BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS

ZOOLOGICAL MUSEUM . AMSTERDAM

No. 153 Volume 13 Oktober 8, 1965

Survey of marshes and wetlands in the Netherlands

M. F. Mörzer Bruijns and Z. Salverda

Rivon-communication nr. 220

The Netherlands are well known as a lowlying country with many marshes, inland waters and "polders" below sealevel.

The relative importance of the area of water and marshland is evident if one compares the areas of land utilisation in the Netherlands, given in ha in table I (Directie van de Landbouw, 1960).

TABLE I. *Land utilisation in the Netherlands on 31 December 1958 (in ha)*

Cultivated land (grasslands 1,324,000)	2,543,540
woodland	363,747
heath	80,434
peatland	31,559
inland dunes	7,733
beaches and seaside dunes	44,830
Flevoland Polder (partially cultivated, partially marshland)	37,897
waste lands	2,837
roads	81,675
dikes (without roads)	8,366
railroadtracks	9,942
built up areas, parks, gardens, etc.	216,311
marshes and wetlands	781,130
total near	4,110,000

Marshes and wetlands cover about one fifth of the total area of the Netherlands. Although in table I the coastal waters of the North Sea are not included, and of inland waters only those wider than 5 m, the marshes and wetland areas belong to a variety of waters and wetland types. The most important categories are given in table II.

Received January 7, 1965

TABLE II. *Categories of marshes and wetlands in the Netherlands (in ha approximately)*

Coastal waters	
Wadden Sea	267,000
coastal waters delta area	124,000
North Sea coastal waters (from the shore to 1 km off shore)	40,000
Coastal tidal marshes and mudflats	29,000
Inland fresh and oligohaline waters (< 300 mg Cl/l)	
IJsselmeer	231,000
other inland waters (static and running)	120,000
inland fresh water swamps	14,000
cultivated reeds and rushes	6,000
Wet cultivated grasslands (important as wetland area) (± 10% of the total area of cultivated grassland mentioned in table I, cf. DE BOER, 1956)	130,000
	961,000 ha

Table II shows that even more than 20% of the total area of the Netherlands is important as a wetland habitat. This survey deals with the following habitats:

I. Coastal waters (intertidal).
II. Coastal lagoons.
III. Coastal marshes.
IV. Shallow inland brackish water (> 100 mg Cl/l).
V. Shallow static inlands fresh water (< 100 mg Cl/l).
VI. Shallow flowing inland fresh water.
VII. Mineral marshes (wet cultivated grasslands).

I COASTAL WATERS

The most important waters of this area are:

1. Wadden Sea.
2. Brielse Gat.
3. Coastal waters of the Rhine-Meuse delta-area.
4. Wester Schelde.
5. Coastal waters of the North Sea.

I. 1. *Wadden Sea*

Location: The Wadden Sea is situated in the north of the Netherlands between the mainland of Friesland and Groningen, the "Afsluitdijk" and the Wadden islands. The Wadden Sea communicates with the North Sea. It is a shallow coastal sea. At low tide large areas fall dry as tidal mudflats, leaving between them a pattern of deeper water (POSTMA, 1954). The total area is 270,000 ha including the Lauwers Sea (7,600 ha) and the brackish Eems and Dollard area (18,000 ha). Along the coast of the mainland and the Wadden islands on several places saltmarshes have developed (cf. Cat. III, "Coastal marshes", p. 9).

Botanical interest: *Zostera* spp. and marine algae vegetations, marine and brackish phytoplankton communities (DEN HARTOG, 1959).

Hydrobiological interest: Plant- and animal life of a shallow tidal coastal sea with sandbanks, sand and mudflats, etc., rich in species (VERWEY, 1954; KRISTENSEN, 1957, 1959).
Fishery importance: Commercial fishing of shrimps (*Crangon vulgaris*), mussel (*Mytilus edulis*) and cockle (*Cardium edule*), flatfish (*Pleuronectes flesus* and other species), eel (*Anguilla vulgaris*).
Other fauna: The Wadden Sea is extremely rich in birdlife. The whole year round hundreds of thousands of birds feed on the tidal flats and in the shallow water (ROOTH, 1960; VERWEY, 1956). Among them geese (*Branta* spp.), ducks (*Anas, Aythya, Bucephala, Melanitta, Clangula, Somateria, Mergus, Tadorna*), waders (*Charadrius, Numenius, Limosa, Tringa, Calidris, Crocethia, Recurvirostra*), gulls (*Larus*) and terns (*Sterna*). The Wadden Sea is without doubt one of the most important feeding areas in Western Europe for migrating and wintering birds. It is also of importance for numerous breeding bird populations for instance for about 50,000 *Somateria mollissima* (WILCKE, 1956), 10,000 *Tadorna tadorna* (TIMMERMAN, 1960), 60,000 *Sterna sandvicensis*. Probably ± 80% of the worldpopulation of this species breeds in the Netherlands (ROOTH & MÖRZER BRUIJNS, 1959). The most important areas for the birds are:
Dollard mudflats, the Lauwers Sea area, the Noorderleeg area north of Friesland, Balgzand area near Den Helder, Eendrachtschorren east of Texel, Vliehors and Posthuiswad on Vlieland, the Boschplaat area on Terschelling and Griend in the centre (BROUWER et al., 1950). The Wadden Sea area also has a population (1,000—1,500 individuals) of the Harbour Seal (*Phoca vitulina*) (VAN BEMMEL, 1956).
Important: In the Wadden Sea area several large wildfowl reserves are established, among them the surroundings of the little island "Griend" in the centre of the area with large breeding colonies of terns and along the coasts of Friesland and of the islands Texel, Vlieland and Terschelling (cf. BRAAKSMA & MÖRZER BRUIJNS, 1958). There are two large Harbour Seal reserves.

I 2. *Brielse Gat*

Location: Formerly the Brielse Gat was the mouth of the river Brielse Maas near the old town of Brielle south-west of Rotterdam. Since the river Brielse Maas was closed by a dam in 1950 (part of the delta works) the Brielse Gat is a bay of the North Sea with sandbanks, mudflats and shallow salt, locally brackish water. The area covers c. 2,000 ha.
Botanical interest: The Brielse Gat is interesting for its algae-communities characteristic for different habitats of salt and brackish waters.
Hydrobiological interest: Rich and well developed

communities of shallow seawater, mudflats and brackish creeks.
Fishery importance: None.
Vertebrate fauna: The "Brielse Gat" is a very important feeding area for numerous bird populations. *Anas, Tadorna,* several *Larus* and 3 *Sterna* species, also for *Recurvirostra avocetta* and *Tringa totanus* breeding in the nearby coastal areas. In autumn, in spring and during winter the shallow water, the mudflats and the large sandbank Westplaat are of great importance for tens of thousands of migratory birds. The same species mentioned for the Wadden Sea. For the shore birds on their way, the Brielse Gat, the station nearest to the Wadden Sea, is at a distance of 100—200 km. The great importance of the Brielse Gat as an area of biological interest is recently stressed by ADRIANI & VAN DER MAAREL (1962).
Other important aspects: A part of the Brielse Gat is a nature reserve. The area is, however, seriously threatened by the construction and extension of the Europort-Rotterdam harbour.

I 3. *Coastal tidal waters of the delta area (Rijn-Maas) in the south-west of the Netherlands*

These waters:
1. Haringvliet (9,500 ha) and Hollandsch Diep (approx. 8,500 ha)
2. Grevelingen, Krammer (approx. 20,500 ha)
   and
3. Ooster Schelde (approx. 34,000 ha)
   belong to different habitat types.

I 3.1. Haringvliet and Hollandsch Diep, located south of the province of Zuid-Holland are tidal. The eastern parts of the Hollandsch Diep are fresh, the mouth of the Haringvliet is salt, while the greater part of the area is brackish.
Botanical interest: The tidal shorelands of these brackish waters have very interesting marshland vegetations (*Scirpus maritimus, Scirpus triqueter, Scirpus tabernaemontani, Phragmites communis* and *Salix* coppice).
Hydrobiological interest: In the brackish water characteristic plant and animal communities live, among them several elements which are rare in this country e.g. *Trochaeta bykowsky* (Hirudinae) and *Pseudamnicola confusa* (Mollusca) (DEN HARTOG, 1960, 1961).
Fishery importance: The Haringvliet and Hollandsch Diep are of great importance to the fishery (mainly *Anguilla vulgaris* and *Osmerus eperlanus*).
Vertebrate fauna: The area is very important to wildfowl and waders. In autumn, winter and in spring sometimes thousands of swans (*Cygnus olor, Cygnus cygnus* and *Cygnus bewickii*), tens of thousands of geese (*Anser anser, Anser albifrons, Anser fabalis, Branta leucopsis*) and much larger numbers of ducks (mostly *Anas platyrhynchos, A. clypeata, A. crecca, A. penelope, A. acuta*) are

living in the area. Many waders feed at low tide along the shores and on the mudflats. Hollandsch Diep is also an important habitat to the Fish Otter (*Lutra lutra*).

I 3.2. Grevelingen, Krammer and Volkerak (20,500 ha).

Location: Between the islands Goeree-Overflakkee and Schouwen and St. Philipsland (Prov. of Zeeland). Brackish to salt water, tidal, partially deeper than 6 m.

I 3.3. Ooster Schelde (34,000 ha).

Location: In the province of Zeeland between Schouwen and Tholen and Noord- and Zuid-Beveland. The Ooster Schelde contains pure unpolluted clear seawater. It has very deep parts (approx. 50 m) and among types of transition areas to shallow water, many sandbanks and tidal mudflats.

Biological important: Biologically the areas I 3.2. and I 3.3. belong to the most interesting coastal waters of the Netherlands, because practically all biotic communities of the North Sea and of brackish coastal water are represented in the area. Vegetation and fauna can be studied in well developed zonations (zones of Phaeophyta and Rhodophyta). Although Grevelingen and Ooster Schelde are more or less comparable with the Wadden Sea both areas are distinctly different.

Fishery importance: The area is of importance to fisheries. The main objects are: *Ostrea edulis, Mytilus edulis, Homarus vulgaris, Crangon vulgaris, Stolephorus encrasicholus, Pleuronectes* and *Solea* sp.

Vertebrate fauna: Breeding area for many birds of the seacoast. A great percentage of the Netherlands populations of *Tadorna tadorna, Recurvirostra avocetta, Charadrius hiaticula, Ch. alexandrinus, Sterna hirundo, St. sandvicensis, St. albifrons, St. paradisea,* lives in this area.

In winter many divers (*Colymbus* spp.) and many thousands of ducks and waders feed along the shores (*Calidris* spp., *Limosa lapponica, Numenius arquata, Haematopus ostralegus, Anas* spp. *Branta bernicla, Somateria mollissima, Melanitta nigra*).

A Harbour Seal population (*Phoca vitulina*) of about 500 individuals lives in these waters.

Important: As the coastal tidal waters of category I 3. will be isolated from the North Sea, as a consequence of the delta works, the water will become brackish and fresh.

Although they will become completely different from what they are at this moment, one may expect that these areas will remain of great importance as wetland habitat. The situation is comparable with that of the former Zuiderzee which became the IJsselmeer in 1932.

I 4. *Wester Schelde*

Location: In the province of Zeeland, between Walcheren

and Zuid-Beveland and the mainland of Zeeuwsch-Vlaanderen. The area is 39,000 ha. The water of the river Schelde flows through the Wester Schelde to the North Sea. The Wester Schelde will be the only coastal water in the delta area which will remain in open communication with the North Sea.

Biological importance: The Wester Schelde for this reason is from a scientific viewpoint of special importance. It will be the only larger area where the biotic communities characteristic of the delta region will be able to survive after the deltaworks are completed.

Interesting for the Wester Schelde are the variety of habitats and the transition areas. In the eastern parts the water is nearly fresh, gradually becoming brackish further to the west and near the North Sea it is almost completely salt. There are deep parts and shallow areas, with sandbanks and mudflats, falling dry at low tide.

Along the shores at several places very interesting coastal marshes can be found (cf. III), the Verdronken Land van Saaftinge being the most important (MAEBE & VAN DER VLOET, 1956).
Due to these circumstances the botanical and hydrobiological interests of the Wester Schelde are great.

Fishery importance and vertebrate fauna: It is an important fishing area and also important to its birdlife. Large flocks of geese, swimming and diving duck and waders live along the shores and on the sandbanks and mudflats. There are also thousands of them during the breeding season, during migration and in wintertime. In the western part of the Wester Schelde there is a moulting place for *Tadorna tadorna* (MAEBE & VAN DER VLOET, 1952). A small population of the Harbour Seal (*Phoca vitulina*) maintains itself in the area.

Important: The Wester Schelde is the entrance to Antwerp harbour and many ships pass day and night, so that the water of the Wester Schelde is more or less polluted. Along the shores in great parts nature or waterfowl reserves are established.

I 5. *Coastal waters of the North Sea*

Location: The length of the North Sea coast in the Netherlands is approximately 400 km. The coastal waters are nearly without exception shallow and the bottom is sandy. There are several rows of sandbanks along the coast parallel to the sandy beach. The animal communities living in this area are adapted to life in tidal currents, turbulent water and moving sand (VAN REGTEREN ALTENA, 1959). There is commercial fishing in these waters (*Crangon vulgaris*, *Pleuronectus* div. spec., *Solea*, etc.).

Many birds visit the zone of shallow water near the shore, for example, in the breeding season thousands of gulls, terns and eider-duck and during migration tens of thousands of *Melanitta nigra*, hundreds of *Melanitta fusca*, thousands of *Somateria mollissima*,

many *Uria aalge* and *Alca torda*. It is important that no shooting is allowed anywhere along the North Sea coast in the Netherlands. The coastal waters however are regularly polluted by oil (TANIS & MÖRZER BRUIJNS, 1962).

II COASTAL LAGOONS

In this survey shallow brackish or oligohalinic waters near the coast are described as coastal lagoons. In the Netherlands four categories of coastal lagoons can be discerned.

1. Shallow static (stagnant) oligohalinic waters in the coastal dunes.
2. Shallow claypits near the coast.
3. Larger waters (former arms of the sea, bays and creeks) cut off from the sea by dams.
4. Shallow waters and marshlands in dune valleys intermittently communicating with the sea and flooded irregularly (at least once a year).

II 1. *Shallow static (stagnant) oligohalinic waters in the coastal dunes.* The most important waters of this category are:

II 1.1. The Muy on Texel (approx. 50 ha).

II 1.2. The Zwanenwater near Callantsoog (approx. 150 ha).

II 1.3. Three waters on Voorne, the Brede Water, the Quackjeswater and the Waal (approx. 50 ha) (cf. BLAAUW 1917, HOFKER e.a., 1934/1935).

II 1.4. The Badhuisplak, the Griltjeplak and Doodemanskisten, Terschelling (together approx. 100 ha) (WESTHOFF, 1947).

These waters are of great interest to botanists, zoologists, and hydrobiologists. They have no importance to fisheries, but are famous for their birdlife: breeding colonies of *Platalea leucorodia* and *Ardea cinerea, Anas* div. spec., *Rallus* spec., *Circus aeruginosus, Acrocephalus* div. spec. (DRIJVER, 1957). Breeding and resting area for migratory waterbirds. Botanically they are interesting for their communities of Littorellion, Nanocyperion, Schoenetum and Caricion nigrae (with species such as *Cladium mariscus, Schoenus nigricans, Anagallis tenella, Carex pulchella, C. trinervis, Juncus balticus, J. anceps, J. pygmaeus, Deschampsia setacea, Cicendia filiformis, Blackstonia perfoliata, Parnassia palustris, Liparis loeselii*) (WESTHOFF, 1947). The areas 1, 3 and 4 mentioned are nature reserves.

II 2. *Shallow claypits near the coast*

The most important areas of this category in the Netherlands are:

II 2.1. Brackish waters behind the Hondsbosse Zeewering near Petten (Prov. of Noord-Holland).

II 2.2. Several "Inlagen" in the Prov. of Zeeland, especially those on Schouwen. These shallow brackish waters have very interesting plant-communities characteristic for siltclay soils with *Salicornia, Puccinellia fasciculata* and *P. distans, Juncus maritimus, Scirpus*

maritimus and *S. tabernaemontani.* The animal life is also interesting. These areas are famous for their birdlife, being among the most important breeding places for the avocet (*Recurvirostra avocetta*) and the terns (*Sterna hirundo, St. sandvicensis, St. paradisea*), but also for waders (*Tringa totanus, Charadrius hiaticula,* etc.). The coastal claypits are also feeding areas and resting places for numerous migratory and wintering ducks and waders.

II 3. *Larger waters cut off from the sea by dams*

Among the most important of this category ought to be mentioned:

II 3.1 Brielse Meer (approx. 1,000 ha) near Brielle (south of Rotterdam) in the vicinity of the "Brielse Gat" (cf. I 2.). Cut off from the sea in 1950 (LEENTVAAR, 1955).

II 3.2. Veerse Meer (aprox. 2.000—3,000 ha) near Veere (on Walcheren, prov. of Zeeland). Cut off from the sea in 1961 (LEBRET, 1962).

II 3.3. Rammekenshoek (approx. 100 ha) on Walcheren (prov. of Zeeland) near Vlissingen (= Flushing) (LEENTVAAR, 1961).

II 3.4. Brakmankreek (approx. 200 ha) near Hoek (prov. of Zeeland). Cut off from the Wester Schelde in 1952. (SUETENS, 1961).

II 3.5. Othenensekreek (c. 100 ha) near Terneuzen (prov. of Zeeland).

II 3.6. Grote Gat (c. 100 ha) near Oostburg (prov. of Zeeland). These waters are important as habitats for plant and animal life of oligohalinic waters (*Ruppia spiralis, Zannichellia pedicellata, Potamogeton pectinatus, Enteromorpha* spp., *Cladophora fracta, Rhizoclonium* spp., Gammaridae).

II 3.3 is the only site in the Netherlands, where *Gonionemus vertens* (Hydromedusae) is found. II 3.6 is famed for the Bryozoa formations forming large calcareous concretions. The waters are important to fisheries: *Anguilla vulgaris.*

F a u n a : These shallow brackish waters are good feeding grounds for birds as well in the breeding season as during the migrating season. Great numbers of duck, waders and other waterbirds visit these areas.

I m p o r t a n t : The numbers II 3.1, II 3.2, II 3.4 are of importance to recreation. The development as recreation area (boating, swimming, bungalows) etc. is threatening seriously some very interesting sites. It caused already the loss of an important part of the Brakmankreek (II 3.4.) as a haunt for many thousands of wildgeese (mostly *Anser albifrons*).

II 4. *Shallow waters and marshlands in dune valleys still communicating with the sea*

Larger dune valleys or comparable areas, with open water, during high or very high tides flooded by the sea, but normally fresh or brackish. This environment is rare in the Netherlands. They form a very characteristic habitat which is biologically highly interesting.

The most important areas of this type are :

II 4.1. Slufter (50—100 ha) on Texel (VAN DER BORG e.a., 1961).

II 4.2. Zwin (approx. 50 ha) near Cadzand partially in the Netherlands (prov. of Zeeland), for the greater part in Belgium (MÖRZER BRUIJNS, LAWALREE e.a., 1952).

II 4.3. Western part of Boschplaat (approx. 400 ha) on Terschelling (WESTHOFF, 1947).

II 4.4. Inundated Zwarte Polder near Cadzand (40 ha).

II 4.5. Eastern part of Schiermonnikoog (approx. 600 ha).

These areas have very interesting plantlife and animal populations. Among the many interesting plant species may be named *Catapodium marinum, Centaurium vulgare, C. pulchellum, Sagina maritima, Schoenus nigricans, Oenanthe lachenalii, Juncus anceps, J. balticus, Scirpus rufus, S. planifolius, S. americanus, Samolus valerandi, Carex vikingensis, C. punctata, Parnassia palustris, Orchis incarnata.* They are especially of great importance to many sea shore breeding birds (*Recurvirostra avocetta, Charadrius alexandrinus, Charadrius hiaticula, Haematopus ostralegus*) to gulls and terns and also to migrating waders and duck.

The areas 1, 2, 3 mentioned are nature reserves.

III COASTAL MARSHES

Coastal marshes in the Netherlands are situated in the north of the country in the Wadden Sea and in the south-western part in the delta-area.

The coastal marshes in the Netherlands are permanent marshes; their outer zones are flooded regularly at high tide. In the Wadden Sea most of them are salt marshes on sandy soils with a low silt content, which may cover considerable areas up to 3,000 hectares. They represent interesting zonations of plant communities, starting from the open Salicornietum europeae. The regularly flooded closed vegetations have joined into the alliance Puccinellion maritimae (formerly named Puccinellio-Salicornion); the higher salt marsh communities are assigned to the alliance Armerion maritimae, with communities such as Artemisietum maritimae, Juncetum gerardi, Armerieto-Festucetum and Junceto-Caricetum extensae. The frequency of *Halimione pedunculata* and *Cochlearia anglica* is remarkable. The Salicornietum often is replaced by a community of the (introduced) *Spartina townsendii.* In the Dollard estuary the coastal marshes are brackish; the dominant vegetation consists of communities of tall-sized *Aster tripolium, Scirpus maritimus* and *Phragmites communis* (WESTHOFF, 1947, 1958).

In de Delta area, i.e. the south-western estuary region, the coastal marshes developed mostly on heavy clayey soils. The native species *Spartina stricta* practically has been exterminated by the invading *Spartina townsendii.*

In the lower salt marsh communities (Puccinellion) the Halimionetum portulacoides on creek banks is the major component near the Puccinellietum maritimae. Near the North Sea the marshes are found mostly on heavy clayey

soils as salt marshes, but at a greater distance from the sea they become more and more brackish and in the eastern parts of the Hollandsch Diep even fresh. This gradient from salt to brackish and fresh is of great interest as well to the botanist as to the zoologist (BEEFTINK, 1957, 1958). In most places the coastal marshes are good grazing grounds for sheep, cattle and horses. They are of great importance to birdlife. During high tide great flocks of birds concentrate in the coastal marshes where on higher places breeding colonies are to be found of *Sterna hirundo, Sterna sandvicensis, Larus argentatus, Larus canus, Larus ridibundus.* Many *Tringa totanus, Haematopus ostralegus, Vanellus vanellus, Recurvirostra avocetta, Somateria mollissima* breed also on higher places in the salt marshes. *Calidris alpina schinzii*, a rare species in the Netherlands, breeds in the habitat. During migration and in wintertime the coastal marshes are a good feeding place for many migratory species (geese, duck and waders).

The most important coastal marshes are:

A. *In the Wadden Sea* (approx. 9,000 ha).

III 1. *Marshes in the Dollard, including Punt van Reide (1,000 ha) (Prov. of Groningen).*
These biologically very important marshes probably will be reclaimed before long.

III. 2. *Coastal marshes of the Wadden islands*
Oosterkwelder on Schiermonnikoog (500 ha), Nieuwlandsrijd on Ameland (500 ha), Boschplaat on Terschelling (1,000 ha) (MÖRZER BRUIJNS & BRAAKSMA, 1954), Posthuiswad on Vlieland (100 ha) (ROOTH, 1960), Eendrachtschorre on Texel (200 ha).

III 3. *Coastal marshes of the north coast of Friesland*
Lauwers Sea (2,000 ha), Noorderleeg (2,000 ha).
The Lauwers Sea will be cut off from the Wadden Sea by a dike which will probably be ready in 1967. In the polder reservoir, which will be an important part of the new polder, a wildfowl reserve will be established.

III 4. *Coastal marshes of the Balgzand near Den Helder (province of Noord-Holland)* (DEN HARTOG, 1958)

B. *In the delta area (8,000—9,000 ha, 5,800 of which in the Wester Schelde)*
The most important coastal marshes in this area are :

III 5. *Salt marshes of the "Groene Strand" on De Beer near Hoek van Holland* (VAN LEEUWEN & WESTHOFF, 1961).

III 6. *Salt and brackish marshes of the "Groene Strand" on the island of Voorne* (ROOSMA, not published; ADRIANI & VAN DER MAAREL, 1962).

III 7. *Salt and brackish marshes of the "Kwade Hoek" on the island of Goeree* (WESTHOFF et al, 1962)

III 8. *Brackish coastal marshes along the shores of the Haringvliet and Hollandsch Diep* (among others: "Scheelhoek" near Stellendam on Goeree and "Ventjagersplaats" east of the island Flakkee (BEEFTINK, 1958).

III 9. *Coastal marshes in the polyhaline Wester Schelde*

The coastal marshes of the Wester Schelde (in total 5,800 ha) are among the most important coastal marshes in the Netherlands, because they will not be affected by the delta-works (BEEFTINK, 1958).

From west or east the "Kaloot" near Borssele on Zuid-Beveland, the "Savoyaardplaat" north of the Brakmanpolder near Terneuzen in Zeeuwsch-Vlaanderen, the "Verdronken Land van Saaftinge" near Hontenisse (Zeeuwsch-Vlaanderen) and the "Schorren van Ossendrecht" in the eastern parts of the Wester Schelde.

From these marshes the "Verdronken Land van Saaftinge" is the largest (± 3,000 ha) and most important area.

IV SHALLOW INLAND BRACKISH WATER

Waters and additional marshes of this category are existing in the Netherlands in all provinces near the coast. The IJsselmeer also belongs to this group. The brackish environment may be reckoned among one of the most characteristic aquatic habitats of the Netherlands.

Normally the water is only slightly brackish oligohaline (between 100 and 1,000 mg Cl/l, rarely mesohaline (more than 1,000 mg Cl/l. The salinity of the inland waters is due to salt water welling up from the subsoil or penetrating into the polderland from outside through sluices, etc. (REDEKE, 1932, 1948).

The total area of inland brackish water in the Netherlands is approximately 70,000 ha, together with the IJsselmeer (231,000 ha), about 300,000 ha, nearly 60% of the total acreage of inland static water.

The most important areas are:

IV 1. *IJsselmeer and its borderlakes Amstelmeer, Ketelmeer and Veluwemeer*

IV 1.1. IJsselmeer (= IJssel-lake)

Location: In the centre of the Netherlands, originally a part from the Zuiderzee. This part became a "lake" and fresh after being separated from the Wadden Sea and North Sea by the "Afsluitdijk" (= dam) between Holland and Friesland, the building of which was finished in 1932. The IJsselmeer now is an oligohaline lake, shallow, only locally deeper then 6 m.

Botanical interest: Interesting are the belts of *Potamogeton pectinatus*-vegetations in the large shallow coastal zones in many places along the coast. These zones often have a width of 1—2 km and a depth of not more than 1.5 m.

Very important are the coastal marshes along the shallow coast of Friesland (with a length of c. 60 km), for instance the coastal marshes of the Makkumerwaard, the Workumerwaard, the Mokkebank near Laaxum and the Steile Bank near Gaasterland. The coastal zones in the southern parts of the IJsselmeer (between Nijkerk and Huizen) are equally important. The *Potamogeton* vege-

tations and the coastal marshland vegetations consisting mainly of Phragmition-phytocoenoses (*Phragmites communis, Scirpus maritimus*) provide food and shelter for animal life rich in individuals and in species.

Hydrobiological interest: The IJsselmeer has been studied by hydrobiologists since 1932. The succession of plant- and animal-life from salt via brackish to nearly fresh has been studied. For example the invasions of *Lymnaea ovata, Dreissena polymorpha* and chironomids were exceptionally interesting, because the flora and fauna of the former "Zuiderzee" have been studied also. The results have been published (REDEKE c.s., 1922, 1935, 1936).

Fishery importance: There is mainly commercial fishing in the IJsselmeer. The most important species are *Lucioperea sandra* (catches up to 60,000—70,000 kg per month during the season), *Abramis brama, Blicca bjorkna, Leuciscus* spp. (up to 100,000—200,000 kg per month during the season), *Perca fluviatilis* (9,000—25,000 kg per month during the season) and *Anguilla vulgaris* (up to 500,000 kg per month) (cf. Uitkomsten van de Visserij in „Visserijnieuws", 's-Gravenhage). The total yield of the IJsselmeer fishery is approximately 5,000,000 kg per annum, worth about *f* 10,000,000. There is also sportfishing in the IJsselmeer.

Fauna: Large numbers of water- and marshland birds live along the IJsselmeer coast especially in the shallow zones with plant-growth. In autumn, winter and in spring hundreds of thousands of waterbirds (mainly duck) visit the IJsselmeer area (the IJsselmeer itself and the border lakes). They stay for a short period, passing on in migration or for months when hibernating in mild winters. Thousands of *Cygnus bewickii* and *Cygnus olor* visit the area. *Cygnus cygnus* is normally present in small numbers only. *Anser anser, Anser albifrons, Anser fabalis brachyrhynchus* sometimes can be observed in flocks of thousands. Far more numerous are *Anas platyrhynchos, A. crecca, A. penelope, A. acuta, A. querquedula, A. clypeata,* in deeper water *Bucephala clangula, Aythya fuligula, Aythya ferina* and *Aythya marila* (cf. TIMMERMAN, 1962a). *Fulica atra* winters on the IJsselmeer in flocks of thousands. Moreover many other marshland birds, *Ardea* spp., *Botaurus stellaria* waders, gulls, terns and smaller reedland birds (for instance the rare *Panurus biarmicus*) are living in the coastal marshland.

Other elements: Parts of the IJsselmeer are reclaimed as "IJsselmeerpolders": Wieringermeerpolder, Noordoostpolder, Oostelijk Flevoland Polder, two other big polders with an acreage of more than 100,000 ha will be reclaimed in the future. Between the new polders and the old mainland, large waters, originally parts of the IJsselmeer, are preserved as border lakes. They are of great value not only to purposes of water management, but also to water-

sports and to the conservation of water- and wetland-habitats. Several of these waters are even among the most important wildfowl reserves in this country (BRAAKSMA & MÖRZER BRUIJNS, 1958). In 1962 the following oligohaline border lakes exist:

IV 1.2. Amstelmeer (appr. 400 ha) between Wieringermeerpolder, the Afsluitdijk and the former island Wieringen (HARMSEN, 1949).

IV 1.3. Ketelmeer (± 4,000 ha) between Noordoostpolder and Oostelijk Flevolandpolder.

IV 1.4. Veluwemeer (± 4,000 ha) between Oostelijk Flevoland and the mainland of Gelderland (LEENTVAAR, 1961). Two other borderlakes of the IJsselmeer. The "Vollenhovensemeer" and the "Zwarte Meer" between Noordoostpolder and the mainland of Overijssel are not oligohaline (although they formerly were), but fresh (vide Chapter V).

The other important oligohaline inland waters are:

IV 2. *Schildmeer* (250 ha) in the north east of the province of Groningen. This shallow lake is the only broad in the oligohaline part of this province. Three other broads or lakes (together 1,000 ha) are located in the inland fresh water area of Groningen (vide Chapter V). The total acreage of oligohalinic and fresh water in Groningen is approx. 7,500 ha.

IV 3. *Larger waters in the province of Friesland.*

The greater part of the province of Friesland has slightly brackish, oligohaline water, covering about 80% of the total area of waters wider than 5 m, which is 26,000 ha. About 17,000 ha of these waters are of importance to fishing.

The Frisian broads or "lakes" as they are called usually, although very shallow (less than 3 m), and well known for their watersport especially yachting, belong with only one exception (Tjeukemeer) to the oligohaline area. Together they cover an area of 8,000 ha. These broads vary individually from 200—2,000 ha. The most important are by name:

Bergumermeer (470 ha), De Leyen (370 ha), Prinsenhof and Eeën, Wijde Ee and Pikmeer and others (500 ha), near Grouw, Sneekermeer (ca. 1,280 ha) near Sneek, Langweerder Wielen (240 ha), Koevordermeer (390 ha), De Grote Brekken (320 ha), Slotermeer (1,140 ha), Heegermeer, Fluessen en Morra (2,280 ha), Grote Gaastmeer and Zandmeer, Vlakke Brekken and Oudegaster Brekken (520 ha). These broads are located in a rather narrow belt in the lowlying grassland area in the middle of Friesland, between the Lauwerszee in the north-east and the IJsselmeer near Stavoren in the south-west (LEENTVAAR, 1956).

IV 4. *Alkmaardermeer and other larger waters* in the northern parts of the province of Noord-Holland. The total acreage of waters in the province of Noord-Holland is approximately 21,000 ha. The greater part of this area consists of smaller waters and canals which

are of great importance as aquatic habitats in this waterland par excellence, but not to be mentioned in this survey. Only about 5,000 ha is formed by larger waters and additional marshlands. Among those the most important are:

IV 4.1. Alkmaardermeer (± 700 ha) S. of Alkmaar.

IV 4.2. Wormer and Jisperveld (250 ha) near Wormerveer.

IV 4.3. Uitdammer Die (300 ha) N. of Amsterdam.

IV 5. *Larger waters in the provinces of Holland and Utrecht*

The waters of Holland and Utrecht are also without exception oligohaline. The total acreage of inland water in this province is 17,000 ha; 4,200 ha is formed by larger waters. Four complexes are of importance to this survey (VAN ZINDEREN BAKKER, 1947).

IV 5.1. Westeinder Plassen (1,040 ha), Brasemermeer (520 ha), Plassen van Langeraar (250 ha) and Kagerplassen (420 ha). A complex of broads S. of the Haarlemmermeer near Haarlem. These broads are noted for watersport (especially yachting), but also for their plant and animal life (OTTO, 1927).

IV 5.2. Vinkeveense plassen (690 ha) and Botshol (300 ha) S. of Amsterdam. The Vinkeveense plassen are important to watersports. Botshol is a nature reserve (WESTHOFF c.s., 1949).

IV 5.3. Nieuwkoopse plassen (400 ha) in the east of the province of South-Holland. For a great part nature reserve, partially of importance to watersports.

IV 5.4. Reeuwijkse plassen (660 ha) in the centre of the province of South-Holland near the town of Gouda. A part of these broads is of great importance to various kinds of watersports, other parts are nature reserves (SCHEYGROND, 1933).

The shallow oligohaline inland waters are of great interest to the biologist, because plantlife, animal life e.g. the planktonbiocenoses in these waters differ distinctly from those in fresh water.

Botanical interest: The plantcommunities of the brackish water have a character of their own. In deeper water (more than 1 m) *Potamogeton pectinatus, Najas marina* and *Nitellopsis obtusa* are typical components of the vegetation. In the surrounding marshland *Phragmites communis, Scirpus maritimus, Althaea officinalis, Cochlearia officinalis* and *Sonchus paluster* are the most characteristic species (VAN NIEUWENHOVEN, 1942). In the adjoining wetlands the communities of *Lychnis flos-cuculi, Hypericum tetrapterum* and that of *Ophioglossum vulgatum* and *Orchis morio*, with some halophytes such as *Samolus valerandi, Glaux maritima, Juncus gerardi, Aster tripolium* and *Apium graveolens* predominate (VAN ZINDEREN BAKKER, 1947; REIJNDERS, 1959; WESTHOFF, 1949).

Hydrobiological interest: Characteristic of the inland oligohaline waters in the Netherlands is that they are shallow. The water in most cases is turbid due to detritus from the bottom

and to rich planktoncommunities. In this plankton the combination of Cyanophyceae, Diatomaeae and Chlorococcales is especially noteworthy (LEENTVAAR, 1956). The copepod genus *Eurytemora* is characteristic of these waters, which are rich in fish. In the waters of IV 5.1. reserves are established for *Siluris glanis.* (For the distribution of molluscs, cf. VAN BENTHEM JUTTING, 1959).

Fishery importance: There is commercial fishing and sport fishing in these waters. Especially to sport fishing they are of great importance. Very probably the greater part of the 650,000 sport fishermen of the Netherlands fish in oligohaline waters. The most important species are: *Esox lucius, Abramis brama, Leuciscus* div. spp., *Perca fluviatilis,* less important *Cyprinus carpio, Carassius carassius, Tinca vulgaris* and *Lucioperca sandra.*

Other fauna: The fauna of these oligohaline waters and the surrounding marshes and wetlands is very interesting. The waters, marshes and wetlands of Friesland, Noord- and Zuid-Holland are famed for their birdlife. The colonies of *Platalea leucorodia, Ardea cinerea, Ardea purpurea* are found in these marshes. *Botaurus stellaris, Ixobrychus minutus, Circus aeruginosus* and many smaller water and marshland birds breed here, e.g. the rare *Locustella naevia, Locustella luscinoides, Panurus biarmicus.* All species of duck are breeding in these marshes. *Anas platyrhynchos, Anas querquedula, Anas clypeata* being the most common ones. *Anas strepera* is rather rare. *Netta rufina* seems to prefer oligohalinic-mesohalinic waters in this country (TIMMERMAN, 1962b). The wetlands surrounding the broads and marshes are well known breeding grounds for *Vanellus vanellus, Limosa limosa, Philomachus pugnax, Tringa totanus, Capella gallinago,* etc..

The Fish Otter (*Lutra lutra*) may be mentioned as a mammal from these waters.

V SHALLOW INLAND STATIC FRESH WATER

Fresh water (Cl content $<$ 100 mg/l) is not so common in the Netherlands as may be expected, although the borderline between the eastern parts of the Netherlands, where the water is fresh and the oligohaline western parts moved to the west in the north-east of the country since 1932, the closing of the Zuiderzee. This borderline is approximately at the same place as published by REDEKE, 1932, 1948 and VAN BENTHEM JUTTING, 1959.

Larger fresh waters, broads or shallow lakes exist only on places where fresh water coming from the higher pleistocene sandy soils penetrates in the lowerlying peat or clay soils of the haff district.

Three complexes of fresh water broads and marshes are of exceptional importance to this survey. They cover together an area of 14,000 ha whereas the total area of shallow static inland fresh water in the Netherlands may be estimated at 40,000 ha.

V 1. *Three larger waters in the province of Groningen, north of the pleistocene soils of Drenthe.*

V 1.1. Zuid Laardermeer (600 ha), south-east of the city of Groningen.

V 1.2. Paterswolder Meer (160 ha), south of the city of Groningen.

V 1.3. Leekstermeer (200 ha), west of the city of Groningen.

All three "lakes" are shallow. They are of importance to water-sport and to the nature conservation, although there are no reserves established in these waters (HAVINGA, 1919; CLASON, 1928). The "Leekstermeer" situated rather far away from the pleistocene sandy soils is fresh, but nearly oligohaline.

V 2. *Complex of broads, peatpit marshes and two of IJsselmeer border lakes in south-east Friesland and north-west Overijssel*

This complex is of very great importance because of its dimensions and its many-sidedness. It is located in the lowlying lands along the former coast of the IJsselmeer and came into existence largerly due to peat digging, which has been carried on in this area for centuries. Half of the area is open water, not deeper than 1.5—3 m. These waters are important to all sorts of water sports (especially yachting) (RIJKSDIENST NATIONALE PLAN, 1956). The other half is marshland with very little open water. These marshlands are important to cultivated reed (*Phragmites communis*) and to its plant and animal life.

Although great parts of marshlands until very recently are reclaimed (as polders), large stretches are still intact. Vast nature reserves are established in this area.

The most important waters of this category in Friesland are:

V 2.1. Tjeukemeer (2,130 ha). In the south of Friesland near De Lemmer. A large broad with little surrounding marshland and Nannewijd (200 ha) near Heerenveen.

V 2.2. "Petgaten in Lindenvallei" (500 ha) near Wolvega and Rottige Meente (1,000 ha) near Nijetrijne south Friesland. Marshland and wetlands with very little open water. Biologically very important. Partly nature reserve.

The most important waters in the province of Overijssel are part of the complex V 2. The total area of shallow static inland fresh waters wider than 5 m in Overijssel is 11,000 ha (7,000 ha of this is suitable for fishery).

The waters and marshlands in N.W. Overijssel (V 2.3. and V 2.4.) cover approximately 5,000 ha, i.e., nearly 50%.

The most interesting waters are:

V 2.3. Weerribben, Pierink and Vrijstaten, Schut- and Grafkampen (2,000 ha). Marshlands, reedlands near Oldemarkt and Steenwijk.

V 2.4. Beulakker- and Belterwijde, Bovenwijde, Kierse Wijde, Giethoornse Meer and Duininger Meer c. (2,000 ha) near Giethoorn, Wanneperveen and Meppel (WESTHOFF, et al. 1946).

V 2.5. Vollenhovense Meer (200 ha) and Zwarte Meer (2,000 ha). Both

"lakes" and border lakes, formerly parts of the IJsselmeer, but isolated from that by the new polder reclaimed in 1942. In the beginning they were oligohaline, in 1962 however fresh or nearly fresh although there are periods when the Cl-content rises above 100 mg Cl/l. Both broads are famous for their birdlife. The "Zwarte Meer" is well known for its cultivated rushes and as wildfowl reserve (MÖRZER BRUIJNS & TIMMERMAN, 1953).

V 3. The *Oostelijke Vechtplassen* area, partially in the province of Noord-Holland, partially in the province of Utrecht. The "Oostelijke Vechtplassen" originated without exception from peat digging during the last 3 centuries. They are situated east of the river Vecht in the lowlying polderland on peat soils between the valley of this river and the high pleistocene sandy soils of the "Gooi" and "Utrechtse Heuvelrug" (VAN ZINDEREN BAKKER, 1947). The following broads and marshes are worth mentioning.

V 3.1 The Naardermeer (500 ha) near the old town of Naarden (Noord-Holland). Famous as nature reserve. Formerly oligohaline, it became fresh rather recently (VAN ZINDEREN BAKKER, 1942).

V 3.2. Ankeveense Plassen (500—800 ha), Kortenhoefse Plassen and Wijde Blik (500 ha), Loenerveense Plas (500 ha), and Loosdrechtse Plassen (1,000 ha), west of Hilversum. (MEIJER, DE WIT, et al., 1955).

V 3.3. Tienhovensche Plassen, Maarsseveense Plassen c.a. (500—1,000 ha), broads north of Utrecht. In the province of Utrecht these broads cover more than 3,000 ha. That is a great part of the total water area of Utrecht: 8,000 ha (1,000 ha of this is oligohaline in the western parts of the province: Vinkeveense Plassen, vide IV).
Botanical interest: The inland static fresh water areas in the Netherlands are very interesting to the botanist. These waters are nearly without exception eutrophic (rich in nutriments) and shallow. The water is rarely deeper then 3 m. The vegetation of these waters and marshlands is composed of a great variety of plant communities (WESTHOFF et al., 1946). The deeper water (deeper than 3—4 m) is often without plantgrowth of phanerogams because the light does not reach the bottom, sometimes due to the dark colour of the water (peat water) and often also because of the high content of detritus and plankton. Plant growth starts in the deeper water with *Potamogeton lucens* and *Potamogeton* div. spp. vegetations. When the water is eutrophic and less then 2 m deep *Nymphaea alba, Nuphar luteum, Myriophyllum spicatum, Potamogeton natans, Polygonum amphibium* often form dense vegetations. Under mesotrophic conditions vegetations of *Hottonia palustris* occur with *Elisma natans* and *Juncus bulbosus.* In small shallow eutrophic waters, e.g. in sheltered inlets, in places where peat has been dug and also in ditches and pools, very dense vegetations of *Stratiotes aloides* and *Hydrocharis morsus ranae* with

Utricularia vulgaris are found. In eutrophic shallow water with a depth of about 1.5—2 m the plant communities of the reedlands (Phragmition) start with *Schoenoplectus lacustris, Phragmites communis, Typha angustifolia, Typha latifolia, Sparganium erectum* etc. Other species of this reedland are *Rumex hydrolapathum* and *Ranunculus lingua.* A characteristic plant community of this type of marshland is, in many places, that of *Cicuta virosa* and *Carex pseudocyperus* with *Calla palustris* and other marshland plants. These reedland marshes are succeeded by vegetations in which various species of tall *Carices* dominate (*Carex riparia, C. acutiformis, C. paniculata* etc.). This Magnocaricion marshland is biologically very interesting. The Magnocaricion is succeeded by woodland developing itself in this marshland as *Alnus, Betula* or *Salix* carr wood. The large fresh water and marshland areas are botanical very important because so many plant communities with such a large number of plant species in so many combinations, seres etc. are present. They live in these areas in "optima forma", probably "more optimal" than anywhere else in Western Europe, because all types of zonations successions and combinations are represented.

Hydrobiological interest: The shallow eutrophic broads and other fresh static waters in the Netherlands have rich plankton communities and a high detritus content. There are rather great local differences, but generally the waters of Category V are characterized by rich coenoses of Crustacea, Rotatoria and Diatomeae.

From the crustaceans, *Cyclops* spp. and *Bosmina* div. sp. are the most numerous. The Rotatoria *Polyarthra trigla, Filinia longiseta* and *Synchaeta* div. sp., *Brachionus bidens, B. pala, Notholca striata* and *N. acuminata* are more conspicuous. The bryozoan *Plumatella* is often found and from the Flagellatae: *Dinobryon divergens* and *D. sertularia* (particularly in V 3.2.). In smaller fresh waters and in sheltered places in the marshlands the Flagellata are extremely numerous, for instance, *Uroglena volvox.* From the Chlorophyceae the genus *Pediastrum* is found in nearly all fresh static waters. *Pediastrum boryanum, P. duplex* and *P. biradiatum* are observed in great numbers in the waters of complex V 2. The Diatomeae are represented by *Asterionella formosa* and *Melosira itala* which are common and numerous nearly ererywhere. *Synedra delicatissima* is especially mentioned from V 2. (REDEKE, 1935, 1948; LEENTVAAR, 1956; MEIJER, DE WIT, et al., 1955).

Fishery importance: There is a rather intensive fishery in the static inland fresh waters. This fishery has about the same importance as that mentioned for the oligohaline waters (cf. Chapter IV).

Other fauna: The Fish Otter (*Lutra lutra*) is characteristic for these waters. The species however is not numerous (BROUWER,

1940). Birdlife in the fresh water areas does not differ much from that in oligohaline waters. Very important colonies of *Ardea purpurea* and *Phalacrocorax carbo* are present at the moment in the fresh water biotopes. The small Netherlands' population of wild *Cygnus olor* lives in the complex V 2. One of the most characteristic birds of the fresh water habitats is *Chlidonias niger* which chooses as nesting sites nearly exclusively the stratiotes vegetations of smaller fresh waters. *Podiceps cristatus* is a common breeder on larger waters. Birdlife of the fresh water habitats during migration is also comparable with that of the oligohaline waters. The differences between oligohaline and fresh water biotopes are more evident in the invertebrate fauna. The habitat of the well-known endemic butterfly *Heodes dispar* is to be found in the marshlands of the complex V 2. only. Comparable local distributions are known concerning other insect species and for instance also concerning molluscs (MÖRZER BRUIJNS & WESTHOFF, 1951; VAN BENTHEM JUTTING, 1959).

Other important things: Great parts of the inland fresh waters are used for water sports. Government and private nature conservation societies, however, aim at the establishment of strict nature reserves in these water- and marshland habitats. A great number of such reserves exist already, ensuring the conservation of the biotic communities of these habitats.

VI SHALLOW FLOWING INLAND FRESH WATER

The Netherlands are the delta area of 3 rivers: Rijn, Maas and Schelde. These rivers are a dominating element in the fluviatile district of the Netherlands. As aquatic habitat biologically interesting, but not so rich as they could be, due to the high degree of pollution (HOPMANS, 1960). The riverwater of all three rivers is already polluted when it reaches the Netherlands (HOPMANS, 1961). The rivers worth mentioning in this survey are:

VI 1. *Rijn branching in Lek and Waal*

They are the main stream of the river Rijn. In earlier days the river continued to the north, the branch to the west was called Lek.

VI 2. *IJssel and Zwarte Water cum annexis*

The IJssel is a branch of the Rijn leaving the main stream near Arnhem. It flows to the north into the IJsselmeer.

VI 3. *Maas, Bergse Maas, etc.*

In the delta area in the south-west of the Netherlands the water of Lek, Waal and Maas intermingle. In this area a biologically highly important complex is formed.

VI 4. *Merwede, Amer and Biesbosch*

This complex is a fresh water tidal area. The tide is running up from the west from the coastal water Hollandsch Diep (cf. Chapter I).

North-west of complex 4 the water of Rijn and Maas flows for a great deal through a network of riverbranches to the North Sea. These riverbranches form a highly specialised, characteristic habitat. The biocenoses existing in this area are not found elsewhere in the Netherlands (VERHEY, et. al., 1961).

VI 5. *Noord, Oude Maas, Nieuwe Maas and Nieuwe Waterweg*

The water in this network is partially oligohaline (DEN HARTOG, 1961).

VI 6. *Schelde*

Where the Schelde enters the Netherlands at the Belgian border it is already a coastal water (cf. I 4, Wester Schelde).

VI 7. *Smaller rivers on the pleistocene sandy soils in the eastern parts of the country*

Besides the large rivers there are a number of smaller rivers, in nearly every province one or more:

Friesland — Boorne, Tjonger and Linde.
Groningen — Westerwoldse A and Ruiten A.
Drente — Hunze, Drentse A, Beiler Stroom, Meppeler Diep, Reest.
Overijssel — Vecht, Regge and Dinkel, Schipbeek.
Gelderland — Berkel and Slinge, Oude IJssel, Barneveldse Beek.
Utrecht — Lunterse Beek and Eem.
Brabant — Mark, Donge, Beerse, Dommel, A.
Limburg — Niers, Roer, Geleen and Geul.

These small rivers are also polluted in many cases. Locally however, they are still interesting for the biologists (HOPMANS, 1960, LEENTVAAR, 1956).

The total area of flowing waters of the great rivers in the Netherlands covers nearly 20,000 ha. The smaller rivers (VI 7) only about 2,000 ha. All rivers have, nearly without exception in the Netherlands, a sandy bottom locally with some deposits of mud. The courses of all rivers are regulated by dikes and cofferdams. In the Maas there are also a number of weirs with sluices for shipping and fish passes. In the Rijn such weirs are in construction.

Botanical interest: Due to the regulation and the pollution of the great rivers there are only few sites in the rivers themselves which are of interest to the botanist. There is very little plant growth along the shores. Characteristic for these habitats are the plant communities of *Bidens* spec., the Nanocyperion and the Agropyro-Rumicion crispi, which are found in places where the waterlevel is changing often and drastically.

In the river only communities of *Potamogeton* spp. poor in species can maintain themselves. Botanically important are the old riverbranches in the river foreland nearly or completely isolated from the main stream and only communicating when the foreland is flooded in winter and in spring.

In these old river branches often interesting plankton communities and marshland vegetation are found (LEENTVAAR, 1957, 1958; VAN DONSELAAR, 1961; VAN DONSELAAR & TEN BOKKEL HUININK, 1961).

Comparable situations sometimes occur where sandpits or gravelpits are made in the river-foreland especially when they are still communicating with the main stream.

The area of Merwede, Amer and Biesbosch is of exceptional biological significance. In this fresh water tidal area a number of types of aquatic habitats exist, which in the Netherlands are extremely rare, nor are they known in comparable dimensions from elsewhere in Western Europe. The vegetation and the soil of the Biesbosch area has been studied thoroughly (ZONNEVELD, 1960; VERHEY et al., 1961). The plant communities of *Scirpus triqueter, Scirpus lacustris, Scirpus tabernaemontani* and of *Phragmites communis* with *Caltha palustris* and those of the willow osiers are the most important.

Hydrobiological interest: The slow moving rivers in the Netherlands have their own plankton communities, different from those of the stagnant fresh waters. There are distinct differenrences between the plankton of the Rijn and its branches Lek, IJssel and Waal and that of the river Maas.

The Rijn-plankton is characterised by *Tabellaria fenestrata* f. *asterionelloides* (Diatomeae) and *Oscillatoria aghardi* (Cyanophyceae). In the Maas plankton these species do not occur. The Maas however, has a richer phytoplankton especially of Chlorococcales. Zooplankton is scarce in both rivers. Only Rotatoria are relatively common (mostly *Brachionus* spp.). The plankton communities are rather poor due to pollution and regulation. Interesting are the studies of the phyto- and zooplankton of the river Maas, made to learn more about its role as a factor in the biological self-purification processes of the river water. The plankton of the Biesbosch area is studied especially by the Hydrobiologische Club (LEENTVAAR, 1960).

Old riverbeds, isolated riverbranches and the "wielen". The waters formed during dyke bursts are hydrobiologically very interesting (LEENTVAAR, 1957, 1958a).

The following fish species, characteristic of the fish fauna of greater rivers, still live in the Netherlands, but rather rare and locally: *Chondrostoma nasus, Barbus fluviatilis, Leuciscus cephalus* (VAN BEMMEL, 1957).

Fishery importance: The great rivers are important to fisheries, both to private and to professional fishing. This importance decreased however in the last decennia for a great deal, due to pollution, to the consequences of regulations and to overfishing. Some of the most valuable species are extinct or extremely

rare, others are seriously on the decrease. Extinct or nearly extinct are *Alosa alosa, Coregonus oxyrhynchus, Salmo salar* and *Acipenser sturio. Salmo trutta* is decreasing (VAN BEMMEL, 1957). On the rivers fishery of the following species are economically important: *Anguilla anguilla* (= *A. vulgaris*), *Alosa fallax, Lucioperca sandra, Esox lucius, Salmo trutta, Abramis brama, Leuciscus* div. sp. and *Lampetra fluviatilis.*

Other fauna: The only aquatic mammal living in the Netherlands worth mentioning in the habitat of the greater rivers is *Lutra lutra,* whose numbers in the Netherlands probably do not exceed a few hundred individuals. Normally they live in static fresh and oligohaline waters, but in periods of severe frost they migrate to the rivers for open water. For the same reason in some years the rivers in the Netherlands are of importance to migrating and wintering waterfowl (OVER & MÖRZER BRUIJNS, 1956). The Biesbosch, already mentioned as an outstanding area for the botanist, is also to the zoologist of exceptional value (VERHEY, et al. 1961). It is the only place in the Netherlands where *Nycticorax nycticorax* breeds. Moreover many other species of water and marshland birds breed in this area. In autumn, winter and in spring tens of thousands of duck (mostly *Anas* div. sp.), thousands of geese (*Anser anser, A. albifrons* and *A. fabalis*) and hundreds of *Cygnus bewickii* visit the area. The running waters of the rivers also have their own invertebrate fauna, the Biesbosch area is the more exceptionally interesting in this respect. In the tidal fresh water-habitats several species are found which do not live or are rare elsewhere in this country.

Other important aspects: Rivers or parts of rivers in this country are not established as nature reserves, while parts of the river foreland, old, isolated riverbranches and in some cases neighbouring sand or gravelpits are. In the Biesbosch fairly large nature reserves are established.

In some places, parts of smaller rivers and of brooks and springs are preserved as nature reserves. These smaller rivers and brooks form, when they are not polluted aquatic habitats in the Netherlands where a number of plant- and animal species (among them birds, amphibians, fishes, crustaceans, insects, molluscs and worms) live, which are extremely rare or unknown in the stagnant fresh waters in other parts of the country.

VII MINERAL MARSHES

In the Netherlands as mineral marshes may be mentioned the wet cultivated grassland which are noted for their birdlife and scientifically important for the interesting plant communities occurring in them.

About $^1/_3$ of the Netherlands is cultivated grassland: 1,324,000 ha. These

grasslands are utilised for dairy farming. More than 80% is good or rather good grassland (according to the standard in the Netherlands), well drained with a high percentage of good grasses particularly *Lolium perenne, Phleum pratense* and *Poa pratensis, Festuca pratensis.* These grassland vegetations nearly without exception belong to the plant communities of the Arrhenatherion (mostly the Cynosureto-Lolietum) used as pasture, as haypasture or as hayfield.

Approximately 10% of this acreage, namely 130,000 ha is classified in the rough survey of the grassland vegetations in the Netherlands (DE BOER, 1956) as poor and moist (40,000 ha) and wet (98,000 ha).

Some areas of these wet grasslands will be mentioned. They occur in nearly all provinces in smaller of larger areas. Only 12 areas will be described in the sequal.

Botanical interest: For the botanist the wet grasslands are of great interest, because they are the localities where a number of plant species and plant communities survive, which became rare in this country during the last decennia due to the large scale improvement of the grasslands by drainage and the use of fertilisers. To the agriculturist these species and communities are humidity or extreme humidity indicators. Among the poor grassland indicators are the still common species *Anthoxanthum odoratum, Agrostis canina, Carex panicea, Molinia coerulea, Festuca rubra, Prunella vulgaris.* Plantspecies which became rare are for instance: *Orchis morio, Orchis maculata, Orchis majalis, Gymnadenia conopsea, Carex pulicaris, Carex hostiana, Cirsium dissectum, Gentiana pneumonanthe.* The humidity indicators in grasslands are for the Netherlands amongst others: *Caltha palustris, Bromus racemosus, Carex nigra, Glyceria maxima, Lotus uliginosus, Poa trivialis, Ranunculus repens, Cardamine pratense, Alopecurus geniculatus.*

The plant communities characteristic for the botanically interesting grasslands are: Calthion, Caricion fuscae, Magnocaricion, Molinion, Nardo-Galion and Agropyro-Rumicion crispi (VAN LEEUWEN, 1953/54; DE VRIES, 1953; WESTHOFF et al., 1946).

Zoological interest: The moist, poor and the wet grasslands are optimal habitats for grasslands birds. Characteristic for these wetlands are often dense populations of *Vanellus vanellus, Limosa limosa, Tringa totanus, Philomachus pugnax, Capella gallinago, Crex crex, Numenius arquata, Haematopus ostralegus, Anthus pratensis, Motacilla flava* and also of *Anas platyrhynchos, Anas querquedula, Anas clypeata,* locally *Sterna hirundo.*

In autumn, winter and spring large flocks of migrating waders and waterfowl visit these grasslands to feed and rest. Especially when the grasslands are inundated (flooded), large numbers of duck, geese and swans are attracted.

Wild geese, for instance, distinctly prefer vast areas of inundated grasslands. For this reason several of the wet grasslands in the Netherlands are internationally important because they are the wintering haunt for large flocks of geese (MÖRZER BRUIJNS, 1962a).

Moreover the wet grasslands are the typical habitat for representatives of other animal groups. *Rana esculenta, Rana temporaria* and *Rana arvalis,*

Triturus vulgaris live in these areas sometimes in dense populations. Many insect- and mollusc-species are characteristic for the wetland habitats (MÖRZER BRUIJNS & WESTHOFF, 1951; MÖRZER BRUIJNS, VAN REGTEREN ALTENA & BUTOT, 1959).

Although there are many areas, nearly in all provinces, all of which are of significance for their vegetation and fauna, only 12 are mentioned in this survey, located in the lowlying western part (the haff-district) of the Netherlands.

VII 1. *Grasslands around Anjumer Kolken and the Bantpolder in the north of Friesland (200—300 ha)*

These grasslands are situated near the Lauwerszee. In the centre are two former duck-decoys, which are now wildfowl reserves. The wet grasslands are interesting to the botanist on account of their Agropyro-Rumicion crispi plant communities. These grasslands are the main winterquarters in the Netherlands of 10,000—20,000 *Branta leucopsis* (TIMMERMAN, 1962a). Other geese, *Anser anser, Anser albifrons,* many ducks and waders (*Vanellus vanellus, Pluvialis apricarius*) visit the area on migration.

VII 2. *Grasslands along the river Boorne, near Beetsterzwaag.*

This complex of wet grasslands in the centre of Friesland (app. 1,000 ha) is regularly inundated during winter. Botanically it is interesting for its Magnocaricion-Calthion, Nardo-Galion and Agropyro-Rumicion crispi plant communities. To the zoologist these grasslands are of great interest as breeding areas by reason of an exceptionally rich population of grassland birds. From November to April the wet grasslands near Beetsterzwaag are a haunt of often more then 10,000 geese (mostly *Anser albifrons*) and many thousands of ducks and waders (MÖRZER BRUIJNS, 1962a; PHILIPPONA, 1961).

VII 3. *Wet grasslands of the "boezemlanden" near Akmarijp and Joure in central Friesland*

A large wetland area of several thousand ha near to the broads of the Snekermeer, etc.

These grasslands are flooded every winter. Botanically they are interesting for the Caricion fuscae, Nardo-Galion and Molinion-vegetation. Rich breeding populations of grassland birds (*Vanellus Limosa,* etc.) and wintering haunt for large flocks of duck, waders and geese (mostly *Anas platyrhynchos, Anas penelope, Anas albifrons* and *Anser fabalis brachyrhynchus*).

VII 4. *Wet grasslands of Makkumerwaard, Workumerwaard near Makkum and Workum*

Some thousand ha of wet grasslands in south-western Friesland. Partially inundated in winter time. Botanically valuable for the plant communities of the Agropyro-Rumicion crispi, Magnocaricion, etc. These grasslands are famous for the breeding populations of *Philomachus pugnax, Limosa limosa, Vanellus vanellus, Tringa*

totanus, etc. (TIMMERMAN, 1962b). In wintertime from October to March in this area often more than 10,000 *Anser fabalis brachyrhynchus* and lesser flocks of *Anser albifrons* and *Branta leucopsis* are wintering.

VII 5. *Wetlands near Sondeler Leyen and Grote Brekken; in Lemsterland near De Lemmer in South Friesland*

Near the coast of the IJsselmeer several thousand ha of lowlying grasslands are of great importance as breeding area for grassland birds. In winter large parts are flooded when the water is high.

Many waterbirds winter hereabout and in autumn and spring large flocks of geese (mostly *Anser anser*) visit the area. Botanically the wet grasslands are also interesting.

VII 6. *Wet grasslands near Kampen (Overijssel)*

Around the old town of Kampen thousands ha of wet grasslands are interesting as wetland area. The most important parts are Oosterwolderpolder, Kampereiland and Mastenbroekerpolder. Botanically interesting is the vegetation of the Agropyro-Rumicion, the Calthion and the Magnocaricion communities. The grasslands around Kampen are famous breeding areas (*Philomachus pugnax, Limosa limosa*, etc.). In wintertime waders, duck and geese (*Anser albifrons, Anser fabalis*) visit the area.

VII 7. *Wet grasslands of the Eempolder, c.a.*

Lowlying, partially wet grasslands east and west of the river Eem in the province of Utrecht between Eemnes and Nijkerk. Botanically comparable with VII 6. The Eempolders are still famous for their breeding populations of *Vanellus, Limosa, Philomachus, Capella*, etc. Since the better drainage of large parts of the polders, winter inundation does not happen any more and the large flocks of geese (thousands of *Anser anser*) and duck, which regularly came to the polders in former years, do not visit the area any longer.

VII 8. *Wet grasslands of Waterland in the province of Noord-Holland*

These wet grasslands are to be found north of Amsterdam. They are especially valuable as breeding area for *Vanellus, Limosa limosa, Tringa totanus, Philomachus pugnax*, etc. and also for several species of duck. In wintertime flocks of wintering waterfowl visit the area.

VII 9. *Wet grasslands of Haagse Beemden north of Breda (province of Noord-Brabant)*

These grasslands (c. 2,000 ha), for a great part lowlying and wet lands near the river Mark, are flooded regularly in wintertime. They are botanically interesting on account of the same plant communities as mentioned previously and zoologically as breeding area for grassland birds and as feeding grounds and resting place for often more than 10,000 *Anser albifrons* (PHILIPPONA & MULDER, 1962b).

VII 10. *Wet grasslands in "de Poel" near Goes (province of Zeeland)*
These lowlying wet grasslands (c. 1,500 ha) are especially important as a wintering haunt for many waders, ducks and geese (*Anser albifrons, Anser fabalis, Branta leucopsis*).

VII 11. *Wet grasslands of "De Putting" near Kloosterzande (Zeeuwsch-Vlaanderen),* about 1,000 ha, are a wintering area for many thousands of *Anser albifrons* (MÖRZER BRUIJNS, 1951).

VII 12. *Wet grasslands of the Groot Eiland near Hulst (Zeeuwsch-Vlaanderen) (c. 1,000 ha)*
Significance as VII 12, also of importance as breeding area of grassland birds.
Important: Reallotment schemes — including improvement of water management and drainage — are threatening the status of several of the wetlands mentioned in this chapter, and in any case the complexes 2, 3, 5, 6, 9, 10 and 11 are seriously threatened in this way.

In former years wet grasslands existed in many more places in the Netherlands and nearly all of them were important as wetland habitat, for instance as wintering ground for waterfowl. The 12 areas mentioned in this chapter are among the last in the Netherlands. When the improvement of these last areas of wet grasslands is realised, it is almost sure that as a consequence the wild geese will have lost their last haunts in this country. As far as is known no comparable wetlands exist in neighbouring countries (MÖRZER BRUIJNS 1961). One has to consider therefore, that almost certainly the proceeding of the improvement of the drainage of the wet grasslands will endanger the waterfowl population, wintering in this country.

CONCLUSIONS

In the preceding paragraphs the most interesting waters, marshes and wetlands of the Netherlands are mentioned. It is hardly possible to say which of these areas are the most important. When, however, a choice must be made to indicate those areas, which are not only nationally, but also internationally of the greatest significance, the following areas might be classified as such.

Category A (first priority):

1. Wadden Sea. c. 280,000 ha (270,000 ha: 1; 1,250 ha: 2; 9,000 ha: 3), with the coastal marshes especially those of the Wadden islands. Botanically important for its salt marshes and algae communities, hydrobiologically as a shallow coastal sea rich in species, zoologically as habitat for numerous breeding populations of coastal sea birds and waterfowl and for hundreds of thousands of migrating and wintering wildfowl and waders.
2. IJsselmeer and its borderlakes. c. 231,000 ha: 4, 5, 7. Shallow oligohaline static inland water. Botanically and hydrobiologically of great

importance on account of its birdlife, especially in the coastal areas, all the year round.

3. Delta area (Haringvliet, Hollandsch Diep, Biesbosch, Grevelingen, etc.; Oosterschelde). 72,500 ha: 1; 2,000—3,000 ha: 2; 20 ha: 3. Salt, brackish and fresh, and brackish and tidal waters which will become fresh after the completion of the delta works. Highly interesting flora and fauna, important wintering area for ducks, geese and waders. Although great changes will take place, these areas will be still of great importance when the delta works are finished.
4. Wester Schelde, with its coastal marshes (in particular the Verdronken Land van Saaftinge). 39,000 ha: 1; 5,800 ha: 3. The Wester Schelde is the only part of the delta area which will remain coastal and in open communication with the sea. Botanically, hydrobiologically and zoologically (birdlife, Common or Harbour Seal (*Phoca vitulina*) very interesting with a gradient from salt to fresh.
5. Complexes of broads, marshes, reedlands and other wetlands in north-western Overijssel and south-western Friesland [from Tjeukemeer near Joure (Fr.) to the "Schinkelland" near Zwartsluis (Ov.)]. 15,000 ha; 5, 7. Very rich shallow static inland fresh water. The biotic communities characteristic of these habitat types have a development in this area which is probably optimal and unique in western Europe. This is true for the flora, for plankton communities and for insects and birds.

6a. Wet cultivated grasslands in several provinces which are of special interest to large flocks of migrating and wintering geese. The most important of these areas have to be mentioned here.
   a. In the province of Friesland: Bantpolder, Anjumer Kolken, river Boorne near Beetsterzwaag, Boezemlanden near Akmarijp and Joure, Makkumerwaard, Workumerwaard, Sondeler Leyen, Grote Brekken (together covering about 8,000—10,000 ha).
   b. In the province of Noord-Brabant: Haagse Beemden and other areas between Breda and Willemstad (covering several thousand ha).
   c. In the province of Zeeland: "De Poel" near Goes, "De Putting" near Kloosterzande and "Groot Eiland" near Hulst (together covering c. 4,000 ha).

Category B (second priority):

7a. Zwanenwater near Callantsoog (Noord-Holland) and the dune lakes.
   b. Brede Water and Kwakjeswater on the island Voorne (Zuid-Holland). Three small sea dune shallow static fresh/oligohaline lakes, the only Netherlands' waters mentioned in the list of hydrobiologically internationally important waters adopted by the International Limnological Congress 1962 in U.S.A.
   c. De Muy on the Island of Texel (approx. 50 ha). Sea-dune-lake: Shallow fresh water. Important for its rich and exclusive birdlife.
8. Alkmaardermeer and Waterland. 1,250 ha: 4, 5. and other large waters of Noord-Holland (21,000 ha: 4, 5). Inland static brackish water and pools, ditches, reedlands and marshy grasslands with characteristic plant-

and plankton communities. Oligohaline water. Important as a breeding area for wading birds.

9. Oostelijke Vechtplassen. Noord-Holland and Utrecht, c. 10,000 ha: 4, 5. Shallow static inland fresh water, nearly as important as 5. Naardermeer Ankeveense-, Kortenhoefse-, Loosdrechtse-, Tienhovense-, Maarseveense Plassen, etc.
10. Large waters in the province of Holland and Utrecht 4,200 ha: 4, 5. Shallow static inland, oligiohaline waters: Westeinder, Brasemermeer, Kagerplassen, Nieuwkoopse Plassen, Vinkeveense Plassen, Botshol and Reeuwijkse Plassen.
11. Broads (and shallow lakes in Friesland). 26,000 ha: 4. Slightly brackish to oligohaline shallow static waters. Biologically interesting, because of the rich plant communities of shallow water and marshy shoreland and many water- and marshland insects and birds. Hydrobiologically the plankton communities are interesting as well.

All the waters mentioned are also of great interest to fishery and to water sports.

LITERATURE

Introduction:

BOER, Th. A. DE
1956 A rough survey of the grassland vegetation in the Netherlands. — Versl. landbouwk. Onderz., 's-Gravenhage, (625): 1—69.

DIRECTIE VAN DE LANDBOUW
1960 Landutilisation on 31 dec. 1958 in ha. — Versl. Landb, Min. Landb. & Viss., Den Haag: 336—337.

DRIMMELEN, D. E. & G. DROST
1961 Het gebruik van de Nederlandse rivieren en binnenwateren als viswater in 1958: 1—34 (Visserij Inspectie 4e, 6e, 7e Distr. Utrecht).

I Coastal waters:

ADRIANI, M. J. & E. VAN DER MAAREL
1962 De duin- en slikgebieden van Voorne en het Brielse gat. — Natuur en Landschap, **16**-2: 177—197.

BEMMEL, A. C. V. VAN
1956 Planning a census of the Harbour Seal (Phoca vitulina L.) on the coast of the Netherlands. — Beaufortia, **5**-54: 121—132.

BRAAKSMA, Sj. & M. F. MÖRZER BRUIJNS
1958 Wildfowl sanctuaries in the Netherlands. — Bull. int. Counc. Bird Preserv., **7**: 65—76.

BROUWER, G. A., et al.
1950 Griend, het vogeleiland in de Waddenzee: 1—310 (Nijhoff, 's-Gravenhage).

HARTOG, C. DEN
1954 The epilithic algal communities occurring along the coast of the Netherlands. — Wentia, **1**: 1—240.
1960 Verspreiding van het slakje Pseudamnicola confusa in het Deltagebied van Rijn en Maas. — Basteria, **24**-4/5: 66—74.
1961 Die faunistische Gliederung im Südwest-Niederländischen Delta Gebiet. — Int. Rev. ges. Hydrobiol., **46**-3: 407—418.

KRISTENSEN, I.
1957 Differences in density and growth in a Cockle population in the Dutch Waddensea. — Arch. Néerl. Zool., **12**-3: 351—453.

1959 The coastal waters of the Netherlands as an environment for molluscan life. — Basteria, **23** (Suppl.): 18—47.

MAEBE, J. & H. VAN DER VLOET

1952 Over rui, trek en biologie der Bergeend (Tadorna tadorna L.) aan de Beneden Schelde. — Gerfaut, **42**-1/2 : 54—83.

1956 De avifauna van het verdronken land van Saaftinge. — Gerfaut, **46**-3 : 151—190.

POSTMA, H.

1954 Hydrography of the Dutch Waddensea. — Arch. Néerl. Zool., **10**-4 : 405—511.

REGTEREN ALTENA, C. O. VAN

1959 The Netherlands' beach as a cemetery for Mollusca. — Basteria, **23** (Suppl.): 63—73.

ROOTH, J.

1960 Bird counts 1953—1956 on the Island of Vlieland. — Limosa, **33** — 3-4 : 134—159.

ROOTH, J. & M. F. MÖRZER BRUIJNS

1959 The sandwichtern as a breeding bird in the Netherlands. — Limosa, **32** — 1-2 : 12—23.

TANIS, J. J. C. & M. F. MÖRZER BRUIJNS

1962 Het onderzoek naar stookolievogels van 1958—1962. — Lev. Nat., **64**-6 : 133—140.

TIMMERMAN, A.

1960 The Shellduck as a breeding bird in the Netherlands. — Limosa, **33** — 3-4 : 159—173.

VERWEIJ, J.

1954 On the ecology of distribution of Cockle and Mussel in the Dutch Waddensea. — Arch. Néerl. Zool., **10**-2 : 171—239.

1956 De Waddenzee als voedselareaal voor vogels bij strenge kou. — Ardea, **44**-1/3 : 218—223.

WILCKE, J.

1956 De Eidereend (Somateria mollissima) in Nederland. — Lev. Nat., **59**-2 : 44—47.

II Coastal lagoons:

BLAAUW, A. H.

1917 Over flora, bodem en historie van het meertje van Rockanje. — Verhand. Kon. Ned. Akad. Wet., Amsterdam, (2) **19**-3 : 1—108, pl. 23.

BORG, M. J. M. H. VAN DER & H. J. VAN DORSSER

1961 De Sluftermond op Texel. — Tijdschr. Kon. Ned. aardr. Gen., (2) **78**-1 : 56—58.

DIJK, J. VAN

1948 Plantengemeenschappen van Muy en Slufter. — Natura, **45**-11 : 194—196.

DRIJVER, J.

1957 Texel, het vogeleiland : 1—280. (L. J. Veen's Uitg. Mij., Amsterdam.)

HOFKER, J. & C. VAN RIJSINGE

1934/35 Plantengroei en waterstand van het Breede Water op Voorne. — Lev. Nat., **39** : 176.

LEENTVAAR, P.

1955 De ontwikkeling van de flora en de fauna van de Brielse Maas na de afsluiting. — Lev. Nat., **58**-12 : 232—239.

1961 Two interesting invertebrates, Limnadia lenticularis and Gonionemus vertens found in the Netherlands. — Zool. Med. Rijksmus. nat. Hist. Leiden, **37**-14 : 225—230.

LEBRET, T.

1962 De vogels van het Veerse Meer. — Vogeljaar, (4) **10**-3 : 337—344.

MÖRZER BRUIJNS, M. F., A. LAWALREE, H. J. W. SCHIMMEL & F. DEMARET
1953 Vegetatieonderzoek van het Zwin in 1951—1952. — Bull. Rijksplantentuin Brussel, **23**-1/2 : 81—123.
REDEKE, H. C.
1903 Planktononderzoekingen in het Zwanenwater te Callantsoog. — Natuurwct. Verhand. Holl. Maatsch. Wetenschapp. Haarlem, **5**-3 : 1—42.
SUETENS, W.
1961 De avifauna van de Braakman. — Gerfaut, **51**-11 : 63—113.
WESTHOFF, V.
1947 The vegetation of dunes and saltmarshes on the Dutch islands of Terschelling, Vlieland and Texel: 1—131. (Diss. Utrecht.)
WESTHOFF, V. et al.
1946 Overzicht der plantengemeenschappen in Nederland: 1—118. (G. W. Breughel, Amsterdam.)
ZINDEREN BAKKER, E. M. VAN
1942 Het Naardermeer : 1—255 (C. V. Allert de Lange, Amsterdam.)

III Coastal marshes :

ADRIANIA, M. J. & E. VAN DER MAAREL
1962 Vide I.
BEEFTINK, W. G.
1957 De buitendijkse terreinen van de Westerschelde en de Zeeschelde etc. — Nat. & Landsch., **11**-2 : 33—51.
1958 De betekenis van de natuurterreinen in het Deltagebied voor de botanie. — Natura, **55** : 102—106.
1965 De zout-vegetatie van ZW-Nederland beschouwd in Europees verband (Eng. summary). — Diss.; Meded. nr. 30 Hydrobiol. Inst. Delta-onderz., Yerseke, Nederl.
HARTOG, C. DEN
1958 De vegetatie van het Balgzand en de oeverterreinen van het Balgkanaal. — Wet. Med. Kon. Ned. nat. hist. Ver., **27** : 1—28.
LEEUWEN, C. G. VAN & V. WESTHOFF
1961 Het natuurmonument de Beer, de plantengroei : 10—20. (Stichting de Beer, 's-Gravenhage.)
MÖRZER BRUIJNS, M. F. & S. BRAAKSMA
1954 Vogeltellingen in het Staatsnatuurreservaat Boschplaat van 1951 t/m 1953. — Ardea, **42**-1/2: 175—211.
ROOSMA, M.
not publ. De halophiele vegetatie van het schor te Oostvoorne. — (manuscript Arch. RIVON, 1961).
ROOTH, J.
1960 Vide I.
WESTHOFF, V.
1947 Vide II.
1958 De Waddenkusten in botanisch opzicht. Natura, **55**-7/8 : 107—111.
WESTHOFF, V., C. G. VAN LEEUWEN & M. J. ADRIANI
1962 Enkele aspecten van vegetatie en bodem der duinen van Goeree, in het bijzonder de contactgordels tussen zout en zoet milieu (Eng. summary). — Wet. Genootsch. Goeree Overflakkee, Jaarb., **1961** : 47—92.

IV Shallow inland brackish water:

ANONYMOUS
1956 Water recreation. — Publ. Rijksdienst Nation. Plan, **10** ('s-Gravenhage.)
1960/63 Mndbl. Dir. d. Visserijen, Visserij Nieuws, **13/15**.

BENTHEM JUTTING, W. S. S. VAN
1959 Ecology of brackish water Mollusca in the Netherlands. — Basteria, **23** (Suppl.): 77—99.
BRAAKSMA, S. & M. F. MÖRZER BRUIJNS
1958 Wildfowl sanctuaries in the Netherlands. — Bull. int. Comm. Bird Presen., **7**: 65—76.
HARMSEN, G. W.
1949 Het Amstelmeer als waterwildreservaat. — In het voetspoor van Thijsse: 192—206. (Veenman, Wageningen.)
KATE, C. G. B. TEN
1936 De vogels van het Zuiderzeegebied. — Publ. Club Zuiderzeewaarnemers, **10**: 1—82.
1952 De broedvogels van de Oosterpolder in 1951 en 1952. — Limosa, **25**-1/2: 1—11.
1954 De broedvogels van „Oostelijk Flevoland" in 1953 en 1954. — Limosa, **27**-4: 119—131.
1955 De broedvogels van „Oostelijk Flevoland" in 1955. — Limosa, **28**-3/4: 112—126.
1957 De broedvogels van „Oostelijk Flevoland" in 1956. — Limosa, **30**-1: 2—12.
1958 De broedvogels van „Oostelijk Flevoland" in 1957. — Limosa, **31**-1; 31—43.
LEENTVAAR, P.
1956 Voorjaarsplankton van enige Nederlandse meren. — Lev. Nat., **59**-6: 132—137.
1961 Hydrobiologische waarnemingen in het Veluwemeer. — Lev. Nat., **64**-12: 273—279.
NIEUWENHOVEN, P. J. VAN
1942 Onderzoek naar het voorkomen van submerse Phanerogamen en van Gastropoden in het polderwater van Noord Holland. — Ned. kruidkund. Arch., **52**: 333—370.
OTTO, J. P.
1927 Een oecologische studie van de fauna der Kager Plassen en omgevende wateren: 1—70 (Diss. E. J. Brill, Leiden).
REDEKE, H. C.
1922 Flora en Fauna der Zuiderzee; 1: 1—460. (De Boer, Den Helder.)
1932 Abriss der regionale Limnologie der Niederlande. — Publ. Hydrobiol. Club, **1**: 1—38.
1935 Synopsis van het Nederlandse zoet en brak waterplankton. — Publ. Hydrobiol. Club, **2**: 1—103.
1936 Flora en Fauna der Zuiderzee; 2: 1—176. (De Boer, Den Helder.)
1941 Pisces. Fauna van Nederland, **10**: 1—331. (Sijthoff, Leiden.)
1948 Hydrobiologie van Nederland: 1—580. (C. de Boer Jr., Amsterdam.)
REIJNDERS, Th.
1959 De Noordhollandse brakwatervennen. — Nat. & Landsch., **13**-3: 66—81.
SCHEYGROND, A.
1933 De Reeuwijkse en Sluipwijkse plassen: 1—48 (Gouda).
TIMMERMAN, A.
1962a De Makkumer Noordwaard als watervogeltrekreservaat. — Vanellus, **15**-9: 184—187.
1962b De Krooneend in Nederland. — Limosa, **35**-1/2: 28—39.
WESTHOFF, V., et al.
1949 De plantengezelschappen van Botshol. — Landschap, flora en vegetatie van Botshol nabij Abcoude: 1—102 (St. Comm. v. d. Vecht en O. en W. Plassengeb., Braambrugge.)
WIBAUT-ISEBREE MOENS, N.
1931-1949 Zoutgehalte van Boezem en Polderwater in Noordholland. — Ned. kruidk. Arch., **1931, 1934, 1946, 1949**.

ZINDEREN BAKKER, E. M. VAN
1947 De westnederlandse Veenplassen. — Heemschut Bibliotheek, **1**: 1—136 (Albert de Lange C.V., Amsterdam).

V Shallow inland static fresh waters:

ANONYMOUS
1956 Vide IV.

BENTHEM JUTTING, W. S. S. VAN
1959 Ecology of fresh water Mollusca in the Netherlands. — Basteria, **23** (Suppl.): 106—131.

BROUWER, G. A.
1940 De uitroeiing van de visotter (Lutra lutra) in Nederland aanstaande. — Lev. Nat., **45-1**: 1—8.
1956 Verarming van de fauna. Gedenkboek vijftig jaar natuurbescherming: 113—250. (Ver. Behoud Natuurmon., Amsterdam).

CLASON, E. W.
1928 Over de plantengroei van het Zuidlaarder Meer en omgeving. — Lev. Nat., **1928/1929**: 1—10, 40—46, 109—116, 245—249.

DIJK, J. VAN & V. WESTHOFF
1955 De plantengroei der natuurgebieden in Noordwest Overijssel. — Nat. & Landsch., **9-2**: 33—57.

HAVINGA, B.
1919 Studies over de flora en fauna van het Zuidlaarder Meer: 1—188 (Diss. Groningen).

LEENTVAAR, P.
1956 Vide IV.

MEYER, W., R. J. DE WIT, et al.
1955 Kortenhoef, een veldbiologische studie van een Hollands verlandingsgebied: 1—128 (St. Comm. v. d. Vecht en O. & W. Plassengebied, Amsterdam).

MÖRZER BRUIJNS, M. F. & TIMMERMAN, A.
1953 Het Zwarte Meer. — Lev. Nat., **56-9**: 161—166.

MÖRZER BRUIJNS, M. F. & V. WESTHOFF
1951 The Netherlands as an environment for insect life. — 1—67 (Neth. Ent. Soc., Amsterdam).

REDEKE, H. C.
1932 Vide IV.
1948 Vide IV.

WESTHOFF, V.
1946 Vide II.

ZINDEREN BAKKER, E. M. VAN
1942 Vide II.
1947 Vide IV.

VI Shallow flowing inland fresh waters:

BEMMEL, A. C. V. VAN
1957 Vissoorten die uit de Nederlandse fauna dreigen te verdwijnen. — Lev. Nat., **60-5**: 109—114.

DONSELAAR, J. VAN, et al.
1961 On the ecology of plant species and plant communities in former riverbeds. — Wentia, **5**: 1—85.

DONSELAAR, J. VAN & W. A. E. TEN BOKKEL HUININK
1961 An ecological study of the vegetations in former riverbeds. — Wentia, **5**: 112—162

HARTOG, C. DEN
1961 Vide I.
HOPMANS, J. J.
1960 Het afvalwatervraagstuk in Nederland. — Chem. Weekbl., **56**-48 : 661—669.
1961 Stand van de maatregelen ter bestrijding van de verontreiniging van de Rijn. — Water, **45**-17, 18 : 225, 241.
LEENTVAAR, P.
1956 De samenstelling van het plankton van de Dinkel en enige zijbeken in 1956. — Lev. Nat., **59**-10 : 233—238.
1957 Observations on the populations of plankton and micro-organisms in an old branch cut off from the river Waal. — Beaufortia, **5**-64 : 205—221.
1958a Observations on the plankton of some inland waters, especially "wielen" in the Netherlands. — Beaufortia, **6**-73 : 171—197.
1958b Hydrobiologisch onderzoek van oude rivierlopen. — Handel. hydrobiol. Ver. **10**-23 : 9—13.
1960 Waarnemingen in het Biesboscomplex. — Lev. Nat., **63**-12 : 276—283.
OVER, H. J. & M. F. MÖRZER BRUIJNS
1956 Waterwildconcentraties in Nederland in februari 1956. — Lev. Nat., **59**-7 : 149—155.
VERHEY, C. J., P. C. HEYLIGERS, et al.
1961 De Biesbosch, land van het levende water: 1—255. (Thieme & Cie, Zutphen).
ZONNEVELD, I. S.
1960 De Brabantse Biesbosch. — Med. Stichting Bodemkartering, **4**-A/B/C : 1—396.

VII Mineral marshes (wet grasslands):

BOER, TH. DE
1956 Vide : Introduction.
LEEUWEN, CHR. VAN
1953/54 Het blauwgrasland (een verdwijnende levensgemeenschap). — Nat. & Landsch., **7**-3/4 : 84—93.
MÖRZER BRUIJNS, M. F.
1958 Pleisterplaatsen van wilde ganzen in Nederland. — Lev. Nat., **61**-6 : 121—126.
1960 De Putting bij Kloosterzande als pleisterplaats van Kolganzen (Anser albifrons). — Lev. Nat., **63**-5 : 97—103.
1961 Bedreigd waterwild — Nat. & Landsch., **15** : 14—20.
1962a Over de betekenis van de lage landen langs de Boorne bij Beetsterzwaag voor de wetenschap. — It Baeken, **24**-2 : 131—143.
1962b De massasterfte van vogels in Nederland door vergiftiging met bestrijdingsmiddelen in voorjaar 1960. — Landbk. Tijdschr., **74**-14 : 578—588.
MÖRZER BRUIJNS, M. F. & C. O. VAN REGTEREN ALTENA & L. J. M. BUTOT
1959 The Netherlands as an environment for land Mollusca. — Basteria, **23** (Suppl.): 132—162.
MÖRZER BRUIJNS, M. F. & V. WESTHOFF
1951 Vide V.
PHILIPPONA, J.
1961 De lage graslanden bij Beetsterzwaag en Gorredijk als pleisterplaats van ganzen en andere vogels. — Lev. Nat., **64**-4 : 91—96.
PHILIPPONA, J. & TH. MULDER
1962a De Haagse beemden als pleisterplaats voor watervogels. — Lev. Nat., **65**-5 : 97—101.
1962b Tellingen van de kolgans in Nederland 1959—1960 en 1960—1961. — Limosa, **35**-1/2 : 39—45.

TIMMERMAN, A.
1962a De brandgans in Nederland. — Limosa, **35**-3/4 : 199—218.
1962b De Workumerwaard als vogelbroedterrein. — Lev. Nat., **65**-9 : 195—200.
VRIES, D. M. DE
1953 Ons grasland en zijn geschiedenis. — Lev. Nat., **56**-11 : 207—212.
WESTHOFF, V.
1946 Vide II.

Prof. Dr. M. F. MÖRZER BRUIJNS and Ir. Z. SALVERDA
State Institute for Nature Conservation Research (RIVON)
Laan van Beek en Royen 40—41
Zeist — The Netherlands

For sale at the Administration of the Zoological Museum, Amsterdam
Price 8.50 (Dutch Guilders)