years, finds a parallel in some core areas elsewhere, e.g. the Dutch Wadden Sea where numbers have grown substantially in winter, perhaps partly because of large-scale redistribution of wintering birds (Hornman *et al*. 2018, Sovon 2018).

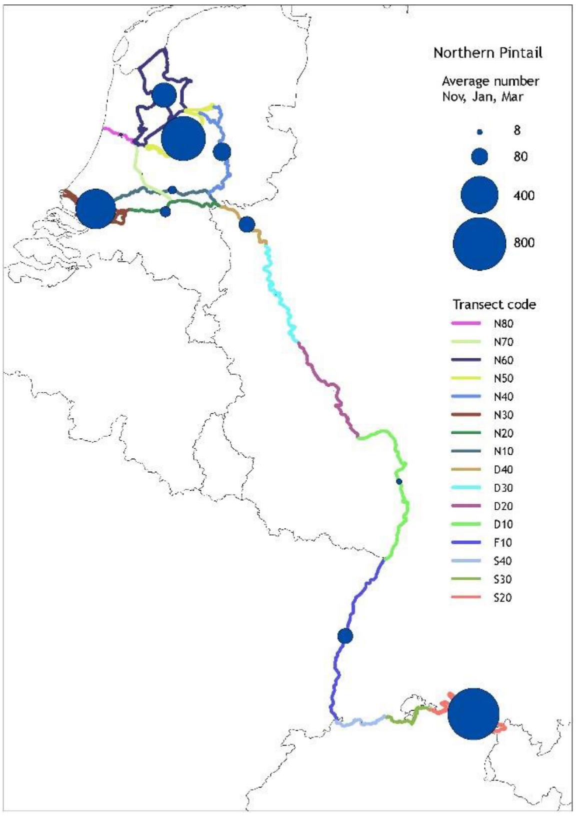


Figure 4.58 *Distribution of Northern Pintail*

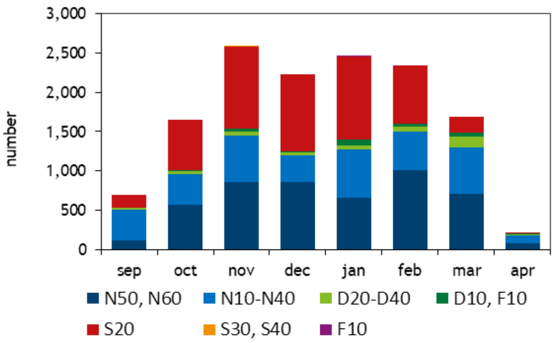


Figure 4.59 *Seasonal pattern of Northern Pintail*

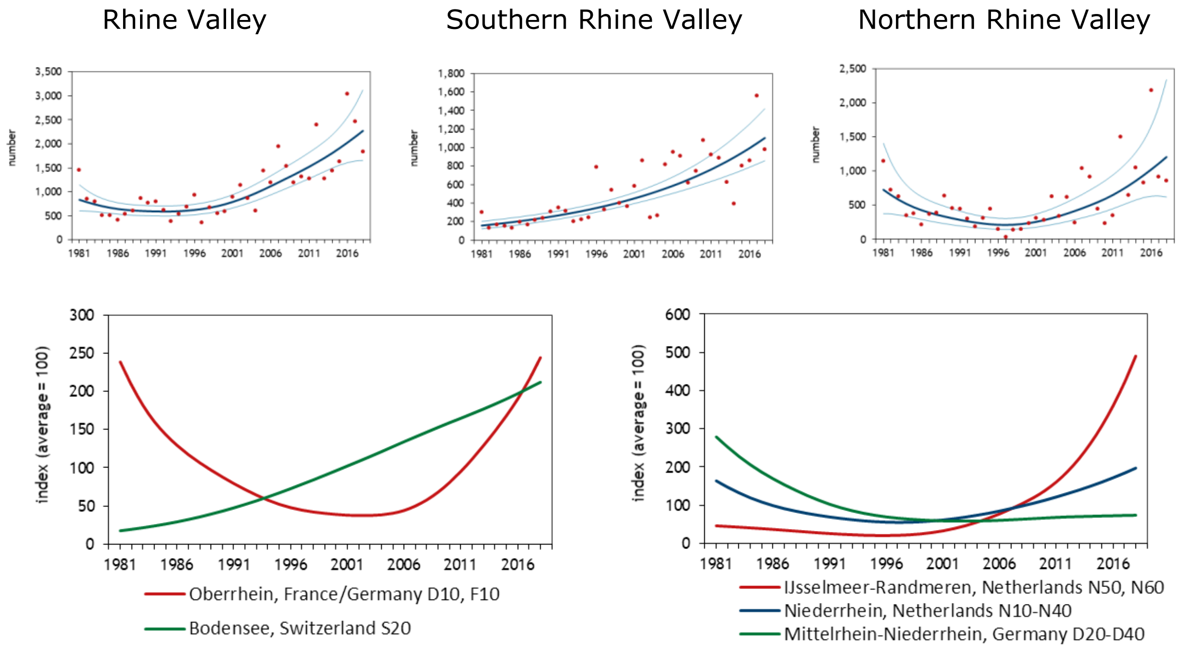


Figure 4.60 *Trends of Northern Pintail. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.19 Northern Shoveler *Anas clypeata*

D: Löffelente; F: Canard souchet; NL: Slobeend

Introduction
The European breeding population of Northern Shovelers is mainly concentrated in damp areas in the eastern part, although fairly high numbers breed in the Low Countries as well. In the Rhine Valley breeding is almost restricted to the Dutch parts and neighbouring German areas, where numbers probably decrease. Outside the breeding season, the birds exploit shallow freshwaters with abundant zooplankton biomass. The majority of Northern Shovelers winter in the Mediterranean and in North and West Africa, but substantial and growing numbers remain in Western Europe. Migrants and wintering birds in the Rhine Valley probably have a northeastern origin.

Status (Distribution, Figure 4.61, Seasonal pattern, Figure 4.62)
The distribution is focused on the Bodensee, some Dutch river branches (especially Lek and Waal) and adjacent parts of the German Niederrhein. Highest numbers are reported in October-November, winter numbers are at least 35% lower. Peak counts in the northern Rhine Valley are recorded somewhat earlier (September-October) than in the southern Rhine Valley (October-November), but show relationship to water levels as well: high water tables usually result in lower numbers than lower tables (like observed in Eurasian Teal). An obvious spring migration peak is lacking in most areas, but in inundated forelands along the Dutch/German Niederrhein relatively high numbers may occasionally be recorded with suitable water levels. Within this general pattern, some regional variation is noticed, with emphasis for instance on autumn (IJsselmeer) vs. autumn/winter (Bodensee).
At peak moments in autumn on average some 6,000 Northern Shovelers may be present (1 % threshold of international Northwest European flyway population is 650 birds).

Trends (Figure 4.63)
Winter numbers are highly regulated by weather circumstances, as freezing conditions may force Northern Shovelers to leave some areas. This partly explains the marked fluctuations until 2000, a period with several severe ice-winters. More recently, total numbers tend to increase, especially since 2010. This boost is, however, not commonplace, as recent numbers in e.g. IJsselmeer/Randmeren did not increase, contrasting with pronounced increases along the German/Dutch Niedererhein and in the Bodensee. In the Dutch section of the Niederrhein, the species may have benefited from expansion of suitable feeding consitions, as a result of renaturation projects (see also Box 3).
Considering the whole period 1981-2018, numbers in the Rhine Valley showed a moderate increase by on average 2 %/year, more pronounced in the northern part (+4 %/year) than in the southern part (1 %/year). Improved feeding conditions, as well as an increase in wintering birds due to warmer winters may have influenced this trend.

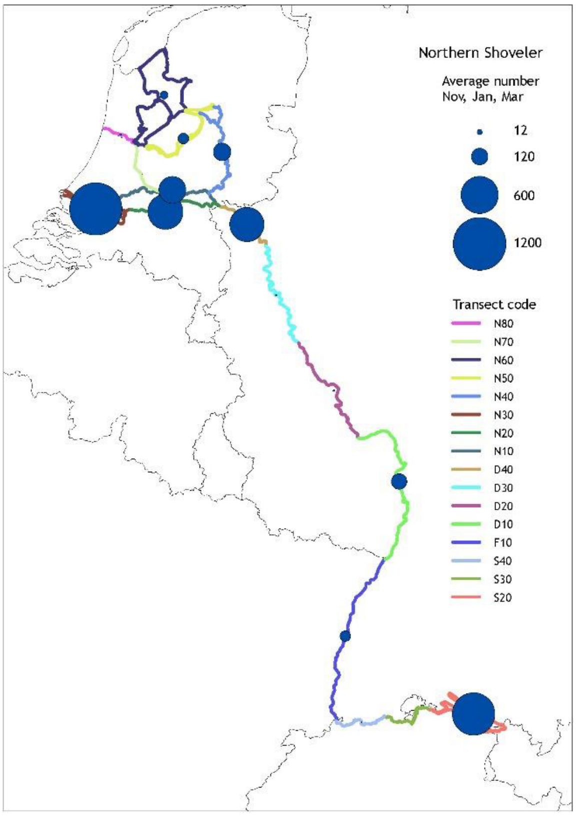


Figure 4.61 *Distribution of Northern Shoveler*

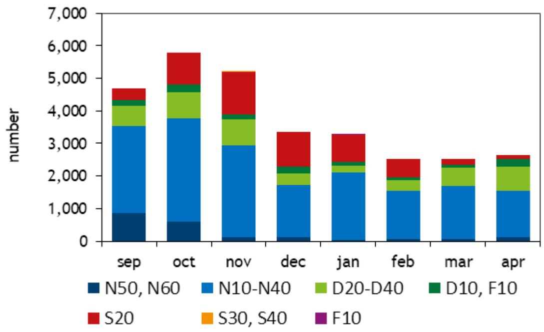


Figure 4.62 *Seasonal pattern of Northern Shoveler*

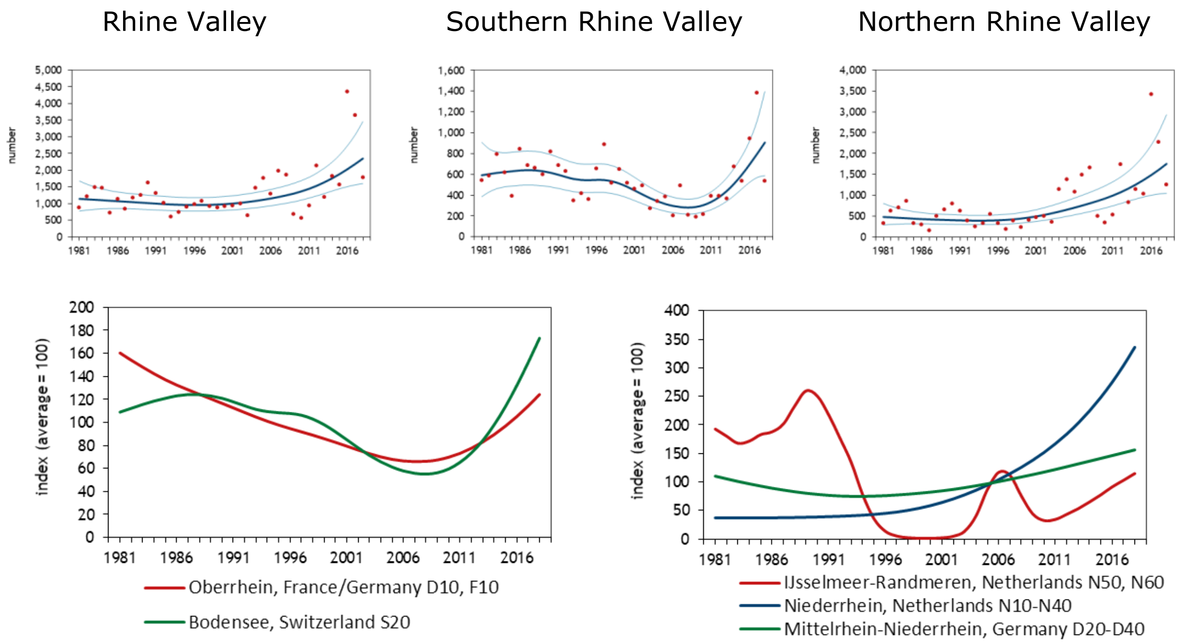


Figure 4.63 *Trends of Northern Shoveler. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.20 Red-crested Pochard *Netta rufina*

D: Kolbenente; F: Nette rousse; NL: Krooneend

Photo: Harvey van Diek

Introduction

The population in the Rhine Valley belongs to the South-west & Central European/West Mediterranean flyway. The species breeds in several hundred pairs in the Rhine Valley, mainly concentrated around Bodensee (Werner *et al.* 2018) and the Dutch part of the Niederrhein (Sovon 2018). The most important part of the flyway population breeds in Spain and southern France. After the breeding season, a major part of the individuals breeding in south-western Europe migrates northeast to moult and winter on lakes at the northern edge of the Alps, among them Bodensee (Keller 2000, 2006, Köhler *et al.* 2009). There, wintering numbers are thus much higher compared to the local breeding population. These birds are attracted by the vast areas of submerged macrophytes (mainly *Characeae*) (Schmieder *et al.* 2006, Werner *et al.* 2018).

Status (Distribution, Figure 4.64, Seasonal pattern, Figure 4.65)

Bodensee hosts by far the largest share of the staging and wintering population of Red-crested Pochard in the Rhine Valley (>95%). Wintering numbers currently vary from 10,000 to 20,000 individuals. These numbers are surprisingly constant for the species, as it typically shows a nomadic behaviour with large flocks shifting between lakes within short time (Keller 2000). The south-west European flyway population is estimated to consist of 50,000-60,000 individuals, thus a share of roughly 25 % of this flyway population winters at the Bodensee. Hence, this area is of outstanding importance for the species. Traditionally, birds gathered during moult in late summer and autumn only and left the area completely towards mid-winter. Nowadays, the species is present in constantly high numbers between September and February (Werner *et al.* 2018). The major share of the staging and wintering population on Bodensee is often concentrated on one or two large flocks, either in areas with extensive beds of macrophytes, or, due to human disturbances, far from the shore in the middle of the lake (Werner *et al.* 2018). In much lower numbers, the species is found on Hochrhein, Oberrhein and Niederrhein, where it mainly occurs in the surroundings of its breeding areas.

Trends (Figure 4.66)

Wintering numbers of Red-crested Pochard have steeply increased in the Rhine Valley. This is due to a combination of several factors. While during the 20th century, the lake was mainly used in autumn as staging and moulting area, the birds now stay longer, what results in constantly high numbers between September and February (Werner *et al*. 2018), thus also recorded in winter counts. This development happened in parallel with the de-eutrophication and the resulting re-colonisation of the lake by charophytes in the 1990s (Schmieder 1998), and a coinciding period of drought in Spain (Keller 2000). During the same period and for the same reasons, wintering numbers also increased at other lakes at the northern edge of the Alps (Lecocq 1997, Wahl *et al.* 2014, Strebel 2018). Furthermore, the establishment of hunting-free zones at Bodensee, Lac Neuchâtel and other Swiss lakes in the 1990s allowed the birds to exploit the rich food resources without being disturbed. Subsequently, the entire flyway population showed a strong positive development with wintering numbers that roughly tripled between 1990 and 2015. In the northern part of the Rhine Valley, wintering numbers have also increased, most likely due to the increase of the local, sedentary breeding population (Dirksen & van der Winden 1996).

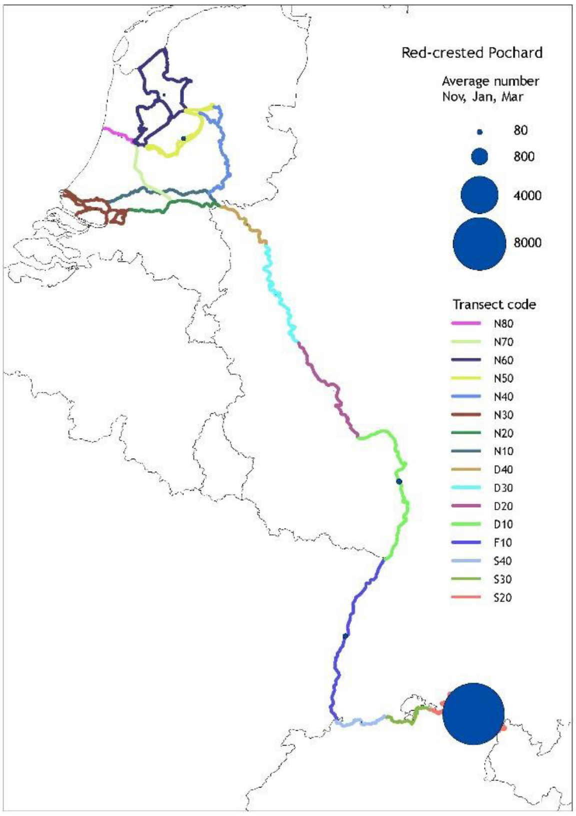


Figure 4.64 *Distribution of Red-crested Pochard*

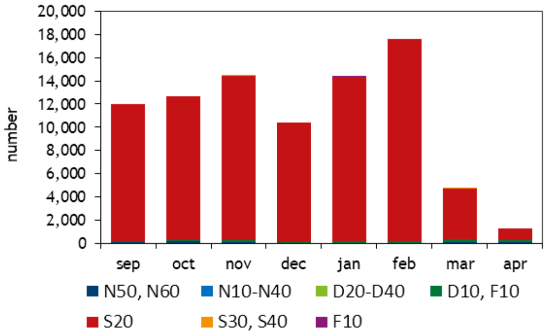


Figure 4.65 *Seasonal pattern of Red-crested Pochard*

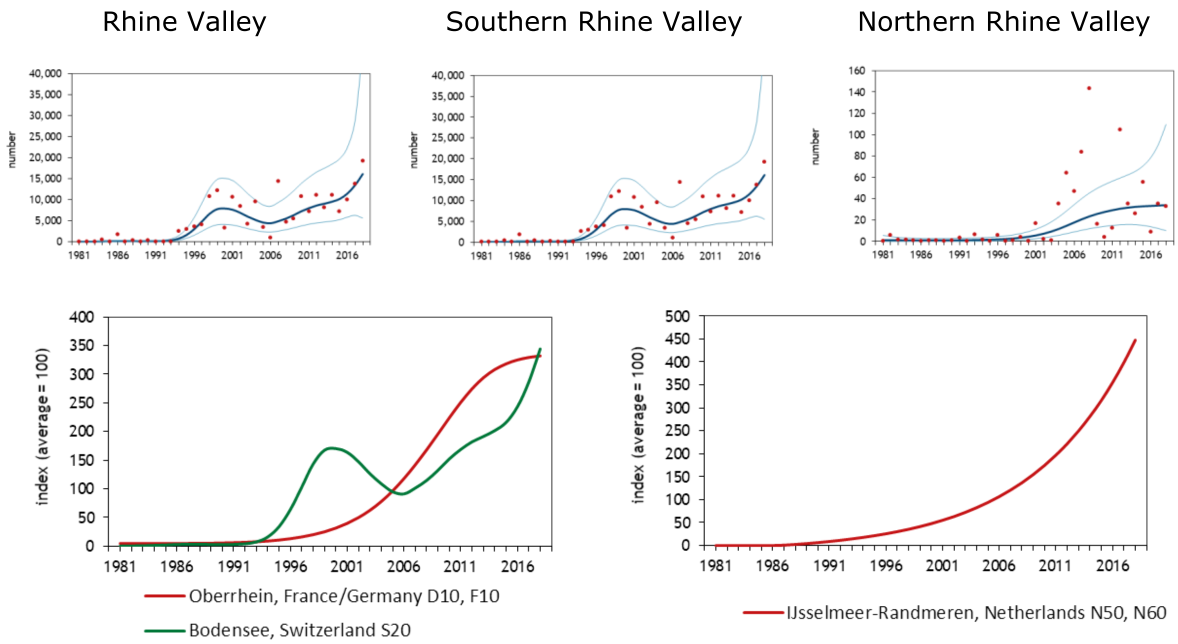


Figure 4.66 *Trends of Red-crested Pochard. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.21 Common Pochard *Aythya ferina*

D: Tafelente; F: Fuligule milouin; NL: Tafeleend

Photo: Harvey van Diek

Introduction
Common Pochards are originally breeding birds of steppe lakes, their main distribution range stretching from Central and Eastern Europe to the east. After a westward range expansion during the 20th century, breeding populations are also present in NW-Europe. In the Rhine Valley the species breeds in rather low densities in floodplains with marshland and open water. Outside the breeding season, Common Pochard is one of the important water birds in the Rhine Valley. In this period of year, it is concentrated in large water bodies, where it feeds primarily on mussels, various other invertebrates (gammarids etc.) and also on submerged aquatic vegetation (notably at Randmeren and Bodensee, Werner *et al.* 2018). The species' winter distribution is concentrated in NW- and Central-Europe, as well as the Mediterranean. Within the Rhine system two flyway-populations occur in winter: The Black Sea / Central Europe / Mediterranean flyway population in the south and the Northwest-European population in the north. However, flyway boundaries are not clear (Scott & Rose 1996).

Status (Distribution, Figure 4.67, Seasonal pattern, Figure 4.68)
The midwinter distribution of Common Pochard shows three large concentrations within the Rhine Valley: largest numbers at the Bodensee, smaller numbers at IJsselmeer and Randmeren. These sections all exceed 1% threshold levels. The species is nowadays relatively scarce along the river stretches of Hochrhein, Oberrhein and Niederrhein, likely because feeding opportunities are limited compared to the other areas. The seasonal pattern shows little regional variation. At Bodensee, numbers are highest between October and February (peaking in November and December), while at IJsselmeer and Randmeren numbers are twice as high in October-December compared to January-February. Total numbers account for some 80,000 Common Pochards in January.

Trends (Figure 4.69)
Winter numbers of Common Pochards have more than halved in the Rhine Valley since 1981. The population decline was strongest in the 1980s; from 2000 onwards, numbers have stabilized. There is a marked difference between the northern and southern part. In the northern Rhine Valley, the numbers have declined continuously since 1981, with on average 5 % per year, both before and after 2000. The decrease was particularly strong in the Niederrhein and Mittelrhein sections, with (almost) 10 % decline annually since the early 1980s. In IJsselmeer/Randmeren however, year-to-year fluctuations are large, and an apparent long-term decline is not statistically significant. In the southern Rhine Valley, numbers declined sharply in the Oberrhein and Hochrhein sections, comparable to Niederrhein. This contrasts with the remarkable increase in numbers at Bodensee, which occurred mostly before 2000 (+5 % annually). These opposite trends result in an overall moderate decrease in the southern Rhine Valley in 1981-2018, and stable numbers since 2000. The decline of Common Pochard in the Rhine Valley reflects the decline of the European Flyway population. The reasons are not well understood, and are possibly a result of desiccation, eutrophication and vegetation succession of breeding habitat in the eastern part of the breeding range, in combination with increased predation (Viksne *et al.* 2010, Fox *et al.* 2016). Besides, various drivers are operating at site-level. The long-term increase of wintering numbers at Bodensee is caused by an improvement of local food conditions, a result of improved water quality and subsequent increase in aquatic vegetation (Werner *et al.* 2018), that probably attracted birds from Hochrhein and

Oberrhein (Koffijberg *et al.* 2001). Also in the Randmeren successful measures to decrease phosphate loads have led to a recovery of submerged macrophytes and mussel (e.g. *Dreissena*) stocks in the mid-1990s, Common Pochards following soon afterwards (Noordhuis *et al.* 2009). These were probably attracted from the adjacent IJsselmeer and Niederrhein, where foraging conditions simultaneously deteriorated (decreased abundance and food quality of *Dreissena* mussels, Noordhuis 2010). After 2005, trends in IJsselmeer and Randmeren reversed again, but declines along the Niederrhein continued. It is not clear to what extent the tendency towards milder winters is also affecting the flyway and Rhine population trends (van den Bremer *et al.* 2015).

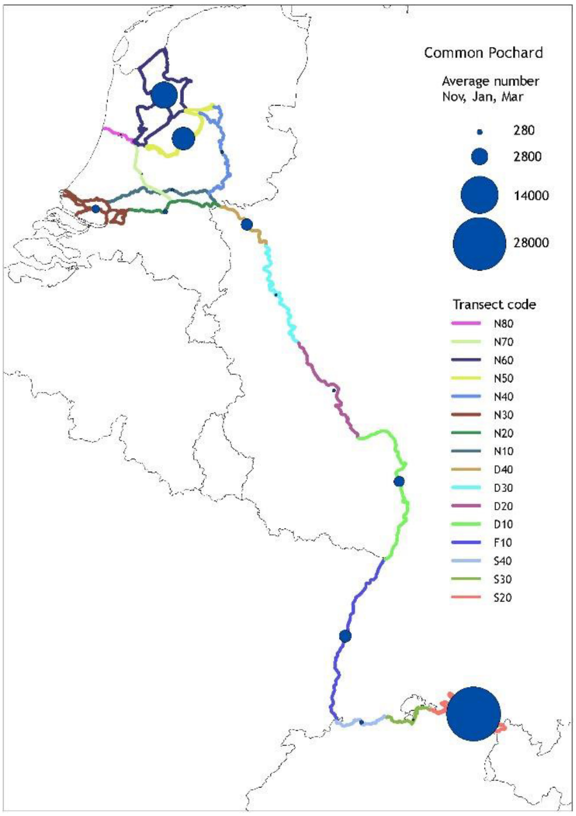


Figure 4.67 *Distribution of Common Pochard*

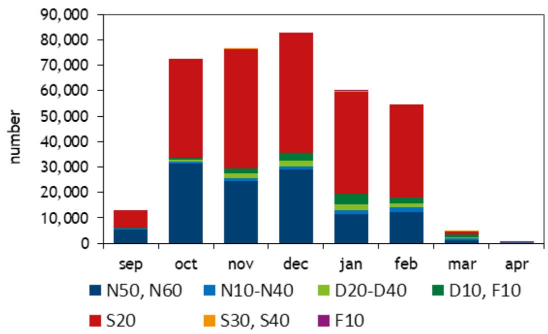


Figure 4.68 *Seasonal pattern of Common Pochard*

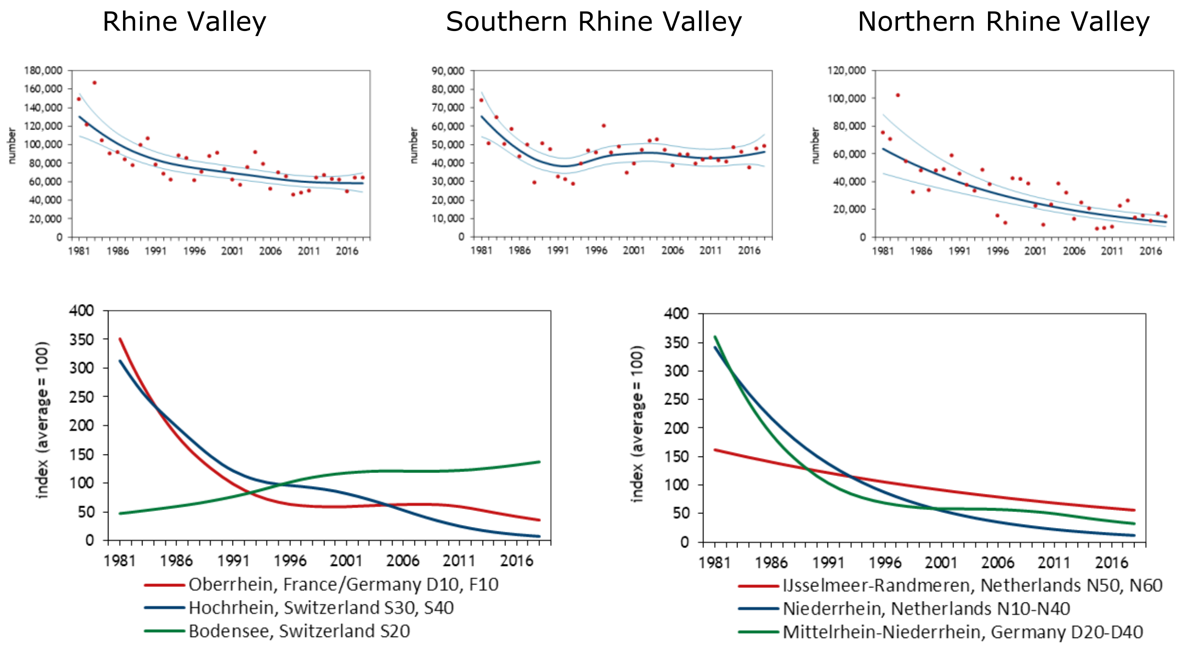


Figure 4.69 *Trends of Common Pochard. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.22 Tufted Duck *Aythya fuligula*

D: Reiherente; F: Fuligule morillon; NL: Kuifeend

Photo: Harvey van Diek

Introduction
The breeding distribution of Tufted Duck stretches from NW-Europe to Asia. In the Rhine Valley the species breeds in floodplains with marshland and open water, locally in rather high densities. Outside the breeding season, Tufted Duck is the most numerous waterbird in the Rhine Valley. In this period of the year, it is concentrated in large waterbodies, where it feeds on mussels and other invertebrates. The species' winter distribution is concentrated in NW- and Central-Europe. Within the Rhine system two flyway-populations occur in winter: The Black Sea / Central Europe / Mediterranean flyway population in the south and the Northwest-European population in the north. However, as in Common Pochard, boundaries of flyways are unclear and probably not strict (Scott & Rose 1996).

Status (Distribution, Figure 4.70, Seasonal pattern, Figure 4.71)
The midwinter distribution of Tufted Duck within the Rhine Valley is concentrated at the Bodensee, IJsselmeer and Randmeren. This resembles the situation of Common Pochard, although numbers of Tufted Ducks in other sections of the Rhine Valley are relatively higher, such as Oberrhein, Niederrhein and Rijnmond. The latter area is probably mainly used as daytime refuge for birds feeding at night in nearby Haringvliet and Hollands Diep estuaries (Koffijberg *et al.* 2001). All sections mentioned above amply exceed 1% threshold levels.
The seasonal pattern shows gradually increasing numbers from September to December, and then decreasing numbers again until April. Within the Rhine Valley, little regional variation exists. At IJsselmeer and Randmeren numbers peak in December, at Bodensee and Niederrhein in January, and along Oberrhein in February.
Total numbers account for some 150,000 Tufted Ducks in January, and over 160,000 in December.

Trends (Figure 4.72)
Winter numbers of Tufted Ducks have decreased with around 25 % in the Rhine Valley since 1981. Although the decline seems quite continuous over the entire study period, it was not statistically significant in the first half of the study period (1981-2000), probably due to large annual fluctuations in the 1980s. The northern and southern parts of the Rhine Valley show similar rates of overall decline but is more pronounced in the south after 2000. This is caused by sharp recent decreases in Hochrhein (-10% per year) and to a lesser extent Oberrhein (-4 %). At Bodensee numbers have been more or less stable since 2000, after an apparent increase in 1981-2000. In the northern Rhine Valley, the decrease is most apparent in the German sections of Niederrhein and Mittelrhein. In the Netherlands, year-to-year fluctuations are large, particularly in IJsselmeer and Randmeren, as a result of which no significant trend emerges.
At site level, Tufted Ducks have been confronted with the same local drivers regarding eutrophication and subsequent oligotrophication (which affected their food situation, e.g. lower abundance and food quality of *Dreissena* mussels at IJsselmeer) as described for Common Pochard, including shifts of populations between adjacent sections (e.g. IJsselmeer and Randmeren; Noordhuis *et al.* 2014). On top of that, a north-eastward shift of the gravity of the entire wintering range along the Northwest-European flyway during the past three decades has been demonstrated, a result of warming winter temperatures (Lehikoinen *et al.* 2013). Tufted Ducks thus show a tendency of spending the winter north of the Rhine Valley, contributing to the overall decline.

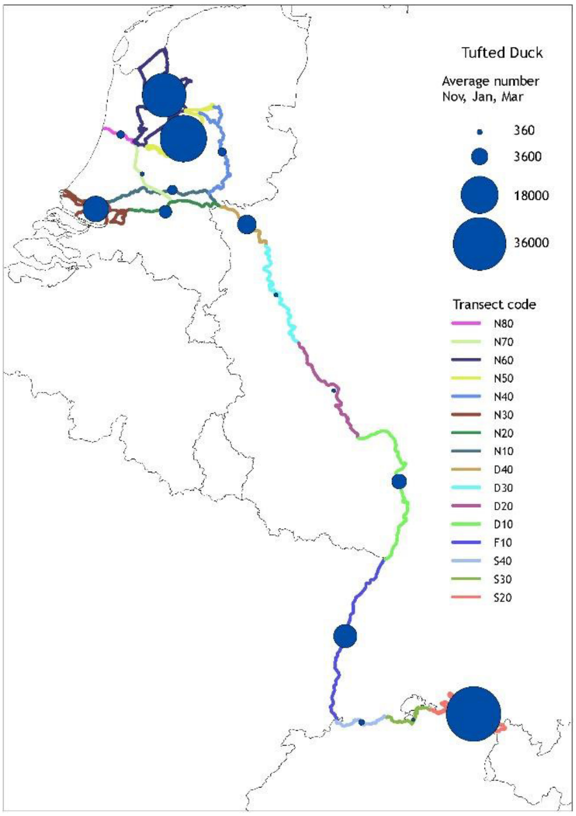


Figure 4.70 *Distribution of Tufted Duck*

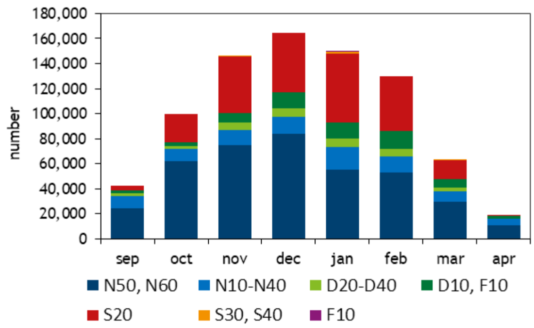


Figure 4.71 *Seasonal pattern of Tufted Duck*

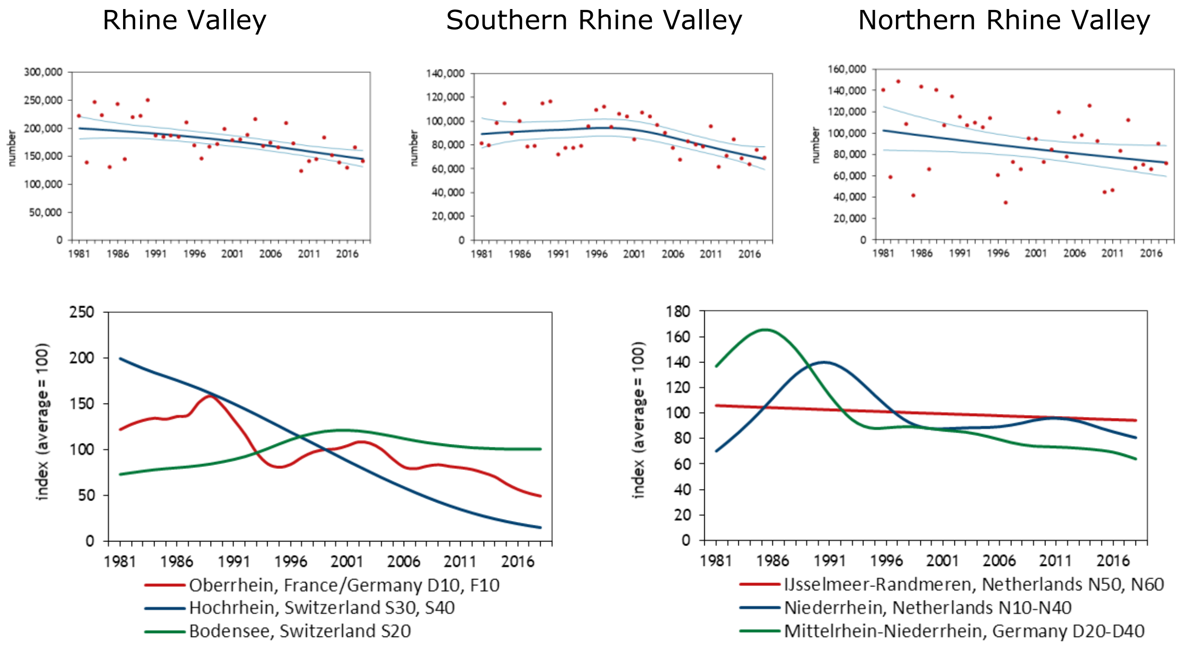


Figure 4.72 *Trends of Tufted Duck. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.23 Common Goldeneye *Bucephala clangula*

D: Schellente; F: Garrot à l'oeil d'or; NL: Brilduiker

Introduction
Common Goldeneyes breed from NW-Europe to the east, with large populations in Fenno-Scandinavia and Russia. In the Rhine Valley the species is a rare breeding bird of small waters covered with reeds or bushes, close to trees with suitable nest holes (or nestboxes). The Northwest-European flyway population winters primarily in the Baltic Sea. Smaller numbers winter in the North Sea area and inland, including deeper water reservoirs in the Rhine Valley. Here, they feed on invertebrates and plant material. The Rhine Valley represents more or less the southern border of the core wintering range.

Status (Distribution, Figure 4.73, Seasonal pattern, Figure 4.74)
The largest concentrations of wintering Common Goldeneyes within the Rhine Valley occur at the Bodensee. Smaller concentrations are present at IJsselmeer, followed by Rijnmond, Randmeren and, upstream, Oberrhein. In the remaining sections of Niederrhein and Mittelrhein Goldeneyes are rather scarce winter visitors. None of the sections mentioned above reach 1% flyway threshold levels in recent years.
The seasonal pattern shows increasing numbers from November to February, after which numbers drop in March. At IJsselmeer and Randmeren numbers peak in February and are even higher in March than in December-January. In the other parts of the Rhine Valley highest numbers are present earlier during the season, and peak in both January and February, with lower numbers in December. Total numbers account for some 8,000 Common Goldeneyes in February, and almost 7,000 in January.

Trends (Figure 4.75)
Winter numbers of Common Goldeneyes have decreased with around 40% in the Rhine Valley since 1981. This decline is only apparent after 2000; numbers even slightly increased in the first half of the study period. Moreover, trends differ strongly between the northern (stable numbers) and southern (decline) parts of the Rhine Valley. In the north, numbers show strong year-to-year fluctuations at IJsselmeer / Randmeren, without a clear trend. In the Dutch part of the Niederrhein, where smaller numbers of Goldeneyes winter, increases occur on both the long and short term, whereas in the German sections of Niederrhein and Mittelrhein an initial increase was followed by a recent decrease. In the south, numbers are declining in all sections after 2000, strongest in Hochrhein (low numbers) and Bodensee (previously high numbers). At Bodensee, the populations have more than halved during the second half of the study period. In 1981-2000, numbers were increasing in all sections of the southern Rhine Valley.
Local increases in Common Goldeneye numbers are caused by improvement of water quality and invertebrate food abundance, e.g. in Rijnmond, Randmeren and parts of IJsselmeer (Heunks *et al.* 2016, Sovon 2018). The decreasing numbers at Bodensee might be partially caused by human disturbance and adverse changes in food abundance (native invertebrates depredated by exotic crustacean species; Werner *et al.* 2018). These local effects are overruled however by changes in the winter distribution at the flyway level. Goldeneyes have shifted their main winter distribution to the north-east during the past three decades, as a response to climate warming (Lehikoinen *et al.* 2013). This has become especially apparent in the southern part of the Rhine Valley since 2000.

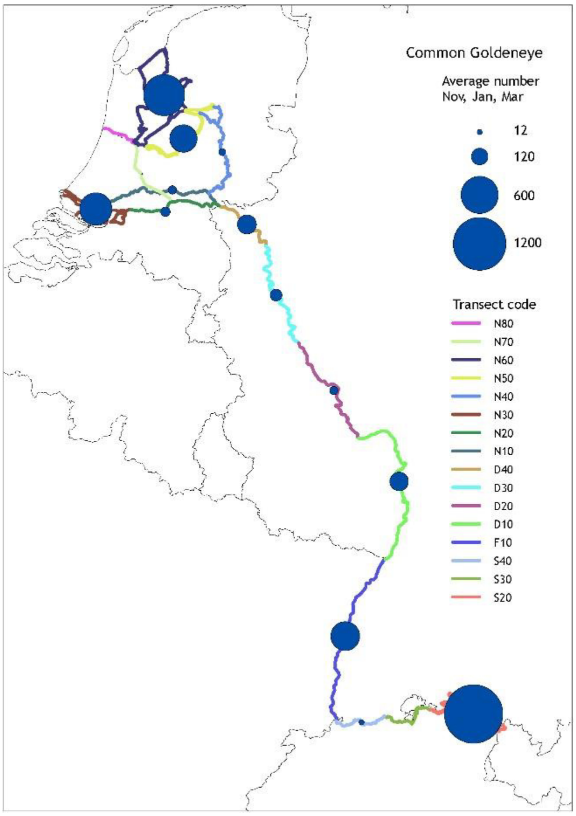


Figure 4.73 *Distribution of Common Goldeneye*

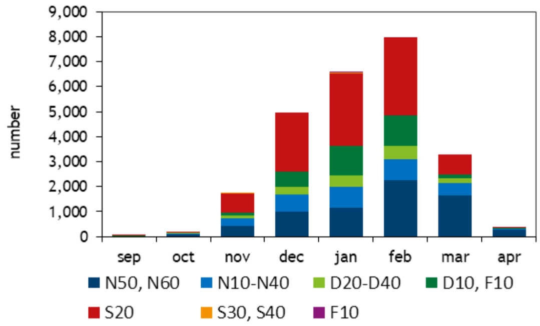


Figure 4.74 *Seasonal pattern of Common Goldeneye*

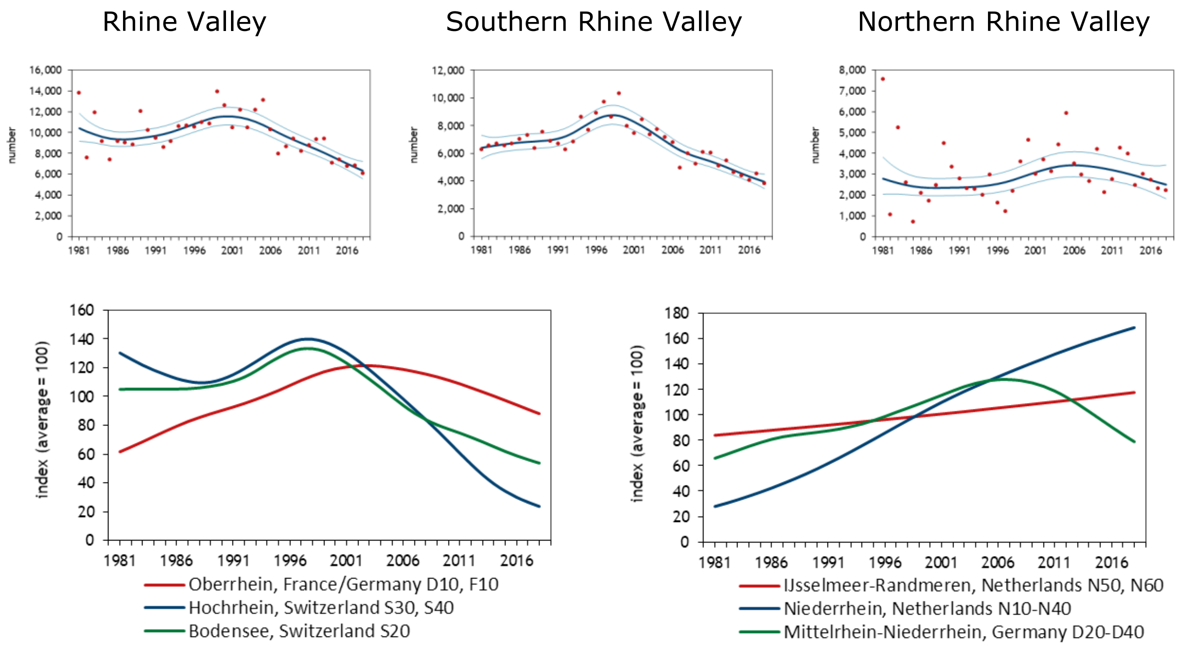


Figure 4.75 *Trends of Common Goldeneyes. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.24 Smew *Mergellus albellus*

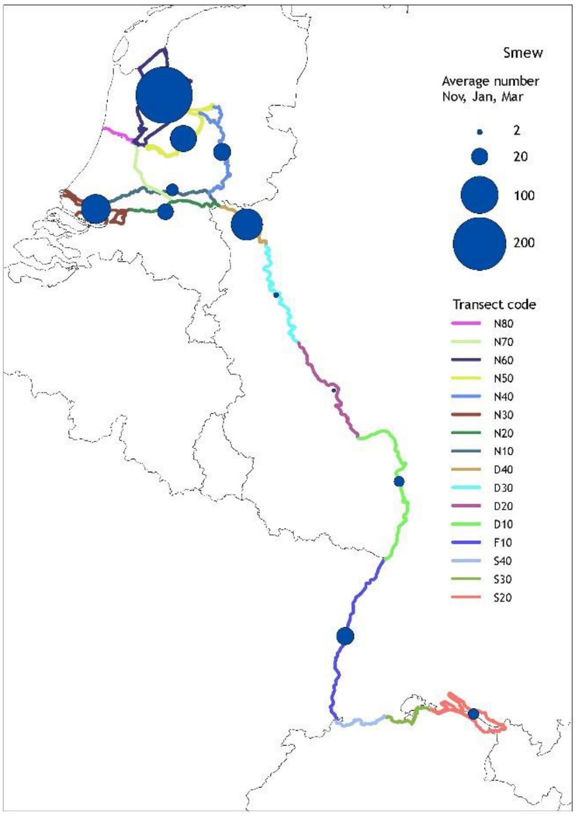
D: Zwergsäger; F: Harle piette; NL: Nonnetje

Photo: Cor Fikkert

Introduction
The boreal breeding distribution of Smew stretches from Fenno-Scandinavia to Eastern Siberia, where they breed in forested areas with lakes. A large part of the Northwest-European flyway population winters in the Baltic Sea. Smaller numbers winter in NW-Europe, including the northern part of the Rhine Valley. Particularly in severe winters, when large parts of the Baltic Sea freeze, more birds spend the winter towards the southern edge of their distribution range (Schröder 2015). Here, Smews prefer relatively large and deep waters, such as lakes and reservoirs, where they feed on fish.

Status (Distribution, Figure 4.76, Seasonal pattern, Figure 4.77)
The largest concentrations of wintering Smews within the Rhine Valley occur at IJsselmeer. Smaller concentrations are present along the Niederrhein, particularly the last stretch in Germany and Rijnmond and Randmeren in The Netherlands. Only numbers at IJsselmeer regularly exceed the 1% flyway threshold levels in recent years. In the southern Rhine Valley Smews are rather scarce winter visitors.
The seasonal pattern resembles that of Common Goldeneye and shows increasing numbers from November to February, after which they strongly decline in March (onset of spring migration). At IJsselmeer and Randmeren numbers strongly peak in February, being two times higher than in January. In the other parts of the Niederrhein Smews occur in more stable numbers between December and February. Total numbers account for over 1,600 Smews in February, and around 1,000 in January.

Trends (Figure 4.78)
Winter numbers of Smews have roughly halved in the Rhine Valley since 1981. This trend is not statistically significant however (only the long-trend sub-trend for the Dutch part of the Niederrhein is), which is mainly due to large annual fluctuations. Particularly in the first half of the study period, numbers in some years were very high. These events coincide with extensive and prolonged ice coverage in the Baltic Sea (Noordhuis 2010). The cold winters of January 1986 and 1996 brought exceptionally high numbers of around 9,000 and 8,000 Smews respectively to IJsselmeer/Randmeren alone. The much lower numbers in the German, French and Swiss parts of the Rhine Valley show no tendency to overall decline at all. Along the Oberrhein Smew numbers even seem to increase.
In the past decades, the Smew’s wintering distribution shifted north-eastwards in Europe as a result of global warming. Numbers increased in the north-eastern region, whereas declines predominated in the central region (Pavón-Jordán *et al*. 2005). This distribution shift is probably the main cause of the decrease in the Rhine Valley. A large proportion of the wintering population nowadays remains unprotected outside of the existing Special Protected Area network in north-eastern areas (Pavón-Jordán *et al*. 2005).
In addition, also local factors have caused changes in numbers. Intensive fisheries and oligotrophication led to shrinking fish stocks in IJsselmeer in the 1990s (for Smews particularly European Smelt *Osmerus eperlanus*). Simultaneously, a decrease in transparency of the water layer made the remaining fish harder to catch (Noordhuis 2010). Only part of the winter population moved to other parts of the Rhine Valley (Niederrhein in cold winters, Randmeren) and smaller inland waters (Sovon 2018).



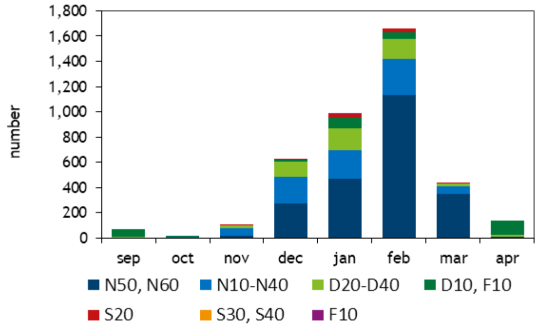


Figure 4.76 *Distribution of Smew*

Figure 4.77 *Seasonal pattern of Smew*

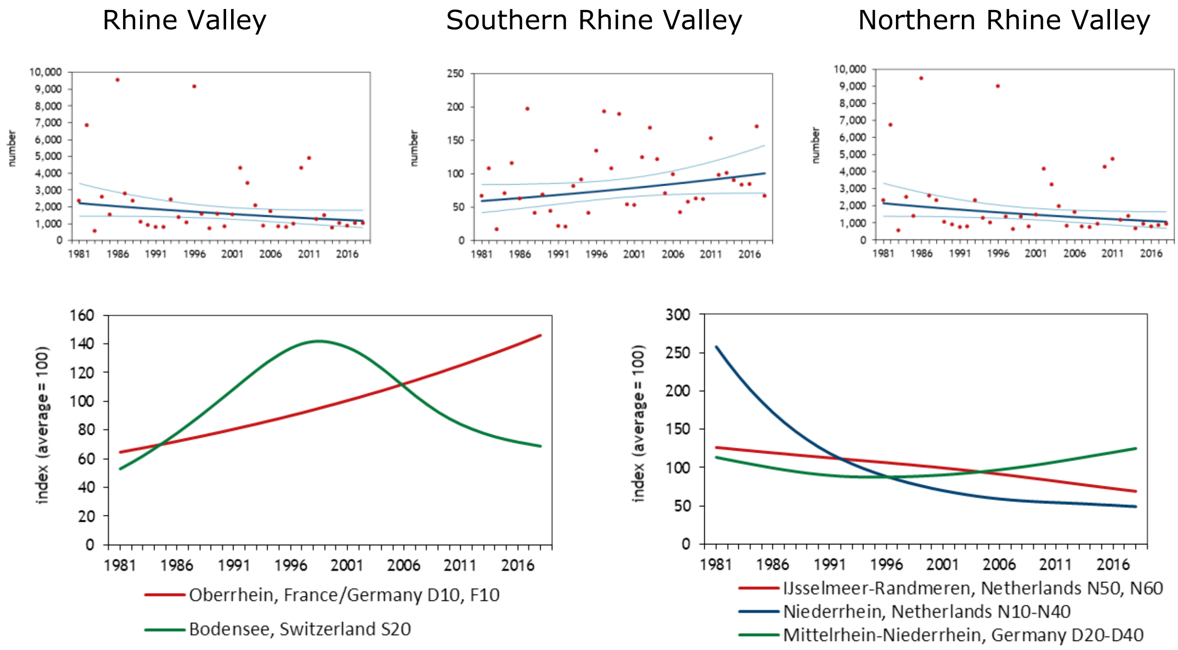


Figure 4.78 *Trends of Smew. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.25 Common Merganser *Mergus merganser*

D: Gänsesäger; F: Harle bièvre; NL: Grote Zaagbek


Photo: Cor Fikkert

Introduction
Breeding Common Mergansers are distributed over large parts of northern Europe, Russia and North America. Besides, a geographically separate population that differs genetically from the northern European, breeds in the Alpine region (Hefti-Gautschi *et al.* 2009. About half of this population breeds on large Swiss lakes and rivers. Here, its range is expanding towards the northeast, colonizing the Rhine Valley both downstream and upstream (Keller 2009). Since 1994 Common Mergansers breed at Bodensee (10 pairs recently, Werner *et al.* 2018). In winter, major wintering areas of the Northwest-European flyway population are situated in the Baltic. Like Smew, Common Merganser typically shows influxes in NW- and Central-Europe during prolonged cold spells in the Baltic region (Schröder 2015). In such cases, a large proportion of the population may also be found in the Rhine Valley. Here, the species prefers relatively large waters, such as lakes and reservoirs, where they feed on fish.

Status (Distribution, Figure 4.79, Seasonal pattern, Figure 4.80)
The largest concentrations of wintering Common Mergansers within the Rhine Valley occur at IJsselmeer. Smaller concentrations are present along the Oberrhein and at the Bodensee, both in the southern Rhine Valley. The species winters in rather small numbers in all other sections of the Rhine. Only at IJsselmeer the 1% flyway threshold is regularly exceeded.
The seasonal pattern shows increasing numbers from November to February, after which numbers drop in March. Only at Bodensee the species is also present in substantial numbers in other months of the year (breeding and moulting birds). At IJsselmeer and Randmeren numbers peak in February, in Oberrhein, Mittelrhein and Niederrhein in both January and February. At the Bodensee Common Mergansers occur in more stable numbers between November and February. Total numbers account for some 7,000 birds in February, and over 6,000 in January.

Trends (Figure 4.81)
Winter numbers of Common Mergansers have decreased with around 30% in the Rhine Valley since 1981. This decline is only apparent before 2000; numbers stabilized in the second half of the study period. Moreover, trends differ strongly between the northern and southern parts of the Rhine Valley after 2000: rather stable numbers versus an increase of on average 6 % per year, respectively.
In The Netherlands, the trends at IJsselmeer / Randmeren and Niederrhein large reflect the situation of the northern Rhine Valley described above: decrease followed by stabilization. The trends in the German parts of Niederrhein and Mittelrhein however, where relatively small numbers are present, more resemble the situation in the southern Rhine Valley: decrease followed by increase. This recent increase is especially strong in Oberrhein, where substantial numbers winter, but also occurs in Hochrhein and at Bodensee.
Lehikoinen *et al.* (2013) have demonstrated a north-eastward shift of the gravity of the entire wintering range of Common Merganser along the Northwest-European flyway during the past three decades, a result of warmer winters. As in Smew, this probably explains the decrease of the winter population in the (northern) Rhine Valley. Other local drivers, such as intensive fisheries and oligotrophication resulting in a decline of European Smelt stocks in IJsselmeer in the 1990s, may have played an even more important role for Common Merganser than for Smew (Noordhuis *et al.* 2014, Sovon

2018). There is a tendency to visit smaller, inland waters in The Netherlands in recent years. In the southern Rhine Valley, the effect of the flyway range shift is probably outbalanced by the growing breeding population in the Alps, consisting of birds that winter locally (Werner *et al.* 2018).

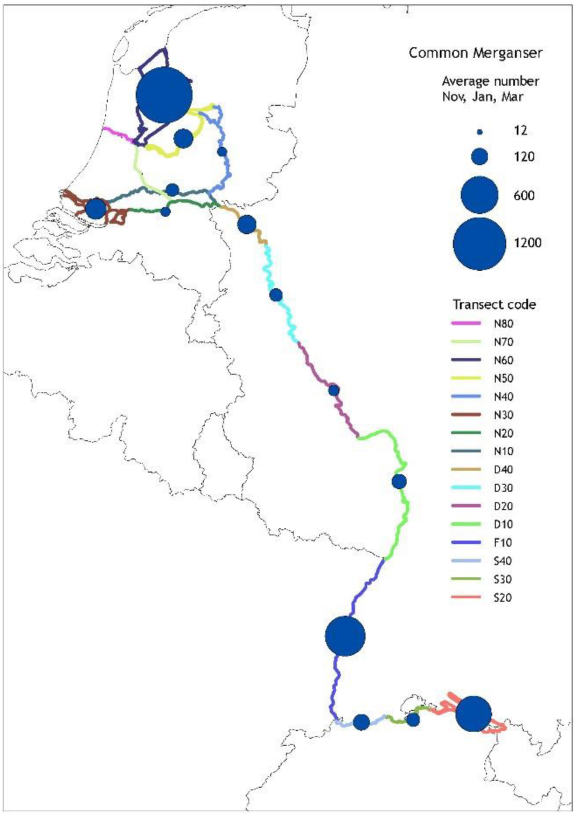


Figure 4.79 *Distribution of Common Merganser*

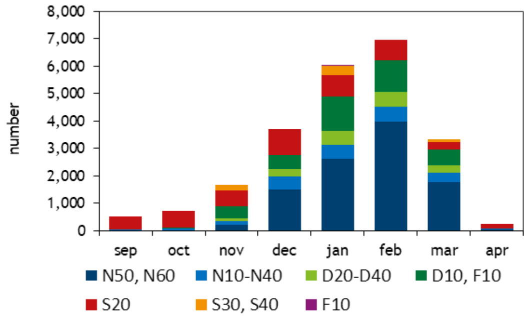


Figure 4.80 *Seasonal pattern of Common Merganser*

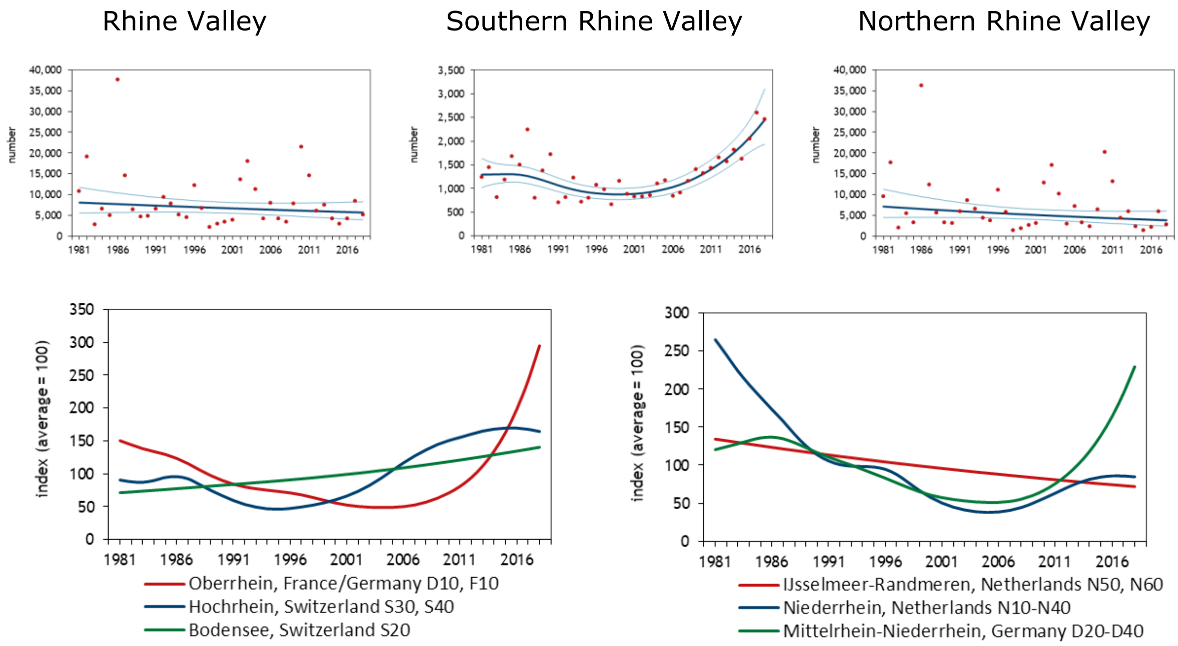


Figure 4.81 *Trends of Common Merganser. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.26 Eurasian Coot *Fulica atra*

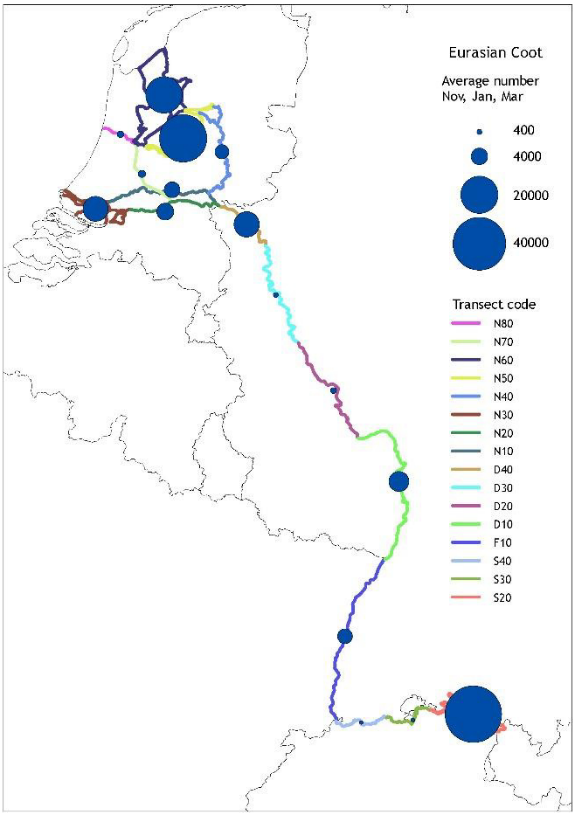
D: Blässhuhn; F: Foulque macroule; NL: Meerkoet


Photo: Gejo Wassink

Introduction
The breeding distribution of Eurasian Coot covers most of Europe, including the Rhine Valley where it is a common bird in all suitable habitats. The winter population in the Rhine Valley will comprise a mix of local birds (partly residents, probably in a growing share; Bairlein *et al.* 2014) and migrants of mainly eastern origin. In summer, large groups concentrate in moulting areas on shallow lakes with submerged vegetation and sufficient benthos supplies. In the course of winter, when other food stocks have become depleted or deteriorated, increasing numbers start feeding on pastures.

Status (Distribution, Figure 4.82, Seasonal pattern, Figure 4.83)
Bodensee, IJsselmeer and Randmeren are core areas, while substantial numbers aggregate along the northern German Niederrhein and some Dutch river branches as well. Numbers peak in late autumn and early winter (October-December) and gradually decrease afterwards. This seasonal pattern is influenced by the large autumnal concentrations on IJsselmeer/Randmeren, gradually dissolving in the course of the winter. At Bodensee, numbers remain more stable throughout October-February while in the river forelands numbers not uncommonly increase in spring, corresponding with the change in feeding habits from aquatic supplies towards pastures.
Total population exceeds averages of 100,000 birds for six months (September-February), reaching a highest level of about 200,000 in November (1 % threshold of international flyway population is 15,500 birds for NW European population and 25,000 birds for Central European/Mediterranean population).

Trends (Figure 4.84)
Numbers using the Rhine Valley have decreased in the 1980s and have remained more or less stable on somewhat lower levels since then. Considering the whole period, a moderate decrease was recorded (mean -1 %/year), being stronger in the northern section (-2 %/year) than in the southern section (-0.1 %/year). The overall negative trend therefore is dictated by trends in the northern parts of the area, with the exception of IJsselmeer (increase). In the southern parts of the Rhine Valley, total numbers remained more stable over the whole period, albeit with contrasting trends between Bodensee (increase up to 2000) and stretches along Mittelrhein, Oberrhein and Hochrhein (decreases). Decreasing local numbers can sometimes be attributed to increasing disturbance and changing farmland practices in the river forelands (transition of pastures into arable land, renaturation projects resulting in unsuitable vegetation succession). Increases are often a result of improved water quality resulting in higher biomass of *Characaeae*, *Potamogeton* and other food supplies. In some areas, seasonal patterns have changed within the period discussed, e.g. at Bodensee from an emphasis on autumn towards more stable numbers throughout autumn/winter (Werner *et al.* 2018).



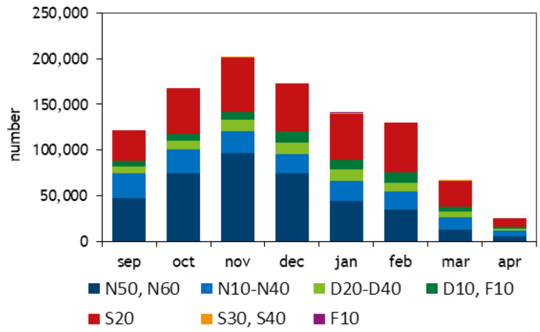


Figure 4.82 *Distribution of Eurasian Coot*

Figure 4.83 *Seasonal pattern of Eurasian Coot*

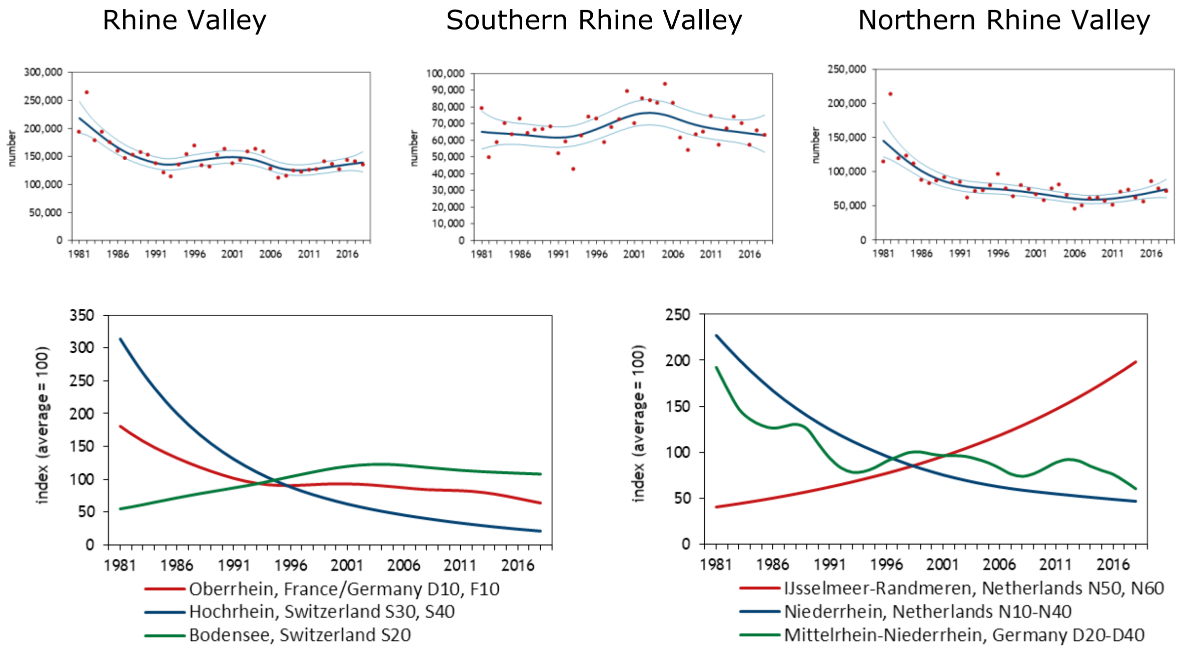


Figure 4.84 *Trends of Eurasian Coot. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.27 Black-headed Gull *Chroicocephalus ridibundus*

D: Lachmöwe; F: Mouette rieuse; NL: Kokmeeuw

Photo: Theo Verstrael

Introduction
The wintering population in the Rhine Valley belongs to the western European / western Mediterranean flyway that partly also winters in western Africa. Breeding colonies are found from Bodensee down to the North Sea (Gedeon *et al.* 2014, Knaus *et al.* 2018, Sovon 2018). The focus of the species' breeding distribution in the Rhine Valley is The Netherlands, in particular channels and coastal areas where it breeds in shallow, calm, temporarily flooded wetland habitats. In contrast to the breeding season where an important part of the population is concentrated in dense colonies, the species occurs rather dispersed during the rest of the year and can be found in different habitats, even in urban centres. It typically roosts in large groups on lakes or reservoirs (typically also in some of the large waterbodies in the floodplain of the Rhine). The species feeds on aquatic and terrestrial invertebrates but also relies on food sources provided by man, particularly during the non-breeding season.

Status (Distribution, Figure 4.85 Seasonal pattern, Figure 4.86)
In the Rhine Valley, the Black-headed Gull is most abundant in mid-winter. More than half of the wintering population concentrates in The Netherlands where the species is present in virtually the whole country (Sovon 2018). The average of the January counts in 2016, 2017 and 2018 is slightly above 60,000 individuals, which equals to 2% of the flyway population. The counts however show substantial variation between years, e.g. with a doubling from 2017 (45,000) to 2018 (90,000). This strong variation is restricted to the northern part of the Rhine Valley. Numbers in the southern part are much more constant. The distribution of the species varies within the season, with a concentration at Randmeren and IJsselmeer towards the breeding season.

Trends (Figure 4.87)
Wintering counts of Black-headed Gull peaked in the early 1990s and subsequently decreased substantially. Since the early 2000s, total numbers levelled off, however showing strong fluctuations between years. The observed trends differ between the northern and the southern part of the Rhine Valley. Whilst the peak and subsequent decrease in the 1990s was found in both parts, the decrease stopped or even reversed on the northern part, whereas in the southern part the decrease still goes on. For the entire flyway, a stable trend was estimated based on wintering counts. In contrast, the breeding population in Western Europe was found to decrease (EBCC 2017). Breeding population trends found for central and eastern European countries tend to be less negative than those from Western Europe (BirdLife International 2015). As wintering populations in Western Europe partly consist of birds breeding more in the east, this might result in wintering populations being more stable than breeding populations in Western Europe. Among the reasons cited for the decline in Western Europe are changes in farming practices that impact the food supply during the nestling period (Francesiaz *et al*. 2017). Earthworms are an important source of nestling food. Intensified farming can reduce the supply of worms. In addition, the window for hunting exposed earthworms shrinks when larger areas are tilled at once, because of faster and more efficient machinery. Outside of the breeding season, the EU-wide closure of rubbish dumps especially after 2005 have reduced the availabilityof food as well.

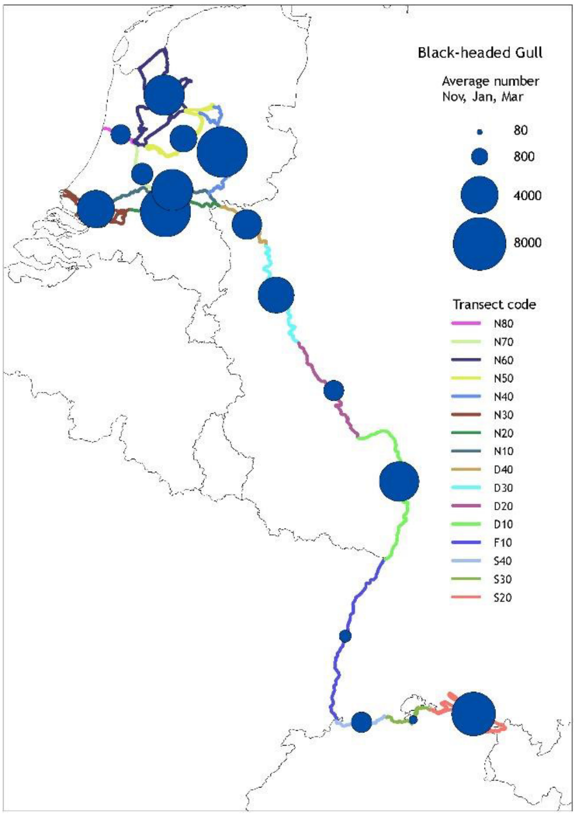


Figure 4.85 *Distribution of Black-headed Gull. The relatively low numbers in the section F10/D10 are partly caused by the fact that Gulls are not counted/reported in some areas (cf. table 1.1).*

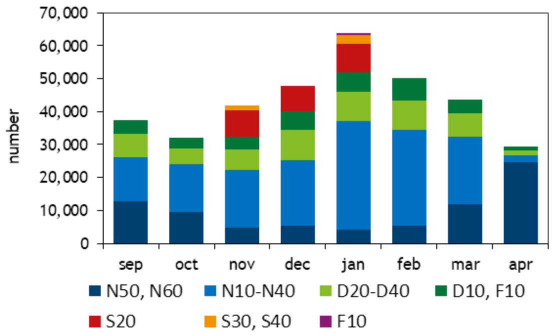


Figure 4.86 *Seasonal pattern of Black-headed Gull*

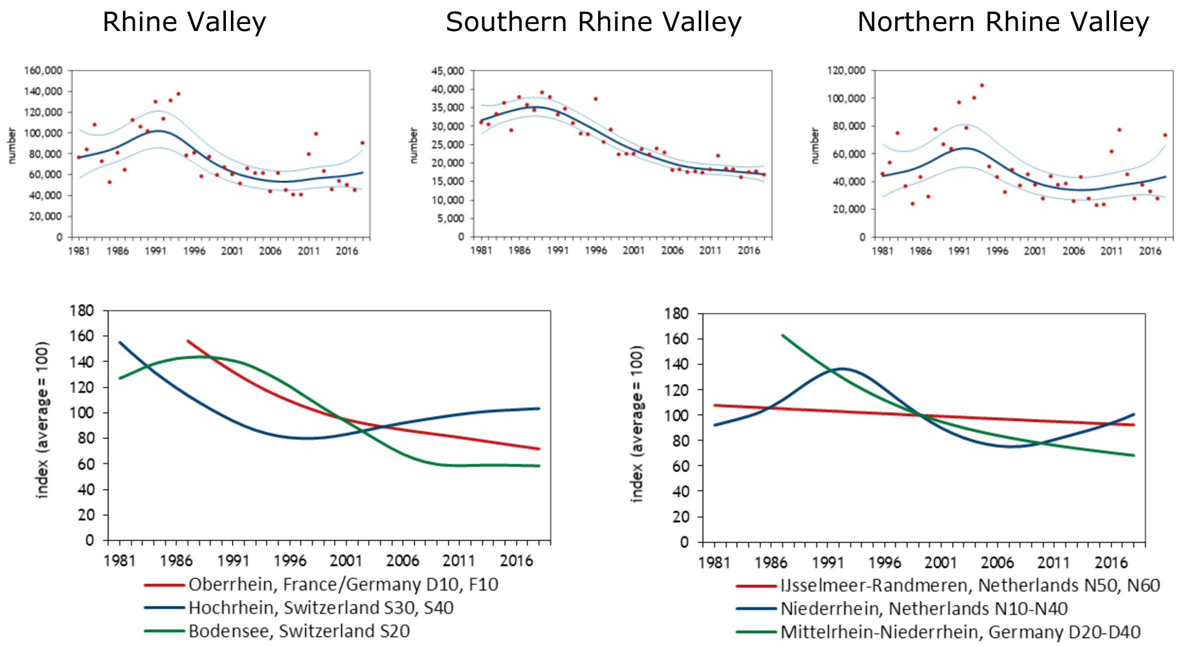


Figure 4.87 *Trends of Black-headed Gull. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

4.2.28 Mew Gull *Larus canus*

D: Sturmmöwe; F: Goéland cendré; NL: Stormmeeuw

Introduction
Mew Gulls mainly breed in the northern half of Europe and further east. In Western Europe most birds nest in colonies near the coast. The rather isolated breeding pairs in the Rhine Valley, almost confined to the northern part, are located at the southwestern edge of the breeding area. In winter, large numbers originating from Northeastern Europe and Russia visit Western Europe (e.g. Bairlein *et al.* 2014), with major concentrations along the coast and around large inland waters. Sitres in the Rhine Valley both attract feeding gulls as well as birds on communal night-roosts, which are not represented in the waterbird counts but locally may involve much larger numbers that found during counts at daytime (see below).

Status (Distribution, Figure 4.88, Seasonal pattern, Figure 4.89)
In the Rhine Valley, Mew Gull distribution is mainly restricted to the northern parts, with major concentrations only in The Netherlands, both along rivers (especially IJssel) and lakes (IJsselmeer). Further south, its status is completely different, especially in Switzerland where it is by now an almost rare bird (Strebel 2018), with Bodensee as exception.
Numbers in the Rhine Valley peak in late winter and early spring (January-March), when up to some 12,000 birds on average can be present.
Numbers are influenced by winter weather, with sometimes influxes under freezing conditions, and water tables along the rivers. Inundated forelands may attract large groups, especially in early spring (and when water level in the forelands retreat). During the day Mew Gulls often spread out widely into the floodplain, mainly to grasslands, for feeding. In the German part these are thus not very well captured by the counts during daytime, which concentrate on waterbodies (waterbird census) or are not covered by the programme (geese and swans). Numbers may thus be much larger if (night) roosts are counted.

Trends (Figure 4.90)
Annual numbers fluctuate markedly, sometimes with a factor five, partly in response to winter weather and water levels (see above). In the main areas, numbers show some increasing tendencies (Niederrhein and Dutch Rhine branches) or fluctuate without clear trend (IJsselmeer). In the southern parts of the Rhine Valley, numbers have obviously decreased, especially after 2000. This partly follows an initial increase since the 1970s. Numbers at the most important area here, Bodensee, have decreased especially in November, being more stable in January and therefore expression of a later arrival of wintering birds (Werner *et al.* 2018).
Considering the whole period, total numbers were considered stable, but with considerable variation between the northern Rhine Valley (on average +2 %/year) and southern Rhine Valley (-4 %/year).

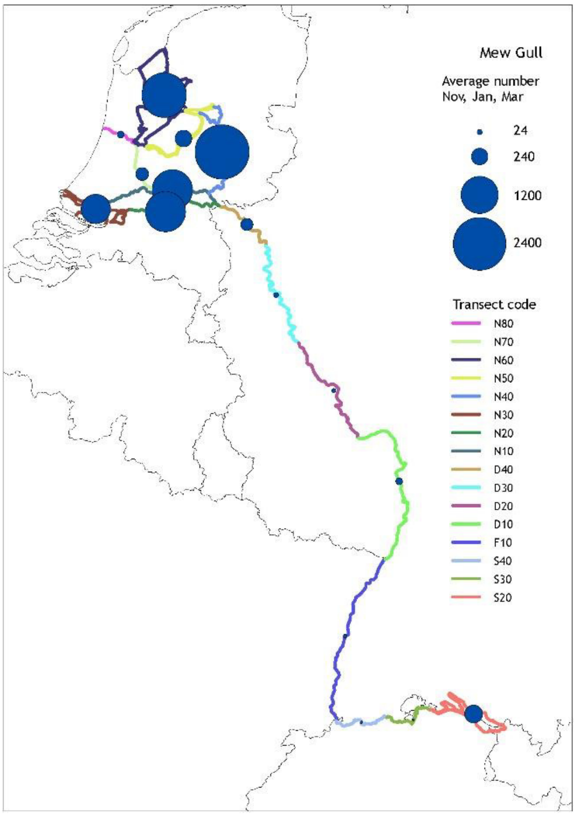


Figure 4.88 Distribution of Mew Gull (see comment Black-headed Gull for Germany).

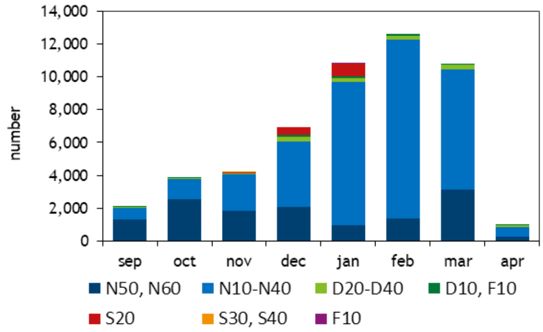


Figure 4.89 *Seasonal pattern of Mew Gulls*

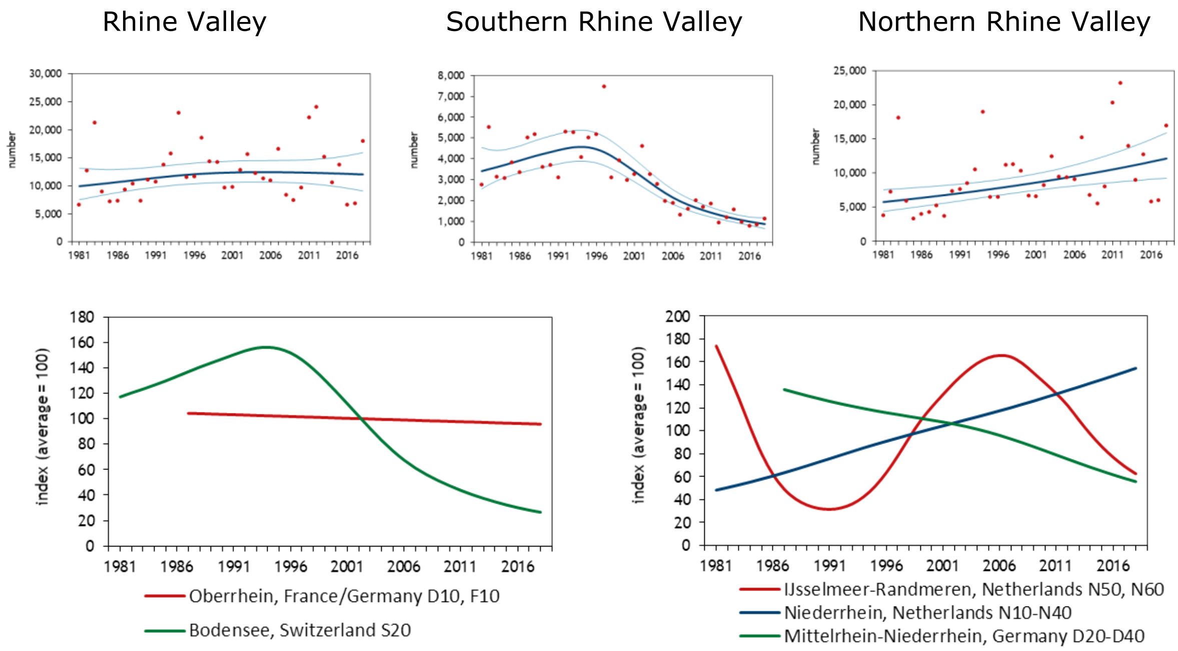


Figure 4.90 *Trends of Mew Gulls. Upper row; numbers (red dots), trend (dark blue line) and confidence intervals (light blue lines) at whole Rhine, Southern and Northern part. Lower row, indexed trend at different Rhine sections.*

Box 3. Large-scale floodplain rehabilitation along the Niederrhein in The Netherlands

Around 1990 a number of visions and plans were published that promoted floodplain rehabilitation in the Dutch part of the Rhine-Meuse Delta, introducing riverine nature reserves and improving river–floodplain interaction (e.g. De Bruin *et al.* 1987, WWF 1992). The core message was that outer-dike floodplains ought to have a primary ecological function again, whereas in the hinterland agriculture may prevail. These aims were combined with targets for flood risk reduction and enabled by economic opportunities, such as superficial clay extraction. Floodplain restoration in The Netherlands has been carried out since the early 1990s in an area of over 8,000 ha up to 2010 and has continued ever since. Now, over 20,000 hectares of Rhine Valley floodplains in The Netherlands consist of nature reserves (data Bureau Stroming). In the German, French and Swiss parts of the Rhine Valley floodplain rehabilitation has been carried out as well, but at a much smaller scale. Examples are the restoration of characteristic flood meadows along the Oberrhein in Baden-Württemberg and Hessen (Brackhane & Reif 2018).

In The Netherlands, rehabilitation generally implies giving space to ecological and hydro-geomorphological river processes at the landscape scale, such as erosion, sedimentation, flooding and vegetation succession, including low-intensity grazing by free roaming semi-wild herbivores (Smits *et al.* 2000). Consequently, in rehabilitated sites all regular agricultural activities, such as mowing of grasslands, are terminated. Also, secondary channels are excavated, summer levees removed or lowered, and primary dikes reallocated. Floodplain rehabilitation aims at creating a diverse and (semi-) natural river landscape, consisting of marshes, pioneer habitats (such as eolian dunes), natural grasslands, shrubs and riverine forests.

In the past decades, generally positive effects of floodplain rehabilitation on biodiversity have been described (Raat 2001, Nienhuis *et al*. 2002, de Nooij *et al.* 2006). A recent study quantified changes in protected and endangered species of seven taxonomic groups over 15 years of river restoration in the Dutch Niederrhein floodplains (Straatsma *et al.* 2017). Of all 179 floodplain sections examined, 137 showed an increase in diversity, particularly for fast-spreading species. Van Turnhout *et al.* (2012) analysed changes in abundance of 93 common and scarce breeding bird species in response to rehabilitation in the first ten years, comparing 75 rehabilitated floodplains with 124 non-rehabilitated reference floodplains along the Dutch Niederrhein. Overall, 35 species performed relatively better in rehabilitated sites compared to non-rehabilitated floodplains, whereas only 8 species responded negatively to rehabilitation. Characteristic river birds, such as waterbird species (e.g. Mute Swan, Gadwall and Shoveler) and typical ‘pioneers’ (e.g. Common Shelduck, Little Ringed Plover and Sand Martin) had disproportionately benefited from rehabilitation compared to non-typical river species, although the latter group only in the first five years after the start of the restoration. Also, birds of shrubs and bushes showed a strong positive response to rehabilitation. However, typical ‘meadow birds’ (e.g. Lapwing and Black-tailed Godwit) showed even more negative trends in rehabilitated floodplains compared to non-rehabilitated floodplains. Since the area of tall vegetation increases after termination of agricultural activities (grazing, mowing), rehabilitated floodplains will be abandoned by these species as the habitat gradually becomes unsuitable (van Turnhout *et al.* 2012). This also applies for grass-eating breeding birds, such as Greylag Goose. Chicks reared on restored, herb-rich meadows appear to have a lower body condition and a lower juvenile and adult survival than chicks reared on intensively-used agricultural grasslands, which might explain the negative response to rehabilitation (Voslamber & van Turnhout 2008, Avé *et al.* 2016), apart from reduced feeding opportunities as a whole.

What about the effects of floodplain rehabilitation on wintering waterbirds? Van den Bremer *et al.* (2009) evaluated the changes in abundance of 19 species in the Dutch Rhine Valley in 1987-2005, again comparing rehabilitated floodplains and agricultural floodplains. For 14 species positive effects on trends were found in the first ten years after rehabilitation, for the remaining five species effects were negative. Waterbird species feeding on fish, benthos and waterplants generally benefited from rehabilitation measures. Examples are Great Crested Grebe, Little Grebe (piscivores), Gadwall, Eurasian Teal (herbivores), Northern Shoveler and Tufted Duck (benthivores). Indeed, most of these species generally show more positive (or less negative) trends along the Dutch section of the Niederrhein after 2000, compared to adjacent river sections in Germany (Figure B3.1, compare Figure 4.5, 4.6). This is probably caused by the increase in the area of (shallow) water bodies, such as newly created side-channels, and an increase in the frequency of inundation of floodplains after lowering or excavation (van den Bremer *et al.* 2009). Between 1990 and 2015 almost 80 kilometer of side-channels and 450 hectares of shallow marshlands and inundated grasslands have been created along the Rhine in The Netherlands

(Reeze *et al.* 2017). This has been beneficial for the diversity and abundance of submersed vegetation (Schoor *et al.* 2011), macrofauna (Geerling 2014) and fish (Dorenbosch *et al.* 2011). Effects of floodplain rehabilitation on four species of grassland herbivores were negative, according to Van den Bremer *et al.* (2009): Mute Swan, White-fronted Goose, Greylag Goose and Wigeon. Again, this is reflected in the trends at the regional scale, these being more negative (or less positive) for the Dutch section of the Niederrhein than for the adjacent German part (Figure B3.1, cf. Figure 4.5, 4.6), particularly for Mute Swan and Wigeon (see species accounts for details). As described for breeding grassland herbivores, this is probably caused by a decrease in suitable foraging habitat, resulting from the replacement of fertilized agricultural grasslands by less nutritious natural grasslands and shrubs (van den Bremer *et al.* 2009, Reeze *et al.* 2017).

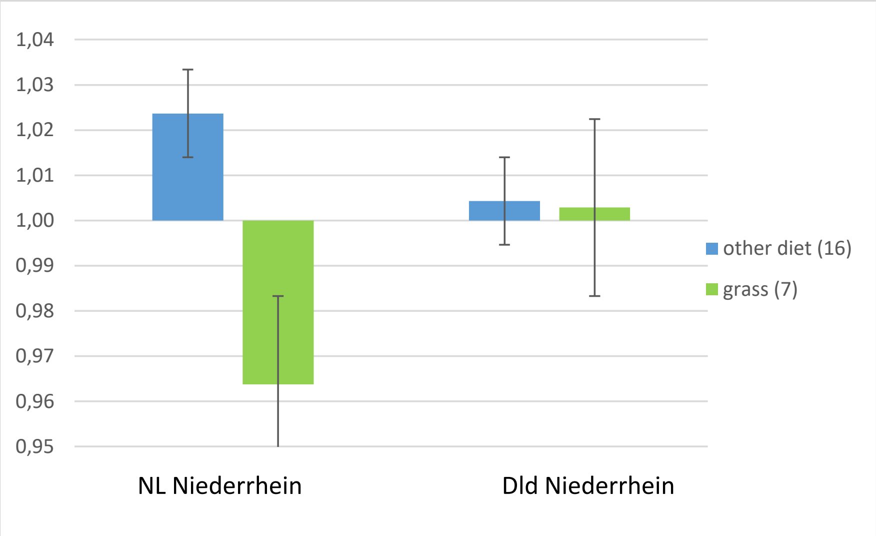


Figure B3.1. *Average trends (incl. standard errors) of 7 grassland herbivores and 16 species feeding on fish, benthos and waterplants in the Dutch parts (N10 - N40,large-scale floodplain rehabilitation) and German parts (D30 – D40, limited floodplain rehabilitation) of the Niederrhein area in the period 2000-2018. Values >1 indicate an average increase (1.02 means 2 % increase per year), values <1 indicate a decrease (0.96 means 4 % decrease per year).*

For most waterbird species, floodplain rehabilitation has therefore contributed to reach the numerical targets that were set for designation of Natura 2000 sites, an implementation of the EU Bird Directive. On the other hand, for grassland herbivores these Natura 2000 targets might come under pressure, since rehabilitation effects are generally negative for these species. However, van den Bremer *et al.* (2019) show that this is not the case at present for wintering White-fronted-, Barnacle- and Greylag Goose in the Natura 2000 site 'Rijntakken' (Dutch section of Niederrhein). The carrying-capacity of suitable foraging habitat is still sufficient to accommodate the targeted numbers of these species in the current and foreseen future situation.

Since an overview of recent developments is lacking, we recommend to update the analyses of large-scale floodplain rehabilitation in the Rhine Valley on both breeding and wintering birds at the site-level. Now that 30 years of monitoring data since the start of the restoration programs is available, this will give a valuable insight in effects on the long-term and provides key-knowledge for implementarion of river rehabilitation elsewhere.

5. Discussion and conclusions

5.1. Advances in data collection and analyses

This report about numbers, distribution and trends of wintering waterbirds in the international Rhine Valley until 2018 is the third in a row, the previous ones being published 20 years (Koffijberg *et al.* 2001) and 25 years ago (Koffijberg *et al*. 1996). Compiling a report about waterbird numbers, merging results from different countries and evaluatings time series of almost forty years, is a challenging task regarding harmonisation and consistency issues. Originally, most waterbird counts were established upon local initiatives (e.g. Suter 1982, Andres *et al.* 1994, van den Bergh *et al*. 1979, Dolich 2014) and were gradually integrated in national monitoring programs with fixed routines, which we now find in all countries within the Rhine Valley. Only the January counts have always been part of the network of the International Waterbird Census, as coordinated by Wetlands International (Atkinson Willes 1976). As a result, we have been able to assess trends in wintering numbers in the Rhine Valley from 1981 onwards. During this period several advances in data availability and methods have enlarged the possibilities of a joint-analysis of the census data. All count data is now digitized available at the level of individual (smallest) counting units. Particularly in Germany, substantial progress has been made in this respect since the last report from 2001. Besides, there is now a better coordination between French and German counting teams along the French-German section of the Oberrhein, avoiding double effort and duplicate counts.

Other improvements in the dataset refer to a better labelling of missing values and extension of the species selection that is included in the waterbird counts (also leading to an overall harmonisation of the species covered). Customized statistical software for analysing time series of waterbird counts has become available (rTRIM, U-index, TrendSpotter), properly accounting for differences in counting effort and able to assess statistical trends with a measure of variation for various time frames. As a result, we are now able to present results for a larger set of species than before, based on counts covering all areas of the international Rhine Valley, and including seasonal patterns for the entire September to April winter season.

Now that estimates of population sizes and especially trends of flyway populations have become regularly available by waterbird population estimates from Wetlands International and the Conservation Status Reports by AEWA (http://wpe.wetlands.org/search), it is possible to make a better assessment of the international importance of the numbers of waterbirds in the Rhine Valley and to compare Rhine trends with flyway trends. This helps disentangling local drivers of population change from drivers operating at larger spatial scales, such as climate change and subsequent shifts in migration strategies.

5.2. Waterbird numbers and responses to ecological change

Waterbirds are an important aspect of biodiversity and are legally protected throughout a number of international treaties (e.g. EU Bird Directive, AEWA, Ramsar Convention) and national legislation. Hence, monitoring of their abundance is essential to keep track of their conservation status, reviewed periodically e.g. by the Art 12 reporting to the EU (applicable for France, Germany and The Netherlands). Moreover, waterbird numbers generally will show a fast response to environmental change, such as changes in feeding opportunities, habitat alteration and climate change. In combination with the fact that waterbirds are relatively easy to count over large areas at rather low costs (thanks to a huge volunteer effort!), they function well as biological indicators.

The results presented in this report show some clear relationships between environmental change and trends in waterbird numbers. Particularly the response to the improved water quality of the Rhine in recent decades stands out. The efforts of reducing the human-induced eutrophication of the Rhine and a reduction of other chemical compounds, has had large effects on the ecosystem, including more favourable conditions for waterbirds. This can be regarded as a success of the Rhine Action Program and the EU Water Framework Directive. Improvement of water quality led to a reduction of the dominance of algae, an increased water transparency and a recovery of vegetation of submerged macrophites (Characea) in the shallow lake systems of Bodensee, Randmeren and IJsselmeer and Markermeer. Herbivorous waterbird species responded instantly, both common species (e.g. Mute Swan and Eurasian Coot) and formerly rare species that heavily rely on submerged vegetation, like Red-crested Pochard. On the other hand, lower euthrophication and subsequent changes in the abundance and composition of phytoplanktons also caused less favourable conditions for filter-feeding mussels (e.g. Zebra Mussel *Dreissena polymorpha*), and thus a negative response in mussel-eating waterbirds like Tufted Duck. In addition, the Rhine valley was invaded by the non-native Quagga Mussel *Dreissena rostriformis* from the Black Sea, largely replacing Zebra Mussels, but from a waterbird perspective a less profitable food resource than Zebra Mussels (Noordhuis *et al*. 2014). The long-term effects of these changes on the diving duck species depend on several factors. Tufted Duck, Common Pochard and Goldeneye recently changed their diet to other benthos species present in the IJsselmeer region (van Rijn *et al.* 2012), perhaps made possible by improvements in water quality as well and serving as an alternative food resource (Noordhuis *et al*. 2014). Greater Scaup is also largely occurring in salt water and the availability of good stocks of sublittoral shellfish (e.g. *Mytilis edulis*) will be important for them (flocks roost in the IJsselmeer area and go to the Wadden Sea for feeding).

Another important driver for population changes and changes in species composition in waterbirds is habitat change. This is especially reflected by species depending on marsh habitat, muddy and shallow water. This group of species has benefited from the large river rehabilitation program carried out in the Dutch section of the Niederrhein area (see also Box 3). At many sites, farmland areas were converted into damp floodplain areas with side-channels and low intensity grazing regimes, boosting food stocks of e.g. aquatic insects and improving feeding opportunities for many waterbird species. Simultaneously, this process has led to lower numbers in specific herbivores like geese, which depend heavily on improved grassland, but have been faced with reduced feeding possibilities. Still, however, their numbers are well within the targets set for Natura 2000 designation.

Responses of fish-eating species to ecological changes are more difficult to link to ecological changes, partly because different waterbird species have largely different prey choice and different feeding strategies. The relation between Smelt *Osmerus eperlanus* and a group of species depending on them is most clear (Noordhuis *et al.* 2014). As Smelt is a planktivorous species, relations with water quality are likely and also the increasing water transparency decreases the catchability of fish by pelagic fishing birds. Opening of barrier dams (e.g. Afsluitdijk between IJsselmeer and Wadden Sea and Haringvlietdam between Haringvliet and North Sea) aims to allow migratory fish populations to restore their movements between those ecosystems, which finally may also lead to improved feeding conditions for fish-eating waterbirds.

5.3. Conservation status of waterbirds in the Rhine Valley

With more than one million wintering waterbirds, the Rhine valley is of major importance for the conservation of waterbirds in Europe and is an important contribution to biodiversity in Northwest and Central Europe. About half of the waterbirds is present in the large lakes of Bodensee, IJsselmeer, Markermeer and Randmeren and the other half along the river stretches itself, especially in the Dutch part of the Niederrhein area (Table 5.1). A common tool to express the importance of sites for waterbirds is to compare the numbers at site level with their total flyway population. Originally developed under the

Ramsar Convention, sites are considered of international importance for the conservation of waterbirds when at least 1% of their flyway population occurs regularly at such a site.

Following the distribution of large waterbird concentrations, it is no surprise that notably Bodensee and the IJsselmeer region (incl. Randmeren) support many species in internationally relevant numbers (Table 5.1). The same applies to the Niederrhein in The Netherlands. Oberrhein and Niederrhein in Germany have internationally important numbers as well, but for fewer species. In addition, within the Rhine Valley, many Special Protection Areas (SPAs) for the Natura 2000 network of the EU-countries have been designated, closely following the international importance of single sites (Table 5.1).

Table 5.1. *Total number of waterbirds (January 2016-18), number of wintering species occurring in 1% or higher percentage of flyway populations, coverage (in %) by Ramsar and/or SPA protection regimes, and number of increasing or decreasing species 2000 – 2018 in the different subareas of the Rhine Valley.*

	nr of wintering waterbirds	nr species matching 1%	% coverage by protected sites	nr increasing species	nr decreasing species
Bodensee	220.000	9	20	10	2
Hochrhein	10.000	0	5	1	8
Oberrhein	97.000	4	57	8	8
Mittelrhein & Niederrhein Germany	82.000	2	47	8	8
Niederrhein Netherlands	386.000	11	>75	10	5
IJsselmeer Region	300.000	12	>90	12	1
Rhine total	1.100.000	25		12	4

As mentioned above, large parts of the Rhine Valley are subject to (international) protection regimes and other environmental treaties such as the EU Water Framework Directive. Threats to wintering waterbirds have changed over time. In the 20st century, wintering waterbirds were most threated by hunting (particularly the disturbances caused by hunting activities) and water pollution. Water quality has increased, and hunting is nowadays largely regulated, so that waterbirds are safe from this source of disturbance at the most important wintering sites. However, other human activities with major disturbance effects increased, also in mid-winter (Werner *et al.* 2018), among them boating, kite-surfing, stand-up paddling (Bull 2018), fireworks (Shamoun-Baranes 2011) and drone flying (Mulero-Pazmany *et al.* 2017). Increases in disturbance levels from these activities can lead to avoidance of areas that, apart from the disturbances, would be well-suited for wintering waterbirds (Tuite *et al.* 1984). Disturbance in staging and wintering areas were shown to reduce individual fitness in the subsequent spring, e.g. by influencing clutch size (overview given in Sedlinger *et al.* 2014), thus also leading to potential impact outside the Rhine Valley. Current regulations of protected areas partly do not cover such novel types of disturbance; thus a periodic revision of the regulations would be crucial to ensure the protection of wintering waterbirds on the long term. This is particularly important in the Rhine Valley, as the area is one of the most densely populated regions in Europe and recreational pressure on lakes and rivers is thus particularly high (Werner 2020).

5.4. Main conclusions

State

- With 1.1 Million waterbirds of almost 70 native waterbird species in 2015/16 – 2017/18, the Rhine Valley represents a region of major conservation importance within Europe. The total numbers (i.e. maxima) of waterbirds were comparable with the 1995 and 2000 period.
- Within this period, 25 species were recorded in internationally relevant numbers (>1% of their flyway population). This is a slight increase compared to 1999/2000 (21 species), as a result of better species coverage (Black-headed Gull) and genuine increase in importance (Red-breasted Merganser, Great White Egret, Black-necked Grebe).
- Of the 28 species for which trends could be calculated, 12 were increasing and 4 decreasing since 2000. Other species were classified stable or were subject to an uncertain trend. Most important sites within the Rhine Valley are protected through designations under the Ramsar Convention and EU Birds Directive and further national conservation implementation.
- Bodensee, the Niederrhein in The Netherlands and IJsselmeer, Markermeer and Randmeren show the most increasing species and only few with declines. Also Oberrhein and Mittelrhein/Niederrhein Germany has many increasing species, but about the same number of decreasing species. Hochrhein stands out with a majority of decreasing species, but this is a result of shifts to the nearby Bodensee, which has gained in attractivity.

Trends in relation to local conditions

- Due to improved water quality, large expanses of submerged macrophytes have returned in the past two decades, especially in the lake systems of Bodensee, IJsselmeer and Randmeren (locally also Markermeer). Waterbirds feeding on these have responded with overall increases. These sites with submerged aquatic vegetation not only provide a food resource for herbivorous waterbird species but improve the general habitat quality with much more diversified macrofauna and fish species occurring there and other waterbirds feeding on these. The improved water quality is the result of the Rhine Action Program and the EU Water Framework Directive, and generally following the long-term environmental protection efforts made by the riparian states.
- Probably also as a result of lower eutrophication levels, standing stocks of especially filter feeding freshwater mussels have decreased, leading to declines in numbers of mussel-eating waterbirds. Also the replacement of Zebra Mussels by the invading Quagga Mussel will have had its effects. Recently most of the mussel-eating diving ducks seems to respond to this new situation by diversifying their diet and prey on other macrobenthos species.
- In the floodplain of the Rhine, former agriculture land has increasingly been converted in more dynamic and wet habitats. This has especially occurred in the Niederrrhein section in The Netherlands, in the context of flood prevention and ecological restauration. Creation of such new areas has had positive effects on waterbird species of marsh habitats, shallow water and muddy shores which have benefited through improved feeding opportunities and larger food resources.
- The forelands are also very important for grass-eating waterbird species and internationally important numbers of wintering swans, geese and ducks. Overall numbers of species using these resources have remained stable since 1981 but also some decreases have become apparent in the recent 10 years, probably as a result of the reduced area of farmland. It remains important that enough feeding habitat for these species remains as grassland and will not be converted into crops like maize, and that levels of disturbance will remain low.
- Among fish-eaters of more open water, several species have increased (Great Cormorant, Great Crested Grebe), but on the other hand species as Smew and Common Merganser have shown some signs of decrease, the latter also because of northeastward shifts in winter distribution (see below).

Other pressures

- The past decades have seen some large changes in ecological conditions along the Rhine, with important effects on the waterbird community. Both the effects of water quality improvement and increased natural habitat in the forelands have had large local effects. On the other hand, also major global changes like climate change, operate, which can cause range shifts among the migratory species visiting the Rhine. By comparing flyway trends with Rhine trends, we do not find much evidence for major differences in local trends with global trends. However, in Smew, Common Merganser and Common Goldeneye there is evidence that warmer winters due to climate change cause range shifts in northeastward direction. For these species the flyway trends are more positive than the local Rhine trends.
- Besides the native waterbird species discussed above, also a number of non-native waterbird species occur in the Rhine Valley in the wild. This group is clearly increasing, both in number and partly also the number of species. For most species no real negative impact on other species are reported but the more common ones, Greater Canada Goose, Egyptian Goose and feral Greylag Goose may cause crop damage and nuisance in parks and leisure areas.

5.5. Recommendations for monitoring

In general, the monitoring system for waterbirds works rather well. In comparison with the report describing the situation around 2000 (Koffijberg *et al*. 2001), some major improvements have taken place, especially in Germany and including a close collaboration between French and German counting teams in the Oberrhein area, where the Rhine is the border between the two countries. Thus, there is now a sufficient level of national coordination and data have become available on the smallest counting unit level. This enables new statistical methods to be used to provide estimates for missing values and calculations of smoothed trends. However, some recommendations for further improvements can be given.

- Most sites are now counted in September – April, except for the Hochrhein and southern part of the Oberrhein. For further harmonization it would be good to investigate if coverage in the other months at these sites is feasible, at least at sites that hold larger numbers of staging waterbirds.
- Best coverage is now reached in November and January. Thus, effort should also concentrate to complete annual coverage especially of the river itself (which nowadays in many areas holds rather low numbers) in these two months and trying to close remaining gaps in some areas in Germany.
- During the early years, only ducks, geese and swans were counted systematically. Nowadays the whole group of waterbird species is covered, enlarging the possibilities to monitor the quality of sites and investigate ecological relationships. For several species the results can also be used to calculate flyway trends and the coverage of all waterbird species is recommended for international surveys (Hearn *et al*. 2018). Along the Rhine this is mostly implemented already with the exception of the group of waders in Switzerland and the Oberrhein. Although numbers of waders are probably not that large at these sites it is recommended that they are routinely included in the counts as well.
- On top of the waterbird species, some other wintering birds are counted in each country during the waterbird surveys. It is recommended that national coordinators see if further harmonization with a small group of species counted in each country is possible.
- With the coverage of the counts from September to April we do not include the important period of late summer - early autumn with important numbers of terns and moulting species. This is especially important at the Bodensee and IJsselmeer area and it is recommended that for a next report it is investigated if this period

can be included in the analyses as well. In both areas summer counts are already running.

Present monitoring is concentrated on the occurrence of non-breeding waterbirds. They show already important relations with other environmental parameters. However, it is recommended to investigate if results of breeding bird surveys along the Rhine can be brought together as well, as these will likely show relationships with ecological changes as well (and even better at site level). All countries already have breeding bird surveys in place, but there has been no international coordination and harmonization in data collection so far.

6. References

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Annex 1. Observers in the Rhine valley from winter 2015/16 onwards

Bodensee (Swiss, Austria and Germany) and Hochrhein (Swiss and Germany):
Hans-Günther Bauer, Christian Beerli, Christian Berger, Markus Berset, Rösly Bienz, Hanspeter Bieri, Andrej Binz, Ueli Bringolf, Daniel Bruderer, Dominic Buergi, Jost Bühlmann, Jörg Dieterich, Daniel Doer, Markus Döpfner, Alfred Engelmann, Stefan Ferger, Kuno Feurer, Jürg Frey, Walter Gabathuler, Bernd Geiges, Manfred Gleinser, Gerda Gschwend, David Gustav, Jörg Günther, Verena Hasler, Georg Heine, Dietmar Heinz, Matthias Hemprich, Johannes Honold, Harald Jacoby, Peter Knaus, Gerhard Knötzsch, Margie Koster, Andrea Kölzsch, Jochen Kübler, Martin Leuzinger, Willy Looser, Hans Lüthi, Lisa Maier, Ulrich Maier, Heiko Marschner, Jürgen Marschner, Lorenz Mattes, Anja Matuszak, Thomas Minder, René Moor, Robert Morgen, Patrick Mächler, Werner Müller, Frank Portala, Georges Preiswerk, Arno Reinhardt, Beatrice Schertenleib-Rebsamen, Tobias Schleusser, Karsten Schäfer, Alwin Schönenberger, Gernot Segelbacher, Ekkehard Seitz, Esther Sonderegger-Brönnimann, Christian Stielow, Vreni Suter-Tague, Heidi Tanner, Stephan Trösch, Manfred Vith, Urs Weibel, Ernst Weiss, Hanns Werner, Stefan Werner, Kühmayer Willi, Katrin Zickendraht, Martin Zimmerli, Mateusz Zimowski, Jean-Fred Zweiacker.

Oberrhein (France):
Adreani Sandrine, Baumlin Yves et al., Bochenek Jérémy, Braun Christian, Bronner Jean-Marc et al., Buchel Eric, Buchert Pierre et al., Casteigts Daniel, D'Agostino Roberto, Dietrich Guillaume, Divoux Julien, Dronneau Christian, Dujardin Denis, Fizesan Alain, Frauli Christian et al., Frenoux Jean-Marie, Hammel Stéphane, Haug Christian, Helbling Charles, Hey Philippe, Jante Vincent, Kasel Fernand, Keller Marc, Kirmser Daniel et al., Knibiely Philippe, Leroy Marie-Magdeleine, Lorenzo M., Lutz André, Lux Thomas , Merck Frédérique, Minery Nicolas, Office Français de la Biodiversité, Perrayon Aurore, Peter Richard, Pfennig Jean-Louis, Régisser Bernard, Repp Daniel, Roquin Claude, Rudinger François, Scaar Bertrand, Schelcher Denis, Schindler Annette, Service Espaces verts et de nature de la Ville et Eurométropole de Strasbourg, Seyffarth Frédéric & Joëlle, Sittler Benoît, St-Andrieux Jean-Pierre, Steck Olivier, Umhang Stéphane, Waeffler Laurent, Wassmer Benoît, Weissgerber-Sigel Madeleine, Willer Alain, Winom René

Oberrhein, Mittelrhein and Niederrhein (Germany):
Jürgen Ackermann, Alfred Amberger, Winfried Arntz, D. Auchinleck, Helmut Barié, Andreas Batt, Hans Baumann, Martin Baumgärtner, Dietmar Beckmann, Willi Bernok, Malte Bickel, Ingrid Birkhold, Wolfram Blug, Harald Bott, Manfred Braun, Ursula Braun, Markus Bretschneider, Stefan Büchel, Rüdiger Burkhardt, Hannah Carstensen, Nicolas Chalwatzis, Maria Danglmayer, Edgar Denner, Bernhard Disch, Thomas Dolich, Otfried Dolich, Aaron Dreißigacker, Dieter Ebert, Monika Eggert, Tobias Epple, Klaus Faaß, Sabine Faißt, Günter Feldner, Matthias Feuersenger, Jürgen Fiegen, Jean-Yves Follet, Albrecht Frenzel, Silke Friedrich, Erhard Gabler, Paulette Gawron, Hans-Otto Geiger, Willi Geiselmann, Bernhard Glaß, A. Gollwitzer, Reinhard Grub, Dennis Günther, Martina Harms, Oliver Harms, Stefanie Hartmann, S. Hartmann-Auchinleck, Ilona Häsle, Ingo Hausch, Michael Held, Doris Heller, Sophia Helmchen, Christoph Hercher, Claudia Hermes, Witiko Heuser, Beate Hippchen, Wolfgang Hoffmann, Martin Hoffmann, Doris Hofscheuer, Jürgen Hübner, Veronika Huisman-Fiegen, Jürgen Hurst, Kathrin Jäckel, Sophie Jaquier, Mathias Jönck, Reinhard Kandler, Bernd Keiler, Peter Keller, Heiner v. Kielpinski, Roland Kirsch, Samantha Kirves, Uli Kofler, Christine Krämer, Antonia Kraus, Josef Kreuziger, Franziska Kurz, Klaus Lechner, Anja Lehmann, Jochen Lehmann, Christopher Lehmann, Marianne Leis-Messer, Peter Linhart, Jörg Lippmann, Bruntje Lüdtke, Thomas Lux, Ulrich Mahler, Siegfried Mattausch, Wolfgang Mayer, Melanie Meier, Wolf Meinken, Moritz Meinken, Gérard Mercier, Johannes Meßer, Helmut Mett, Barbara C. Meyer, Mathias Müller, Birte Müller, Jochen Müller, Birgit Mylo, Alexander Neu, Heidi Nevsimal, Naturschutzzentrum Kleve, Helmut Opitz, Arno Opper, Ina Ottusch, Liviu Pârâu, Karl-Josef Parsch, Brigitte Pehlke, Peter Petermann, Manuel Philipp, Nicolai Poeplau, Falk Pollähne, Hanspeter Püschel, Dieter Raudszus, Jürgen Raudszus, Hendrik Reers, Klaus Rennwald, Johannes Reufenheuser, Wolfgang Riecher, Dieter Rinne, Heinz Rosenberg, Wolfgang Rovers, Michael Rumberger, Jürgen Rupp, John Ryding, Matthias Sacher, Dagmar Schindler, Siegfried Schneider, Gerd Schön, Fabian Schrauth, Natascha Schütze, Hans-Jürgen Schygulla, Erwin Sefrin, Frank Sepold, Ludwig Simon , Helga Simon, Fritz Sperling, Simon Steiger, Rainer Steinmetz, Eberhard Stengele, Darius Stiels, Gunnar Strauß, Sigrid Streit, Lea Stübing, Stefan R. Sudmann, Lukas Thiess, Dieter Thomas Tietze, Steffen Tillmanns, Teodor Trifonov, Jörg Turk, Frank Ulbrich, Thomas Ullrich, Ulf-Christian Unterberg, Linus Ventur, Winfried Vogedes, Andreas Vogel, Thilo Volz, Guido Waldmann, Jürgen Walter, Christiane Wegner, Robin Wegner, Oliver Weirich, Ludwig Wenzel, Vera Werner, Biologische Station im Kreis Wesel, Biologische Station Westliches Ruhrgebiet, Jakob Wildraut, Tobias Wirsing, Friedrich Wulf, Herbert Zettl, Christian Zurek.

Niederrhein (The Netherlands):
Leo Aalders, Carla Aarts, Gert Aartsen, Rino Abrahamse, Wies Akkermans, Jan van Alst, Jouke Altenburg, Dick Andringa, Tjerk Andringa, Lieuwe Anema, Leo Apon, Jettie van Assendelft, Inge Baan, Rob Baars, Wim Baas, André de Baerdemaeker, Carin Barendregt, Betty Barneveld, Els Bary - Peters, Gerrit Bax, Noortje Bax-Loeber, Rein Beentjes, Jan Beerntsen, Nicolette van der Ben, Noor Bennink, A. Berben, Iris Berends, Marcel Bingley, Jip Binsbergen, Jan Blom, Joran Boer, Lars de Boer, Peter de Boer, Vincent de Boer, Joke Boerlage, Egge Boerma, Jaap Bont, Renate van den Boom, Greet Boomhouwer, Paul Borgerding, Esther Borkent-Mollema, Ronald Bos, Theo Boudewijn, P.W. Bouma, J. Bouwhuizen, Ed Bouwman, Jaap Bouwman, Pim Braat, Herman van den Brand, Eelco Brandenburg, Jeroen Bredenbeek, C.W. Breider, Chris Briek, Peter Brouwer, Ellen de Bruin, Theo Bult, Piet Bus, Johan Caldenhoven, Nico Eric ten Cate, Bob Coenen, Mark Collier, Fred Cottaar, Ans Coulier, Herrald Damen, Annemarie Dekker, Arend Dekker, Edial Dekker, Han Derks, Symen Deuzeman, Hans Diepstraten, Bert van Dijk, Hendrik Jan van Dijk, Jeanine van Dijk, Ricardo van Dijk, Jaap Dijkhuizen, Max van Dongen, Hendrik van Driel, Eugene Driessen, Peter Eekelder, Mennobart van Eerden, Tim Eestermans, Marlies Ellenbroek, Sander Elzerman, Ton Elzerman, Ton van Emond, Bas Engels, Thomas van der Es, René Faber, H.E. Fabritius, Rinnert Foekema, Cornelis Fokker, Sierd Folkertsma, Cor Gaasenbeek, Bert Geelmuijden, J. Genee, S.H. Genee, Ko van Gent, Marga Gerards, Wil Gerritse, Gerrit Gerritsen, Anne Gersjes, Yvonne de Geus, W. van de Giessen, Trudy van der Goes, Dolores Gonzalez, Gerard van Gool, Bas Gouda, Peter Gouman, Gerard van der Graaf, Annemieke Gras - Gaasenbeek, Jacques Gregoire, Douwe Greydanus, Frank van Groen, Ton Groen, Ronald Groenink, Eus de Groot, Hans Groot, Arijan Grootenhuis, Henk van Gurp, Rob Haan, Sietse Halma, Ad Hamers, Sonja Hartlief, Frank Haven, Leen Heemskerk, Gerrit Heester, Adrie van der Heiden, Jan Heins, Paul Heitkamp, Frits Hendrikse, Antoon van de Heuvel, Mike Hirschler, Rob ten Hoedt, Pieta van het Hoofd, Wilma Hoogenhuizen, Greta van Hoorn, M.M. Hoorweg, Ton Hooymans, Peter Hoppenbrouwers, Dio Hornman, Menno Hornman, Peter van Horssen, Dick Hörters, Maarten Hotting, Richard Houtman, Henk Hubers, G. Hylkema, Bert Idsingh, Eveline van der Jagt, Albert Jansen, Goen Jansen, Herman Jansen, Jan Jansen, Martin Jansen, Mieke Jansen, M. Jansen, Martien Janssen, Reinier Jaquet, Bart Jaspers, Ronald van Jeveren, Albert de Jong, Gert de Jong, Sem Jongeling, N. Jonker, Robert Jan Jonkvorst, Frank Jorna, Michel Kapoen, Bert Kasius, Paul Keizer, G.J.F. Keultjes, Marian Kienhuis, Olaf Klaassen, Romke Kleefstra, Michel Kleij, Michel Klemann, Jan Klop, Henk Knops, Wilbert Koch, W.J. Koch, Bea Koetsier, Ad Kok, Jeroen Kok, Michiel Kok, Rob Kole, Anton Koot, Ton Kops, Sjon Kortekaas, Jan Kraaiveld, Jan Kramer, Dagmar Kreykenbohm, J.J. van Krieken, Marjon van Kuijk-Rooseboom, J. Kuiper, Angeniet Kuipers, Erik Kuipers, Y.D. Kuipers, Tjerk Kunst, Hendrikus van der Laan, André Lagendijk, Erik Lam, Peter de Lange, Walter Langendorff, Hans Lankhaar, Christine Lecuivre, Marco van der Lee, Jacco Leemans, Ineke Leentvaar, Betty van Leeuwen, Jaap Jan Leeuwenburgh, J.J. Leeuwenburgh, Ruurd Jelle van der Leij, Theo Leijdens, B. van Leijen, C.A.W.M. Ligtvoet, Arie van der Linden, Leen van der Linden, Merijn Loeve, Kinie Lont, Bettie Lurvink, Helen Lut, Vivian Maas, Frank Majoor, Petra Manche, Rolf Mank, Els Marijs, Gert van der Meer, Erik Mensonides, Meriam Mentink, Tonny Molenaar, Hans Mom, Laura Mostert, Adri Mulder, Rob Muller, Jelle Naalden, José de Negro-Dermout, Henk Nekeman, Henrik de Nie, Karin Nieuwenhoff, Kornelis Nijboer, Gerrie Nijenhuis-Jansen, Pim de Nobel, Chris de Nooijer, Henriëtte Nool, P.A. Oirbans, Jos van Oostveen, Toot Oostveen, Luc Oteman, Laurens van der Padt, Frans Parmentier, Jan-Dirk Pater, Mick Pemberton, Jan van der Perk, Anke Persoon, Hans Pietersma, Jos Pilzecker, Matthieu Plaisier, Riëtte Platen, Wim Paul van der Ploeg, Arjan van Poecke, S.R. Polderman, Kees Pols, R.J. Ponsen, Jelle Postma, Astrid Potiek, Ben Pronk, Hans Quaden, Yvonne Rabe, Frank Regeer, Saskia Reinders, Sjoerd Reinstra, Henk Rensink, Bas van de Riet, Harrie Rietberg, Peter Rigterink, Willem Rijsdijk, Remke van Rijswijk, Jan Ritzer, A.L. Roobeek, Fons Roording, Mervyn Roos, Henk Ruissen, Aloys Sanders, Vincent Sanders, Jannes van Santen, Kees Schaper, Zweitse Scheeringa, Josien Schenkels, Piet Schermerhorn, B, Schilder, Sjouke Scholten, Piet Scholtens, Jan Schoonderwoerd, Jan Schoppers, Beppie Schothorst, Gerard Schreurs, Ivo Seelen, K. van Setten, Sipko Sikkes, Roy Slaterus, Wessel Slob, Herman Slot, Ellen Somhorst, K. Spijker, Dave v/d Spoel, H.J.M. Spruyt, Ed Staats, Berend Stam, Ronald Stolk, Wilco Stoopendaal, Dirk van Straalen, Rob Strucker, Johan Stuart, Freek Sturrus, Rob van Swieten, Joop Tempelaars, Sander Terlouw, Gerard Terpstra, Cor Tiecken, Remco Tiecken, Wim Tijsen, Pieter Tjeertes, Coen van Tuijl, Jan Tuin, Chris van Turnhout, Steven Uijen, Gerard Uppelschoten, Cor de Vaan, Laurens van der Vaart, Rick van Pelt, Paul van Veen, Eric v/d Velde, Cor van der Velden, Rian van Velthoven, R. Verbeek, Tineke Verbeek, Machiel Verhagen, Peter Verhelst, Guido Verhoef, Joop Verloo, Joop en Truus Vermeer, J.S.M. Vermeij, Huib Versloot, Rosina Verweij, M.A. Verweijen, Frank Visbeen, Hans Visser, Jan Visser, John Visser, Ruud van der Vlerk, Roland van der Vliet, Rob Vogel, Holmer Vonk, Bert Vos, Fieke Vos, G.E.J. de Vos, Gretha Vos, Marijke Vos, Wim de Vos, Berend Voslamber, Egbert Vrieling, Han Vrielink, Joop Vrielink, J. Vrijlink, Eric de Vroome, Harry van Vugt, Hans de Waard, Leen Walraven, D. Wammes, Tom van Wanum, Saskia Weddepohl, Fred Weel, F.H. van de Weijer, Durk Weijma, Monique Welle, Marc Westermann, Wim Westgeest, Cathy Wiersema, Bob Wiggers, Monique Wiggers, Sjoerd Wiggers, Harry Wijbrands, Anne-Mark Wijkel, René Wijnbergen, Laurens van der Wind, Erik van

Winden, Jan van der Winden, Albert Winkelman, Bert Winters, Bas Wisse, David de Wit, Cees Witkamp, Bob Woets, Pim Wolf, Toon van de Wolfshaar, Jan Fekke Ybema.

Annex 2. Species names

Species	Scientific	German	French	Dutch
Red-breasted Goose	Branta ruficollis	Rothalsgans	Bernache à cou roux	Roodhalsgans
Greater Canada Goose	Branta canadensis canadensis	Kanadagans	Bernache du Canada	Grote Canadese Gans
Barnacle Goose	Branta leucopsis	Weisswangengans	Bernache nonnette	Brandgans
Cackling Goose	Branta hutchinsii minima	Zwergkanadagans	Bernache de Hutchins ssp minima	Kleine Canadese Gans
Bar-headed Goose	Anser indicus	Streifengans	Oie à tête barrée	Indische Gans
Greylag Goose	Anser anser	Graugans	Oie cendrée	Grauwe Gans
Domestic Goose	Anser anser domesticus	Graugans Häuslich	Oie semi-domestique	Soepgans
Swan Goose	Anser cygnoides	Schwanengans	Oie cygnoïde	Zwaangans
Tundra Bean Goose	Anser serrirostris	Tundrasaatgans	Oie des moissons de la toundra	Toendrarietgans
Greater White-fronted Goose	Anser albifrons	Blässgans	Oie rieuse	Kolgans
Black Swan	Cygnus atratus	Schwarzschwan	Cygne noir	Zwarte Zwaan
Mute Swan	Cygnus olor	Höckerschwan	Cygne tuberculé	Knobbelzwaan
Tundra Swan	Cygnus bewickii	Zwergschwan	Cygne de Bewick	Kleine Zwaan
Whooper Swan	Cygnus cygnus	Singschwan	Cygne chanteur	Wilde Zwaan
hybrid goose		Hybrid gans	Hybride Bernache ou Oie	Hybride gans
Egyptian Goose	Alopochen aegyptiaca	Nilgans	Ouette d'Egypte	Nijlgans
Common Shelduck	Tadorna tadorna	Brandgans	Tadorne de Belon	Bergeend
Ruddy Shelduck	Tadorna ferruginea	Rostgans	Tadorne casarca	Casarca
Muscovy Duck	Cairina moschata	Moschusente	Canard musqué	Muskuseend
Wood Duck	Aix sponsa	Brautente	Canard carolin	Carolinaeend
Mandarin Duck	Aix galericulata	Mandarinente	Canard mandarin	Mandarijneend
Northern Shoveler	Anas clypeata	Löffelente	Canard souchet	Slobeend
Gadwall	Anas strepera	Schnatterente	Canard chipeau	Krakeend
Eurasian Wigeon	Anas penelope	Pfeifente	Canard siffleur	Smient
Mallard	Anas platyrhynchos	Stockente	Canard colvert	Wilde Eend
Domestic Mallard	Anas platyrhynchos domesticus	Stockente häuslich	Canard semi-domestique	Soepeend
White-cheeked Pintail	Anas bahamensis	Bahamaente	Canard des Bahamas	Bahamapijlstaart
Northern Pintail	Anas acuta	Spiessente	Canard pilet	Pijlstaart
Eurasian Teal	Anas crecca	Krickente	Sarcelle d'hiver	Wintertaling
Red-crested Pochard	Netta rufina	Kolbenente	Nette rousse	Krooneend
Common Pochard	Aythya ferina	Tafelente	Fuligule milouin	Tafeleend
Ferruginous Duck	Aythya nyroca	Moorente	Fuligule nyroca	Witoogeend
Tufted Duck	Aythya fuligula	Reiherente	Fuligule morillon	Kuifeend
Greater Scaup	Aythya marila	Bergente	Fuligule milouinan	Topper
Common Eider	Somateria mollissima	Eiderente	Eider à duvet	Eider
Velvet Scoter	Melanitta fusca	Samtente	Macreuse brune	Grote Zee-eend
Common Scoter	Melanitta nigra	Trauerente	Macreuse noire	Zwarte Zee-eend
Long-tailed Duck	Clangula hyemalis	Eisente	Harelde boréale	IJseend
Bufflehead	Bucephala albeola	Büffelkopfente	Garrot albéole	Buffelkopeend
Common Goldeneye	Bucephala clangula	Schellente	Garrot à oeil d'or	Brilduiker
Smew	Mergellus albellus	Zwergsäger	Harle piette	Nonnetje
Common Merganser	Mergus merganser	Gänsesäger	Harle bièvre	Grote Zaagbek
Red-breasted Merganser	Mergus serrator	Mittelsäger	Harle huppé	Middelste Zaagbek
Ruddy Duck	Oxyura jamaicensis	Schwarzkopf-Ruderente	Erismature rousse	Rosse Stekelstaart
Red-throated Loon	Gavia stellata	Sterntaucher	Plongeon catmarin	Roodkeelduiker
Black-throated Loon	Gavia arctica	Prachttaucher	Plongeon arctique	Parelduiker
Common Loon	Gavia immer	Eistaucher	Plongeon imbrin	IJsduiker
Little Grebe	Tachybaptus ruficollis	Zwergtaucher	Grèbe castagneux	Dodaars
Red-necked Grebe	Podiceps grisegena	Rothalstaucher	Grèbe jougris	Roodhalsfuut
Great Crested Grebe	Podiceps cristatus	Haubentaucher	Grèbe huppé	Fuut
Horned Grebe	Podiceps auritus	Ohrentaucher	Grèbe esclavon	Kuifduiker
Black-necked Grebe	Podiceps nigricollis	Schwarzhalstaucher	Grèbe à cou noir	Geoorde Fuut
White Stork	Ciconia ciconia	Weissstorch	Cigogne blanche	Ooievaar
Eurasian Spoonbill	Platalea leucorodia	Löffler	Spatule blanche	Lepelaar
Eurasian Bittern	Botaurus stellaris	Rohrdommel	Butor étoilé	Roerdomp
Grey Heron	Ardea cinerea	Graureiher	Héron cendré	Blauwe Reiger
Great Egret	Casmerodius albus	Silberreiher	Grande Aigrette	Grote Zilverreiger

Species	Scientific	German	French	Dutch
European Shag	Phalacrocorax aristotelis	Krähenscharbe	Cormoran huppé	Kuifaalscholver
Great Cormorant	Phalacrocorax carbo	Kormoran	Grand Cormoran	Aalscholver
White-tailed Eagle	Haliaeetus albicilla	Seeadler	Pygargue à queue blanche	Zeearend
Water Rail	Rallus aquaticus	Wasserralle	Râle d'eau	Waterral
Common Moorhen	Gallinula chloropus	Teichhuhn	Gallinule poule d'eau	Waterhoen
Eurasian Coot	Fulica atra	Blässhuhn	Foulque macroule	Meerkoet
Eurasian Oystercatcher	Haematopus ostralegus	Austernfischer	Huîtrier pie	Scholekster
Pied Avocet	Recurvirostra avosetta	Säbelschnäbler	Avocette élégante	Kluut
Northern Lapwing	Vanellus vanellus	Kiebitz	Vanneau huppé	Kievit
European Golden Plover	Pluvialis apricaria	Goldregenpfeifer	Pluvier doré	Goudplevier
Eurasian Curlew	Numenius arquata	Grosser Brachvogel	Courlis cendré	Wulp
Bar-tailed Godwit	Limosa lapponica	Pfuhlschepfe	Barge rousse	Rosse Grutto
Ruddy Turnstone	Arenaria interpres	Steinwälzer	Tournepierre à collier	Steenloper
Ruff	Philomachus pugnax	Kampfläufer	Combattant varié	Kemphaan
Dunlin	Calidris alpina	Alpenstrandläufer	Bécasseau variable	Bonte Strandloper
Eurasian Woodcock	Scolopax rusticola	Waldschnepfe	Bécasse des bois	Houtsnip
Jack Snipe	Lymnocryptes minimus	Zwergschnepfe	Bécassine sourde	Bokje
Common Snipe	Gallinago gallinago	Bekassine	Bécassine des marais	Watersnip
Common Sandpiper	Actitis hypoleucos	Flussuferläufer	Chevalier guignette	Oeverloper
Green Sandpiper	Tringa ochropus	Waldwasserläufer	Chevalier culblanc	Witgat
Common Redshank	Tringa totanus	Rotschenkel	Chevalier gambette	Tureluur
Black-headed Gull	Chroicocephalus ridibundus	Lachmöwe	Mouette rieuse	Kokmeeuw
Little Gull	Hydrocoloeus minutus	Zwergmöwe	Mouette pygmée	Dwergmeeuw
Mediterranean Gull	Larus melanocephalus	Schwarzkopfmöwe	Mouette mélanocéphale	Zwartkopmeeuw
Mew Gull	Larus canus	Sturmmöwe	Goéland cendré	Stormmeeuw
Great Black-backed Gull	Larus marinus	Mantelmöwe	Goéland marin	Grote Mantelmeeuw
European Herring Gull	Larus argentatus	Silbermöwe	Goéland argenté	Zilvermeeuw
Caspian Gull	Larus cachinnans	Steppenmöwe	Goéland pontique	Pontische Meeuw
Yellow-legged Gull	Larus michahellis	Mittelmeermöwe	Goéland leucophée	Geelpootmeeuw
Lesser Black-backed Gull	Larus fuscus	Heringsmöwe	Goéland brun	Kleine Mantelmeeuw
Gull spec.	Larus spec.	Möwe spec.	Goéland spéc.	Meeuw ongedet.
Common Kingfisher	Alcedo atthis	Eisvogel	Martin-pêcheur d'Europe	IJsvogel
Peregrine Falcon	Falco peregrinus	Wanderfalke	Faucon pèlerin	Slechtvalk
White-throated Dipper	Cinclus cinclus	Wasseramsel	Cincle plongeur	Waterspreeuw
Grey Wagtail	Motacilla cinerea	Bergstelze	Bergeronnette des ruisseaux	Grote Gele Kwikstaart

Annex 3. Amount imputing per species and area

Table 1 *Average % imputing per site (average over species) based on the years 2015/16, 2016/17 & 2017/18*

Rhine code	TRANSECT	% impute
S20	Bodensee	0%
S30	Hochhein, Rheinklingen - Aare junction	0%
S40	Hochhein, Aare junction - Basel	0%
F10	Oberrhein, Basel - Lauterbourg	1%
D10	Oberrhein, Lauterbourg - Bingen	28%
D20	Mittelrhein, Bingen - Bonn	55%
D30	Niederrhein, Bonn - Walsum	66%
D40	Niederrhein, Walsum - Grenze	53%
N10	Nederrijn	17%
N20	Waal	18%
N30	Beneden Rivierengebied	30%
N40	IJssel	9%
N50	Randmeren	40%
N60	IJsselmeergebied	0%
N70	Amsterdam-Rijnkanaal	0%
N80	Noordzeekanaal	0%

Table 2 *Percentage imputing per species per year in total Rhine Valley (green low percentage, red high percentage).*

	Average (all years)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Average (all species)	16	24	27	25	25	38	21	33	20	18	14	13	11	11	13	10	11	14	13	11
Greater Canada Goose	28	81	60	97	76	77	40	5	20	0	6	18	15	10	15	19	9	8	17	23
Greylag Goose	17	27	9	50	25	68	8	59	30	46	17	17	8	21	39	4	4	10	9	10
Tundra Bean Goose	45	1	2	2	4	3	7	5	2	2	4	5	18	16	23	3	35	42	82	51
Greater White-fronted Goose	16	26	7	13	19	32	31	48	9	13	15	9	4	3	12	3	2	19	6	15
Mute Swan	11	7	4	6	8	9	8	9	7	6	10	9	8	10	8	8	8	11	10	8
Whooper Swan	6	21	7	20	17	28	22	18	11	8	7	6	3	7	8	1	1	6	1	0
Egyptian Goose	37	94	96	96	89	95	91	98	93	77	71	47	11	14	3	1	2	9	0	2
Ruddy Shelduck	36	98	100	100	99	100	96	99	94	97	0	0	33	0	80	91	20	0	0	17
Northern Shoveler	18	24	31	17	11	46	15	13	9	11	12	8	14	25	14	11	22	17	36	15
Gadwall	9	14	20	16	12	25	8	10	6	14	10	10	7	8	17	4	5	7	6	5
Eurasian Wigeon	11	6	39	7	8	49	10	68	9	10	11	4	2	5	2	2	5	6	5	5
Mallard	23	34	28	33	40	50	33	29	24	26	31	27	24	23	21	13	22	23	20	14
Northern Pintail	15	17	36	20	23	71	30	61	25	21	24	10	14	15	10	2	4	7	7	13
Eurasian Teal	21	29	37	29	29	51	27	39	17	18	20	17	16	40	14	12	17	39	20	18
Red-crested Pochard	0	0	0	4	4	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
Common Pochard	11	25	27	21	31	29	18	22	10	9	8	12	9	8	6	5	8	6	6	5
Tufted Duck	8	8	17	10	13	23	11	21	8	7	6	8	7	5	4	3	6	6	6	5
Common Goldeneye	7	3	10	3	9	9	7	15	8	4	4	5	4	4	3	2	7	6	5	5
Smew	14	14	15	24	17	62	5	48	14	8	6	25	1	2	8	8	4	23	17	13
Common Merganser	10	4	36	12	17	45	6	53	54	4	10	4	1	3	4	3	2	26	6	5
Little Grebe	9	14	18	13	17	14	7	8	5	6	8	7	7	6	4	6	7	6	10	6
Great Crested Grebe	13	28	31	23	25	41	17	29	21	14	15	13	12	11	10	7	12	13	12	10
Black-necked Grebe	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Heron	15	12	16	13	14	17	20	32	19	17	19	19	18	16	17	12	13	20	12	11
Great Cormorant	19	33	43	27	29	34	22	27	15	13	21	24	21	21	22	18	26	33	23	25
Eurasian Coot	14	23	16	17	21	22	17	14	13	12	15	13	13	13	9	9	11	12	15	12
Black-headed Gull	25	29	28	21	33	48	29	56	29	34	33	23	22	20	15	24	37	37	29	26
Mew Gull	9	14	9	5	11	22	14	37	12	19	11	16	6	9	3	3	10	12	1	4

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Average (all species)	11	10	11	9	11	10	10	10	13	13	17	16	12	17	17	15	12	22	19
Greater Canada Goose	18	16	28	18	21	16	21	14	35	29	33	27	21	20	28	21	22	31	37
Greylag Goose	7	2	5	7	6	6	5	6	8	8	20	17	8	9	16	13	7	25	22
Tundra Bean Goose	73	57	76	79	75	75	70	84	59	71	81	92	84	76	67	66	85	83	64
Greater White-fronted Goose	11	2	10	7	7	8	18	17	15	19	23	17	17	19	28	19	25	41	15
Mute Swan	6	22	9	8	6	7	8	6	9	11	19	13	10	26	20	12	11	21	31
Whooper Swan	0	3	1	1	0	0	1	0	0	0	6	2	0	4	1	0	0	4	13
Egyptian Goose	1	3	7	12	7	6	13	13	29	31	43	31	21	26	30	30	25	55	35
Ruddy Shelduck	25	12	24	16	46	6	6	7	14	27	12	8	4	11	4	4	1	2	7
Northern Shoveler	10	7	6	8	3	8	10	8	10	14	28	36	13	30	38	28	4	24	38
Gadwall	5	6	4	3	5	6	5	4	11	5	12	10	5	8	9	16	2	14	17
Eurasian Wigeon	5	2	3	2	3	7	3	8	11	7	11	12	5	11	17	15	4	15	16
Mallard	16	13	14	13	18	20	18	17	19	16	24	22	21	21	20	24	17	25	24
Northern Pintail	5	7	5	1	2	2	2	1	5	3	5	9	4	30	9	10	1	25	24
Eurasian Teal	16	10	10	12	9	10	14	10	17	10	21	25	10	21	24	37	6	24	27
Red-crested Pochard	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Common Pochard	5	19	5	5	5	6	7	5	8	8	13	9	6	12	7	5	4	10	7
Tufted Duck	4	8	4	3	3	4	3	4	5	4	12	7	6	14	11	6	3	25	13
Common Goldeneye	4	6	3	4	4	4	6	4	8	6	13	11	6	12	13	6	5	15	13
Smew	9	6	1	3	7	13	7	6	5	4	3	5	17	34	28	18	16	26	14
Common Merganser	1	2	1	0	1	3	1	1	3	1	1	1	5	5	12	15	10	11	17
Little Grebe	9	6	6	6	11	10	10	10	16	9	12	11	9	8	6	10	6	10	8
Great Crested Grebe	9	6	6	6	5	6	7	7	8	5	9	8	5	7	5	7	5	12	7
Black-necked Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Heron	13	7	9	8	8	6	5	8	11	10	16	21	14	15	17	20	14	25	19
Great Cormorant	20	16	12	10	16	16	10	15	11	9	14	10	11	12	15	14	23	10	11
Eurasian Coot	10	13	9	7	7	8	10	10	10	9	15	15	13	23	18	12	9	27	22
Black-headed Gull	26	23	31	13	10	22	18	17	21	26	33	17	14	17	21	18	25	29	14
Mew Gull	5	1	12	4	9	6	6	5	8	8	10	5	3	4	7	5	8	12	10

Annex 4. Species attributes

Table 1 *Food, Habitat/food preferences and 1% thresholds as used in this report*

The 1 % Threshold for Gadwall, Teal, Mallard and Coot in Southern Rhine is the average of NW population and Mediterranean Population, in Tufted Duck and Common Pochard it is only Mediterranean Population. For the non-native Greater Canada Goose, Egyptian Goose and Ruddy Shelduck no appropriate 1% threshold can be given.

	P: Pisifore		pp: fish pelagic			
	H: Herbivore		hw: herbivore waterplants			
	B: Benthivore		hg: herbivores grass			
			bm: benthos mussels			
			marsh: shallow water, muddy shores, marsh			
Species	Food	Habitat / food lakes	Habitat / food river	1% Whole Rhine	1% Northern Rhine	1% Southern Rhine
Greater Canada Goose	H					
Greylag Goose	H	hg	hg	9,600		
Tundra Bean Goose	H	hg	hg	5,500		
Greater White-fronted Goose	H	hg	hg	12,000		
Mute Swan	H	hw	hg	2,000		
Whooper Swan	H	hw	hg	1,200		
Egyptian Goose	H					
Ruddy Shelduck	B					
Northern Shoveler	B/H	marsh	marsh	650		
Gadwall	H	hw	hw		1,200	1,550
Eurasian Wigeon	H	hg	hg	14,000		
Mallard	H	hg	hg		53,000	33,500
Northern Pintail	B/H	marsh	marsh	600		
Eurasian Teal	H/B	marsh	marsh		5,000	7,500
Red-crested Pochard	H	hw	hw	550		
Common Pochard	B	bm	bm		2,000	6,000
Tufted Duck	B	bm	bm		8,900	4,500
Common Goldeneye	B	bm	bm	11,400		
Smew	P	pp	pp	300		
Common Merganser	P	pp	pp	2,100		
Little Grebe	P	marsh	marsh	4,700		
Great Crested Grebe	P	pp	pp	6,300		
Black-necked Grebe	P	marsh	marsh	1,800		
Grey Heron	P	marsh	marsh	5,000		
Great Cormorant	P	pp	pp	6,200		
Eurasian Coot	H	hw	hg		15,500	20,250
Black-headed Gull	B/P			31,000		
Mew Gull	B/P			16,400		