NATIVE AND NON-NATIVE SPECIES OF HARD SUBSTRATA IN THE DUTCH WADDEN SEA

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In the summer of 2009 a rapid assessment was done of marine algae and macrofauna of hard substrata in the Dutch Wadden Sea. During a three week survey in July-August, 83 localities were searched for native and non-native species. The survey was carried out with a variety of methods: snorkeling, using a Remotely Operated Vehicle (ROV), checking fouling plates, and turning over rocks at low tide. The distributions and salinitiy ranges were recorded for 129 species, 29 of which were cryptogenic or of non-native origin. In addition, an inventory was made of published and unpublished records. Eleven species and one subspecies were found to be new to the Dutch Wadden Sea. One red alga (Ceramiaceae sp.) is probably a new species to Europe. The sea-squirt *Molgula socialis* is recorded as new for the Netherlands. It is probably widespread, may even be native and misidentified in the past as the non-native American species *M. manhattensis*. The total number of non-native species in the Dutch Wadden Sea has been raised to 64. The relatively high number of species that was recorded as new for the area within only three weeks of fieldwork, may be at least partly a consequence of the fact that the ongoing biodiversity research in this UNESCO World Heritage Site is not focusing on hard substrata. However, it is also possible that several species have settled relatively recently.

INTRODUCTION

The Wadden Sea is composed mostly of salt marshes, mudflats and islands, where sea water meets fresh water in an area stretching over the Netherlands, Germany and Denmark. It is known for its habitat variation and rich biodiversity. Because of these unique characters UNESCO has placed the Dutch and German parts of the Wadden Sea, an area of about 10,000 km^2, on the World Heritage List in June 2009. The plants and animals that are related to soft substrata are well studied. However, an analysis of the available data in June 2009, to assess the risks of mussel-imports into the Dutch Wadden Sea, showed that relatively little was known about the organisms that live in association with hard substrata. Therefore, a rapid assessment of these species was organized in July-August 2009, financed by the Invasive Alien Species Team of the Ministry of Agriculture, Nature and Food Quality. The main goals of this survey were: 1. To get a reliable inventory of macrofauna and macroflora that is related to hard substrata in the Dutch Wadden Sea, 2. To focus on non-native species in general, and especially on those species, which were already recorded more to the south, in the Delta area of the Netherlands.

MATERIALS AND METHODS

The survey of hard substrata was carried out during the last week of July and the first two weeks of August 2009. Also species not specifically related to hard substrata were recorded when they were observed. Additionally, an inventory was made of published and unpublished records. Important sources were two projects of the ANEMOON Foundation: MOO (Monitoring Underwater Shore), using records from scuba divers and SETL (referring to SETTLement) an ongoing fouling community monitoring study. In this last project PVC plates are checked regularly for settling species. Some of the

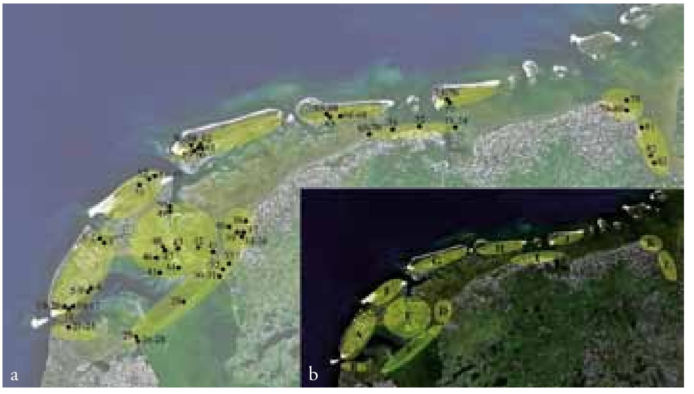

Figure 1. Research localities (a) and regions (b) of the Wadden Sea survey July/August 2009. See also table 1.
Figuur 1. Veldwerklocaties (a) en deelgebieden (b) die onderzocht zijn bij de Waddenzeeinventarisatie juli/augustus 2009. Zie ook tabel 1.

data from the SETL-project have already been published in reports made for Deltares and the Dutch Ministry of Transport, Public Works and Water Management (Gittenberger 2008a, 2009a, Gittenberger & Schipper 2008).

Locations

In July-August 2009, a team consisting of three biologists on average made an inventory of the hard substratum related species diversity in the Dutch Wadden Sea at 83 localities (fig. 1a) in twelve arbitrarily chosen regions, i.e. a. Texel, b. Den Helder, c. Afsluitdijk, d. Harlingen, e. Wadden Sea (open water), f. Vlieland, g. Terschelling, h. Ameland, i. Holwerd-Lauwersoog, j. Schiermonnikoog, k. Eemshaven, l. Eems (fig. 1b). Next to assessing mussel beds, oyster reefs, dikes and harbours in general, floating docks were given extra attention because these are known for their relatively high species diversity (Cohen et al. 2005, Minchin 2007a, Pederson et al. 2003). To get an idea of the complete diversity of species present, we have attempted to search every type of hard substratum present in a region, i.e. all sides of floating docks, wooden poles and pilings, buoys, submerged ropes and objects hanging of the docks and piers, dikes in the tidal and subtidal, and crevices in between and underneath rocks. Every habitat that could be distinguished was treated as a locality and searched separately. A description of each locality can be found in table 1.

Methods

In order to find as many species as possible, a wide range of methods was used. These were based on experience by the Netherlands Centre for Biodiversity (NCB) Naturalis, and by rapid assessments of harbours along the American east coast as described by Pederson et al. (2003). For each locality the best methods were selected on the basis of 1. the goal of recording as many species as possible, 2. the characteristics of the localities, e.g. littoral, sublittoral, its micro-habitats, etc., and 3. the local restrictions for safety purposes or enforced by law. If possible, every locality was searched for at least half an hour, after which the search was continued until less than one extra species was expected to be found within double the time searched. To calculate this, for every new species that was observed the passed away search time was noted since the search was started. Whenever a species was recorded, the rest of the time was spent focusing on finding other species at that locality. At most localities, 95% of all species present were found in the first few minutes. Therefore, the average search time per locality was about 45 minutes.

The following methods were used.

- Visual inspection of the inside, base and outside of floating objects and of non-floating objects at low tide. This was usually done while snorkeling, but also from shore by looking over the edge of a floating dock and by

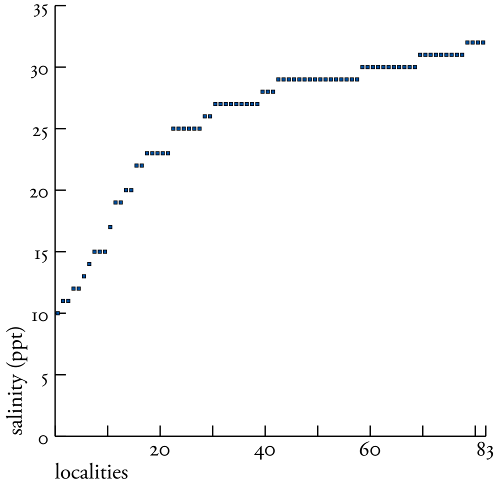

Figure 2. Variation in salinity at the 83 fieldwork localities. See also table 1.
Figuur 2. Variatie in saliniteit bij de 83 veldwerklocaties. Zie ook tabel 1.

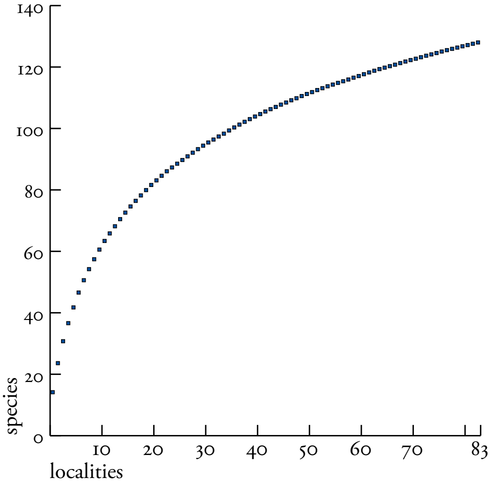

Figure 3. Species accumulation curve on the basis of the total number of fieldwork localities and the average number of additional species found for each extra locality searched.
Figuur 3. Soortenaccumulatiecurve, gebaseerd op het aantal onderzocht locaties en het gemiddelde aantal nieuwe soorten wat per extra locatie gevonden werd.

using a Seabotix LBV150SE ROV (Remotely Operated Vehicle). The benefits of the ROV were that it could be used on localities where it was prohibited to snorkel, that it could dive during an unlimited amount of time, and that it could make a video of the surface searched.

- Usage of a net and grabbing devices to collect material from under the low tide water line.
- Turning over rocks, oysters and other hard substrata during low tide, for access to the underside and the bottom underneath.
- Surfacing submerged objects, which hung (on a rope) in the water along the sides of piers and floating docks. Many species that prefer deep water were found with this method.
- SETL-methodology, checking 14x14 cm PVC settlement plates which were deployed three to six months prior to the assessment along floating docks in Den Helder harbour and Eemshaven harbour.
- Seventeen off-shore localities were searched with a mussel dredge lowered into the water from the vessel 'De Stormvogel' of the Ministry of Agriculture, Nature and Food Quality. These localities included subtidal mussel beds and oyster reefs. The boat was also used to check some off-shore buoys and some floats from which ropes were hanging for catching mussel spat.

A species accumulation curve was made with the program Primer 6.1.10 (Primer-E), based on the relative number of new species for the whole survey that is found in each new locality.

Reference material

For reference purposes, each recorded species was photographed in detail with a Canon 5D 12.8 Megapixel camera, filmed with a SeaBotix LBV150SE ROV (remotely operated vehicle), and/or collected and preserved on ethanol 70% or 96%, or dried and pressed in between news papers (algae). Whenever possible, the species were photographed and filmed in situ, i.e. underwater.

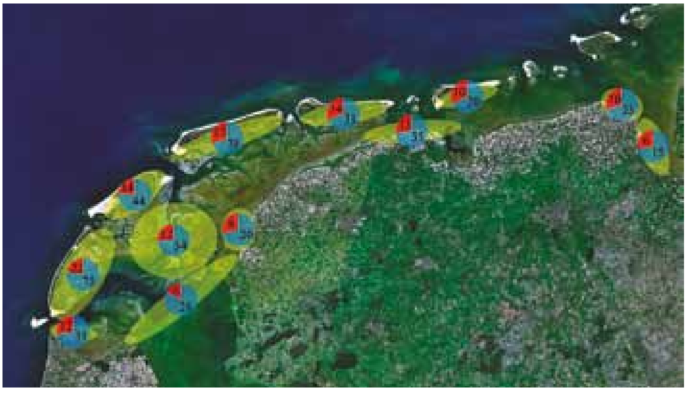

Figure 4. Species diversity recorded per region. Red, number of species of non-native or unknown origin; Blue, number of native species.
Figuur 4. Soortendiversiteit per deelgebied. Rood, aantal uitheemse soorten van uitheemse of onbekende afkomst; Blauw, aantal inheemse soorten.

The microhabitat of each species was described. All files/images were stored on at least two separate hard disks.

Of all algae, rare species, and newly recorded non-native species for the Dutch Wadden Sea, voucher specimens were collected and preserved according to the standards of the Netherlands Centre for Biodiversity (NCB) Naturalis, making sure that diagnostic characters remain preserved. For example, the algae were dried in between news papers pressed together under lead weights, and the sea-squirts were first sedated in a mixture of menthol/seawater before they were preserved in ethanol. The collected specimens will be stored in the governmental collections maintained by NCB Naturalis. As a standard for the scientific names, we have used the World Register of Marine Species (www.marinespecies.org, consulted on 10.1.2010).

RESULTS

In table 2 a summary is given of the survey in 2009. The 83 localities that were searched varied in salinities from 10 to 32 ppt (table 1-2, fig. 2) and in water temperatures from 16.5 to 25.5 °C (table 1-2). A total of 129 species was recorded. The minimum and maximum salinity for each species, is indicated in table 3. Their distribution range throughout the Dutch Wadden Sea is described in table 4. Table 4 also includes the records of the marine monitoring projects MOO (observations by scuba-divers) and SETL (with fouling plates). Species that were not recorded in the inventory in July-August, but were recorded in the MOO or SETL-project, are indicated separately in table 5. The species accumulation curve (fig. 3) based on the number of new species that was found for each new locality searched, indicates that the total number of species that could have been found with the present inventory methodologies used, would be about 150 species. On average 15 species were found per locality. The maximum number of species that was found within one locality was 36, i.e. on the underside of a floating dock in the NIOZ harbour, Texel. The Texel region in the Western Wadden Sea (fig. 1b: region a) had the highest diversity of native and non-native species, i.e. 97 (fig. 4). After Texel, the highest diversity was found in the regions searched off Vlieland and Terschelling, i.e. 58 and 55 species, respectively (fig 1b: regions f and g, fig. 4). A distinctly lower diversity, about 30 species, was found in the areas with relatively low salinity like the brackish waters close to the Afsluitdijk sluices, the city of Harlingen and the Eems river (fig 1b; regions c, d and l, fig. 4). Of all species that were found, 29 had a non-native or cryptogenic origin (table 4). One additional non-native species, i.e. *Sinelobus stanfordi*, was found in association with hard substrata in the Wadden Sea in 2010. In total 11 and one sub-species of the alga *Codium fragile*, are recorded

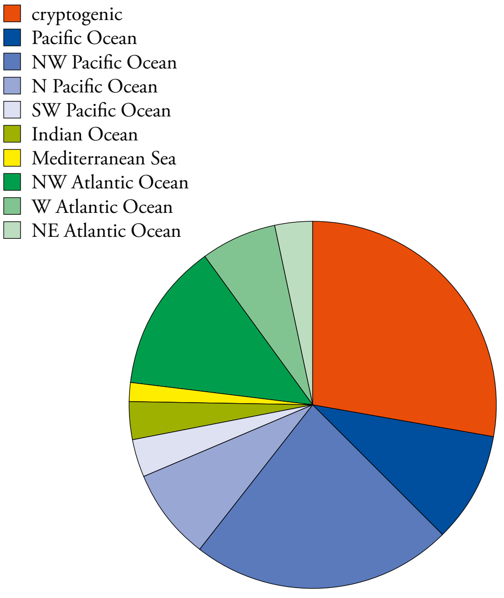

Figure 5. Origin of the 64 non-native or cryptogenic species known from the Dutch Waddensea.
Figuur 5. Oorsprong van de 64 soorten van uitheemse of onbekende afkomst bekend uit de Nederlandse Waddenzee.

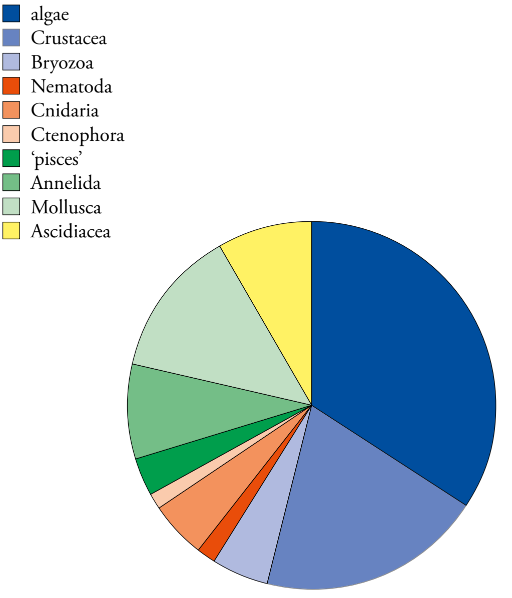

Figure 6. Taxonomic groups of the 64 non-native and cryptogenic species known from the Dutch Waddensea.
Figuur 6. Hoofdgroepen van de 64 soorten van uitheemse of onbekende oorsprong bekend uit de Nederlandse Waddenzee.

here as new to the Dutch Wadden Sea. These are the five algal species *Antithamnionella spirographidis*, *Ceramium cimbricum*, an unknown *Ceramiaceae* species, *Codium fragile* subsp. *atlanticum* and *Gracilaria vermiculophylla*, the two tubeworms *Ficopomatus enigmaticus* and cf. *Neodexiospira brasiliensis*, the crustacean *Sinelobus stanfordi* and the four seasquirts *Aplidium glabrum*, *Botrylloides violaceus*, *Didemnum vexillum* and *Molgula socialis*.

Non-native and cryptogenic species
Wijsman & De Mesel (2009) recorded a total of 50 non-native and cryptogenic species in the Dutch Wadden Sea. In our survey and study of unpublished records we found 30 non-native species, raising the total number to 64 (table 6). The largest number of non-native species had its origin in the Pacific Ocean, and more specifically the NW Pacific. After the Pacific, the NW Atlantic Ocean is the main source of non-native species. Only one and two species, respectively, were introduced from the Indian Ocean and the Mediterranean. More than 25% of the species is of unknown origin, i.e. cryptogenic (fig. 5). Most of the non-native and cryptogenic species are algae, followed by crustaceans, and molluscs, worms, and sea-squirts (fig. 6). The non-native species are described in more detail in the following paragraph.

Algae

Antithamnionella spirographidis (fig. 7)

Origin North Pacific (Maggs & Stegenga 1999).
Distribution This is the first record of this red alga in the Dutch Wadden Sea. It was found in Oudeschild harbour in the sublittoral on the boulders of a dike, and just submerged underwater on the outside of a wooden floating dock.

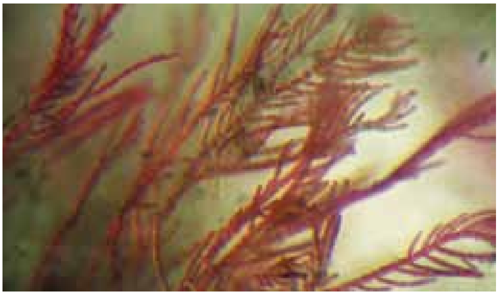

Figure 7. *Antithamnionella spirographidis*, in vitro. Collected in Oudeschild harbour, Texel. All photo's Arjan Gittenberger, unless mentioned otherwise.
Figuur 7. *Antithamnionella spirographidis*, in vitro. Verzameld in de jachthaven van Oudeschild, Texel. Alle foto's Arjan Gittenberger, tenzij anders vermeld.

Figure 9. *Ceramium cimbricum* growing on a metal floating dock in the NIOZ-harbour, Texel.
Figuur 9. *Ceramium cimbricum* op een metalen drijvende steiger in de NIOZ-haven, Texel.

Figure / Figuur 8. *Antithamnionella spirographidis*.

Figure / Figuur 10. *Ceramium cimbricum*.

South of Terschelling a specimen was found on a sublittoral mussel bed (fig. 8, table 4). The salinities at these localities varied from 28 to 31 ppt (table 3). *Antithamnionella spirographidis* was first observed in the Netherlands in 1974 in the Dutch Delta area (Stegenga & Prud'homme van Reine 1998).
Impact This relatively small red alga, which only occurred on hard substrata, is not expected to have a large impact on the ecosystem.

Ceramium cimbricum (fig. 9)

Origin Cryptogenic; its rapid population expansion in the Netherlands over recent years may indicate that this species is exotic, not native to NW Europe.
Distribution This is the first record of this relatively small red alga in the Dutch Wadden Sea. It was found growing on a metal floating dock in the NIOZ harbour, Texel, and on a wooden floating dock in West-Terschelling harbour (fig. 10, table 4). These localities varied in salinity from 30 to 32 ppt (table 3).
Impact This relatively small red algal species, which was only found on floating docks, is not expected to have a large impact.

Ceramiaceae sp. (fig. 11)

Origin Cryptogenic; this is the first record of this red alga in the Dutch Wadden Sea and most probably the first record for Europe. It does not look like any of the Ceramiaceae species that are known for Europe. Ongoing research may reveal its identity.
Distribution One specimen of this relatively

Figure 11. Ceramiaceae sp. collected on a metal floating dock in Eemshaven harbour, in vitro.
Figuur 11. Ceramiaceae sp. verzameld van een metalen drijvende steiger in Eemshaven, in vitro.

Figure / Figuur 12. Ceramiaceae sp.

small red algal species was found growing on a metal floating dock in Eemshaven harbour (fig. 12, table 4). The salinity of the water at this locality was 25 ppt (table 3).
Impact This relatively small red alga, which was only found at one locality on a floating dock, is not expected to have a large impact.

Codium fragile subsp. atlanticum (fig. 13)

Origin NW Pacific (Silva 1955).
Distribution This is the first record of the subspecies *atlanticum* of the forked felt alga *Codium fragile* in the Wadden Sea. One specimen was found growing on a wooden floating dock in West-Terschelling harbour (fig. 14, table 4). The salinity of the water at this locality was 32 ppt (table 3).
Impact The subspecies *Codium fragile tomentosoides*, which is considered to be a synonym of *Codium fragile* subspec. *fragile* by Brodie et al. (2007), was described from Den Helder by Van Goor (1923) as *C. Mucronatum* var. *tomentosoides*. It was present on the locality in 1900, and is still found in the Dutch Wadden Sea (Stegenga & Prud'homme van Reine (1998). This taxon has not had any recorded impact on the ecosystem. It is therefore unlikely that *Codium fragile* subsp. *atlanticum*, which has similar habitat preferences, will have an impact.

Figure 13. *Codium fragile* subsp. *atlanticum* collected on a wooden floating dock in West-Terschelling harbour, a. in situ, b. in vitro.
Figuur 13. *Codium fragile* subsp. *atlanticum* verzameld van een houten drijvende steiger in de jachthaven van Terschelling, a. in situ, b. in vitro.

Figure / Figuur 14. *Codium fragile* subsp. *atlanticum*.

Figure 15. *Gracilaria vermiculophylla* in the littoral zone, on the sand off Ameland at low tide, next to an oyster reef. A, in situ, the shells are oysters giving an indication of the size; B, in vitro (with cystocarps).
Figuur 15. *Gracilaria vermiculophylla* in de litorale zone naast een oester rif op het zand langs de kust van Ameland bij laag water. A, in situ, naast oesterschelpen die een indicatie geven van de grootte; B, in vitro (met cystocarpen).

Figure / Figuur 16. *Gracilaria vermiculophylla*.

Gracilaria vermiculophylla (fig. 15)

Origin W Pacific (Gollasch & Nehring 2006, Thomsen et al. 2007).
Distribution This is the first confirmed record of *G. vermiculophylla* in the Dutch Wadden Sea. During the survey it was found widespread, usually in the littoral zone on sand, on oyster reefs and on mussel beds (fig. 16, table 4). These localities varied in salinity from 19 to 31 ppt (table 3). In the Netherlands this species was first recorded in the Dutch Delta area, close to Yerseke in 1994 (Stegenga et al. 2007).
Impact In the German and Danish parts of the Wadden Sea this invasive species was already known to have settled, with a substantial impact on the local ecosystem by becoming one of the most dominant marcoalgae (Thomsen et al. 2007). As is illustrated in figure 15a, the individuals in the Dutch Wadden Sea may also be relatively large. During the present survey they were found widespread from Texel to Lauwersoog, at least locally dominating and completely covering large areas of the bottom. It is therefore concluded that *G. vermiculophylla* has a distinct impact on the Dutch Wadden Sea ecosystem.

Mastocarpus stellatus (fig. 17)

Origin Probably native. Even though the false carragheen moss *M. stellatus* is considered an exotic species in the Wadden Sea by Wijsman & De Mesel (2009), we argue that it is most probably a native species. It has been recorded in the Wadden Sea since the early 19th century and there are no indications that it may have been introduced here by humans.
Distribution During the survey many specimens were found in the littoral zone at several localities in the western Dutch Wadden Sea along the SE coast of Texel and in Den Helder harbour (fig. 18, table 4). These localities varied in salinity from 27 to 31 ppt (table 3). The species appears to be absent in the eastern Wadden Sea.
Impact It is unclear whether this species has a substantial impact. As is explained above, we consider this species to be native.

Figure 17. *Mastocarpus stellatus* collected in the NIOZ harbour, Texel, a. in situ, b. in vitro.
Figuur 17. *Mastocarpus stellatus* verzameld in de NIOZ-haven-, Texel, a. in situ, b. in vitro.

Figure / Figuur 18. *Mastocarpus stellatus.*

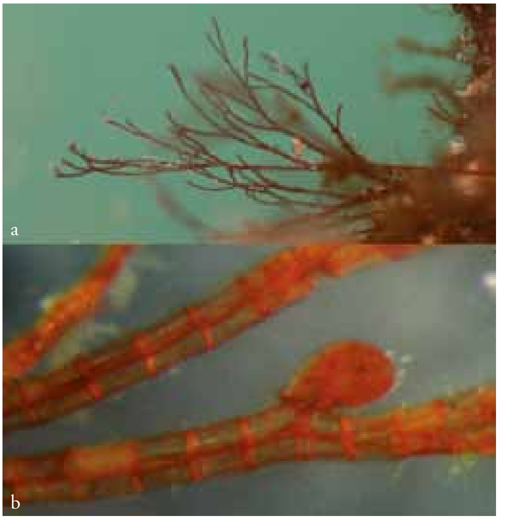

Figure 19. *Polysiphonia harveyi,* a. in situ, growing on a wooden floating dock in the harbour of Vlieland, b. in vitro, female specimen (with cystocarp) collected from a floating dock made out of synthetic material in Oudeschild harbour, Texel.
Figuur 19. *Polysiphonia harveyi,* a. in situ, op een houten drijvende steiger in de jachthaven van Vlieland, b. in vitro, vrouwelijk exemplaar (met cystocarp) verzameld van een kunststof drijvende steiger in de haven van Oudeschild, Texel.

Figure / Figuur 20. *Polysiphonia harveyi.*

Polysiphonia harveyi (fig. 19)

Origin N Pacific (Maggs & Stegenga 1999).
Distribution Previously this usually epiphytic alga was recorded in the Wadden Sea off the island Texel (Maggs & Stegenga 1999). During the present survey many specimens were found throughout the Dutch Wadden Sea (fig. 20, table 4). Most were growing on floating docks. These localities varied in salinity from 19 to 31 ppt (table 3). *Polysiphonia harveyi* was first recorded in the Netherlands in 1960, from the Kanaal door Zuid-Beveland in the Dutch Delta area (Maggs & Stegenga 1999).
Impact It is unclear whether this small alga may have an impact.

Figure 21. *Sargassum muticum* growing sublittoral on a wooden pole in the NIOZ harbour, Texel.
Figuur 21. *Sargassum muticum* op een houten paal in de sublitorale zone in de NIOZ-haven, Texel.

Figure / Figuur 22. *Sargassum muticum*.

Figure 23. *Ulva pertusa*, a. in situ, growing on a wooden floating dock in the harbour of the island Vlieland, b. in vitro, specimen collected in the littoral zone on the dike in the NIOZ harbour, Texel.
Figuur 23. De alg *Ulva pertusa*, a. in situ, op een houten drijvende steiger in de haven van Vlieland, b. in vitro, exemplaar verzameld in de litorale zone van de dijk in de NIOZ-haven, Texel.

Figure / Figuur 24. *Ulva pertusa*.

Sargassum muticum (fig. 21)

Origin NW Pacific (Silva 1955).
Distribution Attached thalli of the Japanese sargasso weed *S. muticum* were first recorded in the Netherlands in 1980 in the Wadden Sea off Texel. A few months later it was also found in the Dutch Delta (Prud'homme van Reine 1980, 1982). During the survey this species was found at several localities in the western Wadden Sea, usually in the sublittoral or just in the supralittoral (fig. 22, table 4). These localities varied in salinity from 23 to 33 ppt (table 3). It was not found in the eastern Wadden Sea.
Impact At none of the localities *S. muticum* was found as a dominant species. Instead, it was usually rare. Therefore, at the time of the survey, *S. muticum* did not seem to have a large impact.

Ulva pertusa (fig. 23)

Origin NW Pacific (Silva 1955).
Distribution During the survey, specimens of this sea lettuce species were found in the littoral and in the sublittoral (fig. 24, table 4). These localities varied in salinity from 19 to 31 ppt (table 3). Previously *U. pertusa* was only recorded in the western Wadden Sea off Texel (Stegenga & Mol

Figure 25. *Undaria pinnatifida* collected from a wooden floating dock in West-Terschelling harbour.
Figuur 25. *Undaria pinnatifida* verzameld van een houten drijvende steiger in de haven van Terschelling.

Figure / Figuur 26. *Undaria pinnatifida*.

2002). Its first Dutch record is from the Delta region in 1993 (Stegenga & Mol 2002).
Impact This species was locally abundant, having a distinct impact on the local ecosystem. Because it is hard to distinguish *U. pertusa* in the field from native *Ulva* species (Koeman & Van den Hoek 1981), its overall impact is uncertain.

Undaria pinnatifida (fig. 25)

Origin NW Pacific (Silva 1955).
Distribution The Wakame seaweed *U. pinnatifida* was first recorded in the Wadden Sea in 2008 in West-Terschelling harbour (De Ruijter 2008). During the present survey several specimens were found at the same locality, on wooden floating docks in the harbour of Terschelling (fig. 26, table 4). The salinity of the water at this locality was 32 ppt (table 3). It was not found anywhere else. Its first Dutch record is from the Delta region in 1999 (Stegenga 1999).
Impact It is questionable whether the relatively murky water and sandy bottoms of the Wadden Sea form a suitable habitat for this large brown kelp species of which the individuals can become up to two meters long. It may become a fouling problem for harbours with floating docks though. De Ruijter (2008) recorded the species to be very abundant on the floating docks in West-Terschelling harbour in May 2008. During the survey it was still found to be common, even though this annual species is known for its seasonality, being virtually absent during summer, and abundant in winter.

Annelida - segmented worms

Ficopomatus enigmaticus (fig. 27)

Origin SW Pacific (Grosholz & Ruiz 1996).
Distribution This is the first record of the reef-building tubeworm *F. enigmaticus* in the Dutch Wadden Sea. In Harlingen harbour, it was found on a wooden floating dock (fig. 28, table 4), in brackish water with a salinity of 15 ppt (table 3). The second locality where the species was found is the exposed side of the dike of the NIOZ harbour, Texel, despite the high salinity (30 ppt) measured at that locality (table 3), which may not be accurate for the exact spot where the calcareous worm tubes of *F. enigmaticus* were found. There seemed to be a small fresh water run-off from the dike which may locally have caused lower salinities. In general *F. enigmaticus* is known for its preference for brackish water (Gittenberger 2009b, Schwindt et al. 2001). In the Netherlands it was first found in 1967 in the Dutch Delta area in the Kanaal door Walcheren (Wolff 1968).
Impact With its tubes this worm can build relatively large and strong calcareous reefs (Schwindt et al. 2001), which can hinder or even completely obstruct the water flow in pipelines and cooling

Figure 27. *Ficopomatus enigmaticus*, in vitro. Collected in Harlingen harbour.
Figuur 27. *Ficopomatus enigmaticus*, in vitro, verzameld in de haven van Harlingen.

Figure 29. cf. *Neodexiospira brasiliensis*, in vitro. Collected in the littoral zone on the dike in NIOZ harbour, Texel.
Figuur 29. cf. *Neodexiospira brasiliensis*, in vitro. Verzameld in de litorale zone onderaan de dijk in de NIOZ-haven, Texel.

Figure / Figuur 28. *Ficopomatus enigmaticus*.

Figure / Figuur 30. cf. *Neodexiospira brasiliensis*.

systems (Gittenberger 2009b). Because of its preference for brackish waters, it will probably not cause any significant problems in the Wadden Sea, but it may do so in neighbouring waters with relatively low salinities.

cf. Neodexiospira brasiliensis (fig. 29)

Origin Tropics, including Brasil (Eno et al. 1997).
Distribution This is the first record of this spirorbid polychaete in the Dutch Wadden Sea. Its minute spiral calcareous tubes were found on the alga *Mastocarpus stellatus* in the littoral zone on the dike in the NIOZ harbour, Texel (fig. 30, table 4). The salinity of the water at this locality was 29 ppt (table 3). In the Netherlands it was first recorded in the Dutch Delta by Critchley & Thorp (1985).

Impact The small calcareous tubes are several millimetres in diameter, and were only found at one locality during the survey. Therefore this species is not expected to have a distinct impact.

Ascidiacea - sea squirts

Aplidium glabrum (fig. 31)

Origin Cryptogenic, possibly native to the NE Atlantic (Wolff 2005).
Distribution This is the first record of this colonial ascidian in the Wadden Sea. In West-Terschelling harbour it was found abundantly on a wooden floating dock (fig. 32, table 4). It was found nowhere else in the Dutch Wadden Sea, which may be an indication that its introduction is recent. The salinity of the water at this locality

Figure 31. *Aplidium glabrum* colonies collected from a wooden floating dock in West-Terschelling harbour, a. in situb. in vitro.
Figuur 31. *Aplidium glabrum* kolonies, verzameld van een houten drijvende steiger in de haven van Terschelling, a. in situ, b. in vitro.

Figure / Figuur 32. *Aplidium glabrum*.

was 32 ppt (table 3). In the Netherlands it was first recorded in the Dutch Delta region in 1977 (Buizer 1983).
Impact The colonies of this species can cover mussel ropes (Gittenberger 2007, 2009c) and large areas of a rocky bottom, as may be observed in the seawater lake the Grevelingen, Zeeland. In the literature *A. glabrum* is not known to cause extensive ecological damage in areas where it is introduced, however. The chance that this species will have a significant impact is therefore small.

Botrylloides violaceus (fig. 33)

Origin NW Pacific (Minchin 2007b).
Distribution This is the first record of the violet tunicate *B. violaceus* in the Dutch Wadden Sea. The colonies can have a violet colour, but may also be brightly yellow, reddish, white or purple (fig. 33). The species occurred very abundantly on the floating docks in virtually all the harbours of the islands (fig. 34, table 4). Probably because of its preference for relatively high salinities (27-32 ppt), it was not found in any of the mainland harbours (table 3). As a cryptic species *B. diegensis* may also be present in the Wadden Sea (Faasse 2006). It can only be distinguished from *B. violaceus* by its anatomy. The random selection of colonies of which the anatomy, i.e. the morphology of the larvae, was checked through a microscope, always confirmed the identification as *B. violaceus*.
Impact The fact that this abundant and very distinctly coloured species was not recorded before, indicates that its introduction in the Wadden Sea is probably recent and that it may be spreading rapidly. With its ability to overgrow large surface areas and outcompeting many of the native species, this species will have a distinct impact on the Dutch Wadden Sea ecosystem. This is supported by the fact that, at least locally, it became and still is a dominant species in the Dutch sea inlet the Oosterschelde, Zeeland, within a few years after its first sighting in 1999 (Gittenberger 2007).

Didemnum vexillum (fig. 35)

Origin NW Pacific (Stefaniak et al. 2009).
Distribution This is the first record of this whitish colonial ascidian species in the Wadden Sea. In 2008 Rob Dekker of NIOZ identified the first

Figure 33. Yellow, purple, red, white and orange *Botrylloides violaceus* colonies growing on a floating dock made of synthetic material in Oudeschild harbour, Texel.
Figuur 33. Gele, paarse, rode, witte en oranje *Botrylloides violaceus* kolonies op een drijvende kunststof steiger in de haven van Oudeschild, Texel.

Figure / Figuur 34. *Botrylloides violaceus*.

Figure 35. *Didemnum vexillum* colonies collected from a wooden floating dock in West-Terschelling harbour, a. in situ, b. in vitro.
Figuur 35. *Didemnum vexillum* kolonies verzameld op een houten drijvende steiger in de haven van Terschelling, a. in situ, b. in vitro.

Figure / Figuur 36. *Didemnum vexillum*.

colony of *D. vexillum* on a mussel bed in the Wadden Sea, just south of Terschelling (pers. comm. R. Dekker). During the present survey we found it at two additional localities off Terschelling, in and just outside the harbour (fig. 36, table 4). The salinity of the water at both localities was 32 ppt (table 3). In the Netherlands it was first recorded in 1991 in the Dutch Delta, where it remained inconspicuous in its so-called lag time until 2006, after which it rapidly expanded its population and became one of the most dominant species in the ecosystem (Gittenberger 2007).

Impact Recent morphological (Lambert 2009) and molecular (Stefaniak et al. 2009) studies have shown that the white *Didemnum* species that expanded their populations worldwide in temperate areas in about fifteen years time, belong to one and the same species; *Didemnum vexillum*.

Figure 37. *Molgula socialis*, a-b. specimens growing on hydroids hanging on a metal floating dock in the NIOZ harbour, Texel, c. in vitro, dissected specimen, collected from a floating dock in Oudeschild harbour, Texel.
Figuur 37. *Molgula socialis*, a-b. exemplaren groeiend op hydroidpoliepen op een metalen drijvende steiger in de NIOZ-haven, Texel, c. in vitro, dissectie van een exemplaar dat verzameld werd van een drijvende steiger in de haven van Oudeschild, Texel.

Because of its intraspecific variation and the presence of several very morphologically similar species, its identity has remained disputed for more than ten years. In most areas where it was introduced, it had a severe impact on the native ecosystem; overgrowing large areas of the bottom, suffocating virtually every organism. It is mainly found on hard substrata, but has also shown the ability to overgrow sandy bottoms (Gittenberger 2007). For now, it is only known to occur near Terschelling. Taking past experiences and the literature into account, it is likely to expand its populations into at least the more saline areas of the Wadden Sea.

Molgula socialis (fig. 37)

Origin NE Atlantic (Monniot 1969).
Distribution This is the first record of this solitary ascidian in the Netherlands (fig. 38, table 4).

Figure / Figuur 38. *Molgula socialis*.

Whether it is an introduced or a native species remains unclear, since it is native to the NE Atlantic (Monniot 1969). In the past, the N American *M. manhattensis* has been reported as abundant in the Netherlands. Most probably at least part of these records include *M. socialis*, which is morphologically very similar to *M. manhattensis*. The latter differs most clearly from *M. socialis* by the presence of multiple openings of the sperm duct, instead of a single opening at both sides (pers. comm. G. Lambert, Monniot 1969). This difference becomes only visible when specimens are dissected and studied in detail.
A large number of the presently collected *Molgula* specimens (fig. 37-38) were dissected for this purpose. They all turned out to be *M. socialis*.
It is concluded that even though the distribution of *M. socialis* throughout the Netherlands is uncertain, the species is at least abundantly present in the Dutch Wadden Sea, where it is found in water varying in salinity from 32 ppt to as low as 12 ppt (table 3). The ability to live in brackish water at such low salinities, is rare in ascidians, since most species prefer more saline waters.
Impact Being native to the NE Atlantic, it can very well be native to the Wadden Sea too. It was probably not recorded previously because of confusion with the sibling species *M. manhattensis*.

Figure 39. *Styela clava*, in situ, growing on a metal floating dock in Eemshaven harbour.
Figuur 39. *Styela clava*, in situ, op een metalen drijvende steiger in de haven van Eemshaven.

Figure / Figuur 40. *Styela clava*.

Styela clava (fig. 39)

Origin NW Pacific (Lützen 1999).
Distribution Specimens of the club tunicate *S. clava* were found abundantly throughout the Dutch Wadden Sea in both natural and artifical habitats, mussel beds and floating dock, respectively (fig. 40, table 4). It was found at localities that varied in salinity from 19 to 32 ppt (table 3). In the Netherlands the club tunicate was first found in 1974, in the Dutch Wadden Sea in Den Helder harbour (Huwae 1974). Even though it is was not found there during the present survey, it was recorded in Den Helder harbour in 2009 in the SETL-project (table 4, Gittenberger 2008a, 2009a).
Impact Over the years *S. clava* has become part of the Dutch Wadden Sea ecosystem. It becomes particularly very abundant in harbours, having a distinct impact on its surroundings.

Bryozoa - bryozoans

Bugula stolonifera (fig. 41)

Origin NW Atlantic (Cohen & Carlton 1995).
Distribution During the present study the bryozoan *B. stolonifera* was only found off the Wadden Sea islands, but not in the mainland harbours (fig. 42, table 4). This may be due to a preference for more saline waters. The localities where it was found varied in salinity from 27 to 32 ppt (table 3). In the Netherlands it was first found in 1993 in the NIOZ harbour, Texel (D'Hondt & Cadée 1994), where it was also found during the present survey (fig. 41b).
Impact Locally the species can be very abundant (fig. 41a). It therefore does have an impact on the ecosystem. Without any further research, it remains hard to quantify or describe this impact.

Cnidaria - cnidarians

Diadumene cincta (fig. 43)

Origin Pacific (Gollasch & Nehring 2006), but its non-native origin has been questioned by Ates (2006).
Distribution During the present survey the orange sea anemone *D. cincta* was found in Den Helder harbour (fig. 43) and in the harbour of the island Ameland (fig. 44, table 4). The salinity of the water at these localities was 27 and 31 ppt (table 3), respectively. The first Dutch record, in 1925, is from both the Wadden Sea near Den Helder, and from Schouwen in the Dutch Delta region (Pax 1936).

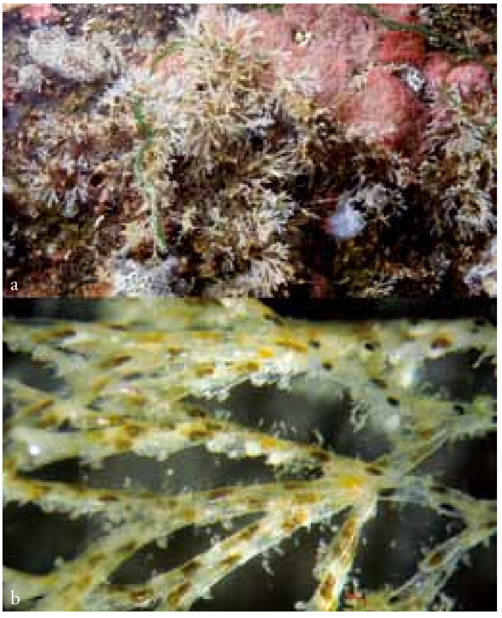

Figure 41. *Bugula stolonifera*, a. in situ, colonies collected from a floating dock made from synthetic material in Oudeschild harbour, Texel, b. in vitro, colony collected in the NIOZ harbour, Texel.
Figuur 41. *Bugula stolonifera*,a. in situ, kolonie verzameld van een kunststof drijvende steiger, de haven van Oudeschild, Texel, b. in vitro, kolonie verzameld in de NIOZ-haven, Texel.

Figure / Figuur 42. *Bugula stolonifera.*

Impact The fact that *D. cincta* was only found at two localities during the present survey, indicates that this sea anemone has not expanded its populations much over the last century. It is therefore unlikely that it will have a large impact in the future.

Figure 43. *Diadumene cincta*, in situ, growing on a floating wooden dock in the harbour of Ameland.
Figuur 43. *Diadumene cincta*, in situ, op een houten steiger in de haven van Ameland.

Figure / Figuur 44. *Diadumene cincta*.

Crustacea - crustaceans

Balanus improvisus (fig. 45)

Origin Cryptogenic, possibly native to NE Atlantic (Gollasch 2002).
Distribution The barnacle *B. improvisus* was found throughout the Wadden Sea (fig. 46, table 4), at localities that varied in salinity from 10 to 31 ppt (table 3). It showed a preference for habitats in the sublittoral zone and on the carapace of crabs hiding in tide pools in the littoral zone. In more saline waters it was found in mixed populations together with the morphologically similar, native species *B. crenatus* and the invasive New Zealand barnacle *Elminius modestus*. The

Figure 45. *Balanus improvisus* from the exposed side of the jetty of Vlieland harbour, a. on a green crab *Carcinus maenas* b. a pair of operculum plates, diagnostic for *Balanus improvisus*.
Figuur 45. *Balanus improvisus* buitendijks bij de haven van Vlieland, a. op een gewone strandkrab *Carcinus maenas* b. de operculum platen, kenmerkend voor *Balanus improvisus*.

Figure / Figuur 46. *Balanus improvisus*.

operculum plates of all barnacles (fig. 45b) were inspected through a microscope to distinguish *B. improvisus* from *B. crenatus*. In brackish water, *B. improvisus* was found to be the dominant barnacle species in the sublittoral zone, sometimes co-occurring with *E. modestus*. Waardenburg (1827) first recorded this species in the Netherlands (as *Balanus ovularis*) (Wolff 2005).
Impact Especially in the less saline areas this species is abundant and it does not seem to compete with any native barnacle species. Its impact on the native species is therefore limited.

Elminius modestus (fig. 47)

Origin SW Pacific (Harms 1999).
Distribution Since the 1950s *E. modestus* is found in the Dutch Wadden Sea (Wolff 2005). Since then it has spread rapidly and during the present survey it was found to be the most abundant barnacle by far, inhabiting a wide range of littoral and sublittoral habitats (fig. 48, table 4), at localities varying in salinity from 12 to 32 ppt (table 3). It was found almost everywhere, but not in the deeper offshore localities. *Elminius modestus* was first found in the Netherlands in 1946 at Wassenaarse Slag and at Loosduinen-Kijkduin (Boschma 1948).
Impact Because of its ability to live and become abundant in a relatively wide range of habitats it competes for space with several native species. In the littoral zone it competes mostly with the native barnacle *Semibalanus balanoides,* which is abundant there. In the sublittoral zone it competes with the native barnacle *Balanus crenatus*. Therefore, it has a distinct impact on the flora and fauna living on hard substrata.

Caprella mutica (fig. 49)

Origin Pacific (Schrey & Buschbaum 2006).
Distribution *Caprella mutica* was first recorded in the Dutch Wadden Sea in 2005 off the island Texel (Cook et al. 2007). It was first recorded in Europe in 1994 in the Delta area of the Netherlands (Cook et al. 2007). During the present survey it was found to be locally very abundant, especially on the colonial tunicate *Botrylloides violaceus* (fig. 49A) and on hydroids that were growing on floating docks (fig. 50, table 4).
In addition to these sightings, unpublished records from the MOO-project are present in the

Figure 47. *Elminius modestus* in the NIOZ harbour, Texel, a. in situ, b. a pair of operculum plates, diagnostic for *Elminius modestus*.
Figuur 47. *Elminius modestus* in de NIOZ-haven, Texel, a. in situ, b. in vitro.

ANEMOON Foundation database from the localities 't Horntje, Texel and Eemshaven (tables 1,4). The localities where *C. mutica* was found varied in salinity from 25 to 32 ppt (table 3).
Impact As can been seen in figure 49a, *C. mutica* can become very abundant locally. Because it is one of the largest caprellid species found in the NE Atlantic, it may be able to outcompete all native caprellid species. Even though many collected specimens were studied in detail through a microscope, none of these native species was found. It is unclear whether the native species were also absent in the past or were outcompeted by *C. mutica*. More detailed studies are necessary to get an idea of the impact that this caprellid species has on the native flora and fauna.

Jassa marmorata (fig. 51)

Origin NW Atlantic (pers. comm. K. Conlan, Conlan 1990).
Distribution Even though Stock (1993) and Dankers & Van Moorsel (2001) have recorded

Figure / Figuur 48. *Elminius modestus*.

this exotic marine amphipod species in the Dutch Wadden Sea, it is unclear when it was introduced because of its morphological resemblance to the native amphipod *J. falcata*. During the present survey thousands of specimens were found on the ropes of mussel spat collectors, which floated in the middle of the Dutch Wadden Sea (fig. 1a: loc. 45, table 4). Furthermore the species was found in low densities at two localities along the SE coast of Texel (fig. 52, table 4). The localities where *J. marmorata* was found varied in salinity from 25 to 32 ppt (table 3). Even though Gittenberger (2009d) missed this species in a review of the exotic species recorded in the Oosterschelde, *J. marmorata* has been present there for quite some time (Faasse & Van Moorsel 2000). As is clearly described by Faasse & Van Moorsel (2000), the two species *J. marmorata* and *J. herdmani* have often been misidentified as *J. falcata*. *Jassa marmorata* and *J. herdmani* both occur commonly in the province of Zeeland, while *J. falcata* is native for the NE Atlantic but rare in the Netherlands. It was only recorded there once with certainty (Faasse & Van Moorsel 2000, Stock 1993). The recently published record of *J. falcata* in a list of species that live in association with mussels in the Delta area of the Netherlands (Wijsman & De Mesel 2009), is also probably based on a misidentification. It is at least very unlikely that *J. marmorata* and/or *J. herdmani* were not found in association with these mussels, while *J. falcata* was found as the only *Jassa* species present. To distinguish these three species from

Figure 49. *Caprella mutica*, a. in situ, on a *Botrylloides violaceus* colony growing on a wooden floating dock in Oudeschild harbour, Texel, b. in vitro, collected from a metal floating dock in NIOZ harbour, Texel.
Figuur 49. *Caprella mutica*, a. in situ, op een kolonie van *Botrylloides violaceus* op een houten drijvende steiger in de haven van Oudeschild, Texel, b. in vitro, verzameld van een metalen drijvende steiger in de NIOZ-haven, Texel.

Figure / Figuur 50. *Caprella mutica*.

each other, one has to check every specimen through a binocular. They differ most clearly in the presence and/or form of the cilia, protuberances, ridges and spines on their legs (Chapman 2007, Conlan 1990).
Impact According to Conlan (pers. comm.) *J. marmorata* has spread worldwide in temperate areas from its native range in the NW Atlantic. It can be especially abundant in harbour systems. *Jassa marmorata* furthermore has a preference for areas with strong currents (Faasse & Van Moorsel 2000). This may explain why it was found in high densities on the floating mussel spat collectors that are situated in the middle of the Dutch Wadden Sea where the currents can be very strong. Even though *J. marmorata* did not seem to be harmful to the mussel spat, high densities of *Jassa* species can have a distinct impact on an ecosystem as they form an important food source for fishes. For as long as *J. marmarata* remains dominant on the floating mussel collectors only, the negative impact of this species will remain limited however. The moment that it would start to settle in such high densities in the more natural habitats, this strong competitor for food and space will have a clear impact.

Eriocheir sinensis (fig. 53)

Origin NW Pacific (Adema 1991).
Distribution Since the 1930s the Chinese mitten crab has expanded its populations along the mainland of the Dutch Wadden Sea in waters with a relatively low salinity (Wolff 2005). During the survey large numbers were found in brackish waters, in Den Oever harbour and Harlingen harbour (fig. 54, table 4), at localities that varied in salinity from 14 to 20 ppt (table 3).
Impact The largest part of the Dutch Wadden Sea appears to be too saline for the Chinese mitten crab. This species therefore does not have a large impact.

Figure 51. *Jassa marmorata*, in vitro, collected from a floating mussel spat collectors. These amphipods are about 7 mm in size.
Figuur 51. *Jassa marmorata*, in vitro, verzameld van een mosselzaadinvanginstallatie (MZI). De marmerkreeftjes zijn ongeveer 7 mm groot.

Figure / Figuur 52. *Jassa marmorata*.

Hemigrapsus sanguineus (fig. 55)

Origin NW Pacific (Breton et al. 2002).
Distribution The Asian shore crab *H. sanguineus* was found to be common throughout the Dutch Wadden Sea (fig. 56, table 4), usually hiding under boulders. In its distribution it showed a preference for the more saline waters. It was found at localities varying in salinity from 19 to 32 ppt (table 3). See 'Distribution' of the Asian pencil crab *H. takanoi*, a morphologically very similar species that was found sympatrically with *H. sanguineus* at several localities. The males of these two species can be distinguished by the presence of a balloon-like swelling on the claws in *H. sanguineus* (fig. 55) instead of a small puff of hairs on the claws of *H. takanoi* (fig. 57a, b). All specimens, male and female, can be distinguished by the crest; by the thin line, just underneath the eye, which is continuous in *H. sanguineus* (fig. 55b, c) (Breton et al. 2002) and interrupted in *H. takanoi* (fig. 57b, c). *Hemigrapsus sanguineus* was first sighted in the Netherlands in 1999 in the Dutch Delta area (Wolff 2005). In 2004 it was found for the first time in the Dutch Wadden Sea.
Impact Regardless of their small size, the Asian shore crabs that were found were extremely aggressive when caught (fig. 55a). They occurred

Figure 53. *Eriocheir sinensis*, in situ, in Harlingen harbour. Specimens of the exotic brackish water barnacle *Balanus improvisus* grow on its carpace and legs.
Figuur 53. *Eriocheir sinensis*, in situ, een Chinese wolhandkrab in de haven van Harlingen met brakwaterzeepokken (*Balanus improvisus*) op zijn poten en rugschild.

Figure / Figuur 54. *Eriocheir sinensis*.

Figure 55. *Hemigrapsus sanguineus* collected on the bottom in the littoral zone underneath rocks and oysters in Lauwersoog (a, male), Eemshaven (b, female), and Oudeschild, Texel (c, female).
Figuur 55. *Hemigrapsus sanguineus* verzameld in de litorale zone onder stenen en oesters in Lauwersoog (a, mannetje), Eemshaven (b vrouwtje), en Oudeschild, Texel (c vrouwtje).

mostly in aggregations of at least 5-10 specimens underneath a boulder. In areas where they occurred sympatrically with the native green crab *Carcinus maenas* and/or the Asian pencil crab *H. takanoi* they never co-occurred with these species in the same microhabitat, e.g. underneath the same rock. These observations support the hypothesis that *H. sanguineus* is in strong competition for space with these species.

Figure / Figuur 56. *Hemigrapsus sanguineus*.

Figure 57. *Hemigrapsus takanoi* collected in the littoral zone on the dikes of Texel. a-b. male, c. female.
Figuur 57. *Hemigrapsus takanoi* exemplaren die in de litorale zone op de dijken langs de oostkust van Texel verzameld werden. a-b. mannetje, c. vrouwtje.

Hemigrapsus takanoi (fig. 57)

Origin NW Pacific (Asakura & Watanabe 2005).
Distribution The Asian pensil crab *H. takanoi* was commonly found throughout the Dutch Wadden Sea (fig. 58, table 4), usually hiding under boulders and Japanese oysters. Even though *H. takanoi* does occur sympatrically with the morphologically similar Asian shore crab *H. sanguineus* at some localities, the habitats of the two species are clearly segregated. This was also reported by Dauvin et al. (2009) for the Opal Coast of France, where *H. takanoi* was found mainly in low hydrodynamic muddy habitats

Figure / Figuur 58. *Hemigrapsus takanoi*.

while *H. sanguineus* was found in high hydrodynamic habitats. A similar pattern was found here, where, in general, *H. takanoi* was found in the more sheltered muddy habitats and *H. sanguineus* at more exposed places. In addition to their preferences for low or high hydrodynamic habitats, the segregation of the two species also seemed to be related to salinity. Their distributions indicate that *H. takanoi* can tolerate lower salinities, from 12 to 32 ppt (fig. 58, table 3), than *H. sanguineus*, from 19 to 32 ppt (fig. 56, table 3). See 'Distribution' of the Asian shore crab *H. sanguineus* for the diagnostic characters of these two species. Its first Dutch record is from the Dutch Delta in 1999 (Nijland & Beekman 1999). In 2006 it was found for the first time in the Dutch Wadden Sea.
Impact Just like the Asian shore crabs, the Asian pencil crabs were very aggressive when caught. They also occurred in aggregations of at least 5-10 specimens underneath each boulder and in areas where they occurred sympatrically with the native green crab *Carcinus maenas* and/or the Asian shore crab *H. sanguineus,* they never co-occurred with these species. These observations support the hypothesis that *H. takanoi* is in strong competition for space with these species.

Sinelobus stanfordi (fig. 59)

Origin Cryptogenic (Van Haaren & Soors 2009).
Distribution Although the known range of *Sinelobus stanfordi* is circumtropical penetrating

Figure 59. *Sinelobus stanfordi* in Harlingen harbour. a. in vitro, b, in situ. Photo Floris Bennema.
Figuur 59. *Sinelobus stanfordi* in Harlingen haven. a. in vitro, b, in situ. Foto Floris Bennema.

Figure / Figuur 60. *Sinelobus stanfordi*.

the northern and southern temperate waters (Sieg 1986), it was not recorded in NW Europe until 2006, i.e. in the river 'Oude Maas', the Netherlands (Van Haaren & Soors 2009). It is therefore likely that it is an invasive species in at least NW Europe (Van Haaren & Soors 2009). Quickly after the first record, *S. stanfordi* was also found in brackish to fresh waters (3.1-13.2 psu) in the harbours and neighbouring waters of Terneuzen and Antwerp in the south, in the proximity of Rotterdam, and in the Noordzeekanaal, close to Amsterdam, as the northernmost locality. We here report the expansion of its range even further north to the Wadden Sea, where marine biologist Floris Bennema found many specimens of *S. stanfordi* including females with eggs in Harlingen harbour on April 16th and on May 21st 2010 (fig. 60). The salinity at that locality during the survey in 2009 was 20 ppt. This is much higher than the maximum salinity measured at the other localities were it was encountered in NW Europe, i.e. ~13.2 ppt (Van Haaren & Soors 2009). In other areas of the world this species is found from fresh water to hypersaline habitats with salinities up to 52 ppt (Van Haaren & Soors 2009), indicating its potential to invade marine, estuarine and freshwater systems.

Impact Because of its ability to withstand huge fluctuations in salinity and settle in fresh to highly saline waters (Van Haaren & Soors 2009), it is likely that this species will expand its populations throughout the Wadden Sea. Its potential to spread is illustrated by the large number of records and localities in Belgium and the Netherlands where it was found within a few years after the first record in 2006 (Van Haaren & Soors 2009). Although no evidence has been reported of any competition between *S. stanfordi* and (non-) native species, it does seem to inhibit the same niches as native species like corophiids. In Harlingen harbour it was found to live in syntopic populations with *Corophium acherusicum* and *C. insidiosum* (det. by Floris Bennema and Godfried van Moorsel). It is therefore likely to compete for food and space (Van Haaren & Soors 2009). Whether *S. stanfordi* will have a distinct impact on the Wadden Sea ecosystem remains uncertain. Like most of the exotic species recorded here, '*S. stanfordi* is taking advantage of the human introduction of hard substrates in estuaries where soft sediments naturally prevail' (Van Haaren & Soors 2009). This species may therefore only spread to areas

Figure 61. *Mnemiopsis leidyi*, a. in situ, in the NIOZ harbour, Texel, b. washed ashore at low tide in the littoral zone on the exposed side of the jetty of Delfzijl harbour.
Figuur 61. *Mnemiopsis leidyi*, a. in situ, in de NIOZ-haven, Texel, b. aangespoeld bij laag water in de litorale zone aan de buitenzijde van de dijk van de jachthaven van Delfzijl.

Figure / Figuur 62. *Mnemiopsis leidyi*.

within the Wadden Sea where hard substrata are present. The Wadden Sea harbours are likely to be invaded first as *S. stanfordi* is found to be introduced mainly by ballast water or hull fouling according to Van Haaren & Soors (2009).

Ctenophora - comb jellyfish

Mnemiopsis leidyi (fig. 61)

Origin W Atlantic (Kideys 2002).
Distribution Even though this ctenophore species does not live in association with hard substrata, it is usually abundantly found in harbours. During the present survey *M. leidyi* was found in high numbers up to at least 50 individuals/m3 (fig. 62, table 4), at localities that varied in salinity from 15 to 31 ppt (table 3). This species was first recorded in the Netherlands, in 2006, in both the Delta area and the Wadden Sea (Faasse & Bayha 2006, Tulp 2006).
Impact *Mnemiopsis leidyi*, which feeds on zooplankton, has the potential to cause extreme ecological and economical damage in areas where it is introduced. In the Black Sea, it devastated the anchovy stock and consequently the fisheries (Kideys 2002). Risks for the Dutch waters including the Wadden Sea are described in detail in the risk assessment by Gittenberger (2008b). The high numbers that were recorded during the survey throughout the Wadden Sea indicate that *M. leidyi* must already have a large impact. More research is necessary to assess this impact in detail.

Mollusca - molluscs

Crassostrea gigas (fig. 63)

Origin NW Pacific (Eno et al. 1997).
Distribution The Japanese oyster *C. gigas* was found throughout the Dutch Wadden Sea (fig. 64, table 4), in habitats that varied in salinity from 15 to 32 ppt (table 3). At most localities it formed reefs. The first autochthonous (born in the Netherlands) Japanese oyster was recorded the Netherlands in 1928 (Wolff 2005), but

Figure 63. *Crassostrea gigas*, in situ, a. oyster reef, Molwerk, Texel, b. oyster reef in the littoral zone on the exposed side of the jetty of Vlieland harbour.
Figuur 63. *Crassostrea gigas*, in situ, a. oesterbank Molwerk, Texel, b. een oesterbank in de litorale zone buitendijks bij de haven van Vlieland.

Figure / Figuur 64. *Crassostrea gigas*.

reproduction remained rare. Since that time Japanese oysters were repeatedly imported, directly from Japan, by oyster farmers. In 1975 it suddenly started to reproduce and rapidly expand its populations in the Netherlands, causing great economical and ecological damage (Wolff 2005).
Impact The extended reefs of *Crassostrea gigas* have completely changed the Wadden Sea ecosystem.

Figure 65. *Crepidula fornicata* specimens on an oyster from a subtidal oyster reef at Westkom, Central Dutch Wadden Sea.
Figuur 65. *Crepidula fornicata* exemplaren op een oester in een sublitorale oesterbank in de Westkom, in het midden van de Waddenzee.

Figure / Figuur 66. *Crepidula fornicata.*

Crepidula fornicata (fig. 65)

Origin NW Atlantic (Nehring & Leuchs 1999).
Distribution Even though the slipper limpet *C. fornicata* was found throughout the Wadden Sea (fig. 66, table 4), it was relatively rare in comparison to localities in the Dutch province of Zeeland, where at least locally large aggregations are found. During the survey it was found at localities with salinities varying from 10 to 32 ppt. Living specimens of *C. fornicata* were first recorded in the Netherlands in 1926 at Zandvoort and a few years later in the Dutch Wadden Sea (Korringa 1942).
Impact At most localities, only a single or a

Figure 67. *Haliclona* (*Soestella*) *xena* colony. The specimen found was identified on the basis of its form and spicules, without a voucher photograph. Photo, a typical colony in the Dutch Delta area.
Figuur 67. *Haliclona* (*Soestella*) *xena* kolonie. Het exemplaar dat werd gevonden is geïdentificeerd op basis van de vorm en spicules. Illustratieve foto's zijn niet gemaakt. Foto: Typische kolonie in het Nederlandse Delta gebied.

Figure / Figuur 68. *Haliclona* (*Soestella*) *xena*.

few specimens were found. Even though *C. fornicata* has had a large impact on other marine systems, this invasive species does not seem to have a distinct impact on the Wadden Sea ecosystem.

Porifera - sponges

Haliclona (Soestella) xena (fig. 67)

Origin Cryptogenic (Van Soest et al. 2007).
Distribution After this sponge species was first recorded in 1977, it has become one of the more common species in the Netherlands (Van Soest et al. 2007). During the survey it was only recorded once, on a metal floating dock in the NIOZ harbour, Texel (fig. 68, table 4). The salinity at that locality was 30 ppt (table 3).
Impact Even though *H.* (*Soestella*) *xena* is one of the more common sponge species in the Netherlands, it was found to be rare in the Dutch Wadden Sea. It is therefore unlikely that it has or will have a significant impact.

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SAMENVATTING

Inheemse en niet-inheemse soorten van hard substraat in de Waddenzee

Bij een inventarisatie van hard substraat in 83 locaties in de Nederlandse Waddenzee, in zoutgehaltes van 10-32 ppt, werden in juli/augustus 2009 in totaal 129 soorten planten en dieren waargenomen. Van deze soorten hadden er 29 een uitheemse of onbekende oorsprong. In aanvulling hierop werd een inventarisatie gemaakt van nog ongepubliceerde waarnemingen in de Waddenzee. Elf soorten en één ondersoort waren nog niet eerder geregistreerd in de Nederlandse Waddenzee. Eén alg, Ceramiaceae sp., met onbekende oorsprong, is vermoedelijk een nieuwe soort voor Europa. Eén zakpijpsoort, *Molgula socialis*, is nieuw voor Nederland. Deze soort is waarschijnlijk algemeen verspreid in Nederland en is mogelijk zelf inheems. In het verleden was hij vermoedelijk vaak foutief gedetermineerd als de invasieve Amerikaanse zakpijp *Molgula manhattensis*, die van *Molgula socialis* alleen onderscheiden kan worden aan de hand van anatomische details. De 11 nieuwe soorten (en één nieuwe ondersoort) verhogen het totaal aantal van in de Waddenzee geregistreerde soorten van uitheemse of onbekende afkomst tot 64. Het relatief hoge aantal nieuwe soorten voor de Waddenzee dat binnen drie weken veldwerk gevonden kon worden, lijkt gerelateerd te zijn aan het feit dat het biodiversiteitsonderzoek in de Waddenzee zich in het verleden nooit specifiek heeft gericht op hard substraat, zoals drijvende steigers in jachthavens. Verder valt niet uit te sluiten dat verschillende soorten zich pas recentelijk in de Nederlandse Waddenzee hebben gevestigd.

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Table 1. The 83 fieldwork localities in the regions a. Texel, b. Den Helder, c. Afsluitdijk, d. Harlingen, e. Wadden Sea (open water), f. Vlieland, g. Terschelling, h. Amelandi. Holwerd-Lauwersoog, J. Schiermonnikoog, k. Eemshaven, l. Eems. See also figure 1.
Tabel 1. De 83 onderzochte locaties in de deelgebieden a. Texel, b. Den Helder, c. Afsluitdijk, d. Harlingen, e. Waddenzee (open water), f. Vlieland, g. Terschelling, h. Ameland, i. Holwerd-Lauwersoog, j. Schiermonnikoog, k. Eemshaven, l. Eems. Zie ook figuur 1.

Area (Fig 1)	Nr	Date	Time	Description	Temp (°C)	Sal (‰)	Geographical coordinates
A	1	28.vii.2009	8:05	Lancasterdijk, in the littoral zone of the jetty (1)	-	29	53°9' 17'' N 4°53' 20'' E
A	2	28.vii.2009	8:30	Lancasterdijk, in the littoral zone of the jetty (2)	-	29	53°9' 20'' N 4°53' 05'' E
A	3	28.vii.2009	7:15	Lancasterdijk, oyster reef, littoral zone	-	29	53°8' 58'' N 4°54' 07'' E
A	4	30.vii.2009	9:00	Oudeschild, in the littoral zone on the exposed side of the jetty	18.0	27	53°2' 51'' N 4°51' 41'' E
A	5	28.vii.2009	19:30	Oudeschild, harbour, sublittoral	19.5	28	53°2' 39'' N 4 °51' 28'' E
A	6	30.vii.2009	10:00	Oudeschild, harbour, floating dock made of synthetic material	18.1	29	53°2' 39'' N 4°51' 26'' E
A	7	30.vii.2009	10:55	Oudeschild, harbour, sublittoral zone under wooden pier	18.1	29	53°2' 40'' N 4°51' 25'' E
A	8	30.vii.2009	11:10	Oudeschild, harbour, sublittoral zone	18.1	29	53°2' 39'' N 4°51' 25'' E
A	9	30.vii.2009	11:20	Oudeschild, harbour, wooden floating dock	17.9	30	53°2' 35'' N 4°51' 23'' E
A	10	27.vii.2009	16:05	't Horntje, bottom next to pier, sublittoral	18.2	29	53°0' 22'' N 4°47' 38'' E
A	11	27.vii.2009	16:20	't Horntje, pillars of pier, sublittoral	18.2	29	53°0' 22'' N 4°47' 38'' E
A	12	27.vii.2009	16:50	't Horntje, stone dike next to pier, sublittoral	18.2	29	53°0' 22'' N 4°47' 38'' E
A	13	27.vii.2009	19:10	't Horntje, sublittoral objects under pier	18.2	29	53°0' 22'' N 4°47' 38'' E
A	14	29.vii.2009	18:25	't Horntje, wooden poles next to pier, sublittoral	19.7	30	53°0' 20'' N 4°47' 40'' E
A	15	27.vii.2009	17:25	't Horntje, in the littoral zone of the dike	18.2	29	53°0' 20'' N 4°47' 38'' E
A	16	29.vii.2009	16:50	't Horntje, metal floating dock	19.7	30	53°0' 19'' N 4°47' 46'' E
A	17	27.vii.2009	19:45	't Horntje, in the littoral zone on the exposed side of the jetty	18.9	30	53°0' 19'' N 4°47' 49'' E
A	18	30.vii.2009	8:20	't Horntje, landing stage, in the littoral zone of the dike	-	30	53°0' 15'' N 4°46' 56'' E
A	19	29.vii.2009	8:25	Molwerk, in the littoral zone of the dike	20.3	29	53°0' 28'' N 4°45' 46'' E
A	20	29.vii.2009	7:55	Molwerk, oyster reef, littoral zone	20.1	29	53°0' 23'' N 4°45' 39'' E

Area (fig. 1)	Nr	Date	Time	Description	Temp (°C)	Sal (‰)	Geographical coordinates
B	21	30.vii.2009	15:30	Den Helder, harbour, wooden floating dock	18.8	31	52°57' 46'' N 4°46' 51'' E
B	22	30.vii.2009	16:15	Den Helder, harbour, sublittoral zone	18.8	31	52°57' 46'' N 4°46' 51'' E
B	23	30.vii.2009	16:30	Den Helder, harbour, wooden floating dock	18.3	31	52°57' 44'' N 4°46' 58'' E
B	24	30.vii.2009	17:30	Den Helder, marine port, landing stage Patrias, sublittoral zone	18.5	28	53°57' 41'' N 4°46' 51'' E
C	25	31.vii.2009	14:10	Den Oever, loating dock near sluice, sublittoral synthetic object	21.0	11	52°56' 08'' N 5°02' 19'' E
C	26	31.vii.2009	14:30	Den Oever, harbour, wooden floating dock and concrete ponton	21.0	15	52°56' 03'' N 5°02' 21'' E
C	27	31.vii.2009	15:40	Den Oever, harbour, pier, sublittoral object	19.5	15	52°56' 14'' N 5° 02' 08'' E
C	28	31.vii.2009	16:10	Den Oever, harbour, floating dock, submerged object	19.0	14	52°56' 28'' N 5° 01' 53'' E
C	29	31.vii.2009	13:50	Afsluitdijk location 3, harbour in the littoral zone of the dike	23.0	22	53°01' 11'' N 5°12' 10'' E
C	30	31.vii.2009	20:15	Afsluitdijk location 4, Kornwerderzand, in the littoral zone of the dike near the sluice	20.0	12	53°04' 31'' N 5°20' 08'' E
C	31	31.vii.2009	20:45	Afsluitdijk locatie 4, Kornwerderzand, in the littoral zone of the dike	18.7	23	53°04' 31'' N 5°20' 21'' E
C	32	6.viii.2009	9:30	LNV boat Stormvogel, Boontjes - Verversgat, mussel bed, sublittoral	20.7	23	53°05' 36'' N 5°19' 96'' E
C	33	6.viii.2009	9:07	LNV boat Stormvogel, Boontjes mussel ground B17, mussel bed, sublittoral zone	20.8	13	53°06' 14'' N 5°22' 00'' E
D	34	8.viii.2009	14:33	Harlingen, Willemshaven, metal floating dock RWS	20.0	20	53°10' 11'' N 5°24' 52'' E
D	35	8.viii.2009	19:35	Harlingen, Willemshaven, in the littoral zone on the sheltered side of the jetty	20.0	20	53°10' 10'' N 5°24' 54'' E
D	36	8.viii.2009	19:06	Harlingen, Willemshaven, in the littoral zone on the exposed side of the jetty	20.0	25	53°10' 08'' N 5°24' 47'' E
D	37	8.viii.2009	17:10	Harlingen, harbour, wooden floating dock	21.5	15	53°10' 33'' N 5°25' 09'' E
D	38	31.vii.2009	9:40	Harlingen, in the littoral zone on the exposed side of the jetty	16.5	23	53°11' 55'' N 5°25' 46'' E
E	39	6.viii.2009	8:30	LNV vessel Stormvogel, Molerak, sublittoral zone	21.1	17	53°10' 30'' N 5°22' 91'' E
E	40	6.viii.2009	9:00	LNV vessel Stormvogel, Boontjes mussel ground B19, bussel bed, sublittoral zone	20.9	12	53°10' 74'' N 5°22' 01'' E
E	41	6.viii.2009	10:00	LNV vessel Stormvogel, Verversgat, mussel bed, sublittoral zone	21.2	10	53°07' 55'' N 5°17' 75'' E

Area (Fig 1)	Nr	Date	Time	Description	Temp (°C)	Sal (‰)	Geographical coordinates
E	42	6.viii.2009	10:30	LNV vessel Stormvogel, mussel bed, sublittoral zone	21.3	23	53°07' 94'' N 5°14' 75'' E
E	43	6.viii.2009	11:00	LNV vessel Stormvogel, Scheurrak - Omdraai, mussel bed, sublittoral zone	21.8	25	53°07' 81'' N 5°10' 46'' E
E	44	6.viii.2009	11:30	LNV vessel Stormvogel, Scheurrak - Omdraai, oyster reef, sublittoral zone	21.1	25	53°05' 33'' N 5°11' 08'' E
E	45	6.viii.2009	11:45	LNV vessel Stormvogel, Scheurrak - Omdraai, buoy, floating mussel spat collector MZI 12	21.1	25	53°04' 70'' N 5°06' 51'' E
E	46	6.viii.2009	13:15	LNV vessel Stormvogel, Westkom, mussel bed, sublittoral zone	21.8	27	53°07' 02'' N 5°06' 01'' E
E	47	6.viii.2009	13:30	LNV vessel Stormvogel, Westkom, oyster reef, sublittoral zone	21.4	28	53°08' 12'' N 5°07' 63'' E
E	48	6.viii.2009	13:45	LNV vessel Stormvogel, Westkom, sea bottom dominated by *Ensis* sp, sublittoral zone	21.4	27	53°08' 40'' N 5°07' 31'' E
E	49	6.viii.2009	14:40	LNV vessel Stormvogel, mussel bed, sublittoral zone	21.4	30	53°12' 57'' N 5°08' 51'' E
E	50	6.viii.2009	15:00	LNV vessel Stormvogel, mussel bed, sublittoral zone	21.4	30	53°13' 43'' N 5°08' 43'' E
F	51	2.viii.2009	11:00	Vlieland, breakwater 40, in the littoral zone on the exposed side of the jetty	18.0	30	53°16' 49'' N 5°01' 56'' E
F	52	2.viii.2009	12:10	Vlieland, oyster reef in the littoral zone on the exposed side of the jetty	19.5	32	53°17' 36'' N 5°04' 06'' E
F	53	2.viii.2009	13:08	Vlieland, harbour, in the littoral zone on the exposed side of the jetty	21.0	31	53°17' 40'' N 5°05' 29'' E
F	54	2.viii.2009	13:30	Vlieland, harbour, dike, littoral	19.6	31	53°17' 46'' N 5°05' 23'' E
F	55	2.viii.2009	15:20	Vlieland, harbour, wooden floating dock	20.0	31	53°17' 50'' N 5°05' 18'' E
G	56	1.viii.2009	11:30	Terschelling, harbour, in the littoral zone on the exposed side of the jetty	21.0	23	53°21' 56'' N 5°13' 33'' E
G	57	1.viii.2009	14:15	Terschelling, harbour, wooden floating dock	20.0	32	53°21' 53'' N 5°12' 25'' E
G	58	1.viii.2009	12:00	Terschelling, harbour, in the littoral zone on the exposed side of the jetty	21.0	32	53°21' 51'' N 5°13' 18'' E
G	59	1.viii.2009	10:00	Terschelling, in the littoral zone on the exposed side of the jetty	12.0	32	53°21' 29'' N 5°14' 2'' E
G	60	6.viii.2009	15:50	LNV boat Stormvogel, mussel bed, sublittoral zone	23.7	31	53°21' 54'' N 5°14' 57'' E
G	61	6.viii.2009	15:35	LNV boat Stormvogel, mussel bed, sublittoral zone	23.8	30	53°21' 40'' N 5°14' 98'' E
G	62	6.viii.2009	15:15	LNV boat Stormvogel, mussel bed, sublittoral zone	23.8	30	53°22' 71'' N 5°15' 11'' E

Area (Fig 1)	Nr	Date	Time	Description	Temp (°C)	Sal (‰)	Geographical coordinates
H	63	4.viii.2009	14:00	Ameland, floating dock of KRM made of synthetic material	21.0	26	53°26' 10'' N 5°53' 03'' E
H	64	4.viii.2009	16:10	Ameland, dike KRM, littoral	21.0	26	53°26' 08'' N 5°43' 05'' E
H	65	4.viii.2009	15:00	Ameland, oyster reef in the littoral zone on the end of the jetty	21.0	27	53°25' 50'' N 5°53' 54'' E
H	66	4.viii.2009	11:12	Ameland, harbour, wooden floating dock	19.5	27	53°26' 13'' N 5°46' 31'' E
H	67	4.viii.2009	17:24	Ameland, harbour in the littoral zone of the jetty	25.5	27	53°26' 09'' N 5°46' 30'' E
H	68	4.viii.2009	17:37	Ameland, in the littoral zone on the exposed side of the jetty	25.5	27	53°26' 04'' N 5°46' 27'' E
I	69	4.viii.2009	8:25	Holwerd, docking stage, in the littoral zone on the exposed side of the jetty	17.5	29	53°23' 44'' N 5°52' 40'' E
I	70	4.viii.2009	8:40	Holwerd, metal floating dock RWS	18.7	29	53°23' 42'' N 5°52' 47'' E
I	71	3.viii.2009	17:12	t Schor, mussel bed in the littoral zone on the exposed side of the jetty	23.5	30	53°23' 52'' N 5°59' 28'' E
I	72	3.viii.2009	15:24	Moddergat near grenaatfabryk, littoral zone	21.2	29	53°24' 23'' N 06° 04' 21'' E
I	73	3.viii.2009	13:25	Lauwersoog, metal floating dock RWS	20.0	19	53°24' 35'' N 6°11' 52'' E
I	74	3.viii.2009	14:25	Lauwersoog, oyster reef in the littoral zone of the jetty	20.0	19	53°24' 34'' N 6°11' 50'' E
J	75	5.viii.2009	15:20	Schiermonnikoog, harbour, floating dock	20.0	31	53°28' 11'' N 6°10' 01'' E
J	76	5.viii.2009	15:47	Schiermonnikoog, harbour in the littoral zone of the jetty	20.0	31	53°28' 05'' N 6°09' 60'' E
J	77	5.viii.2009	16:37	Schiermonnikoog, littoral mussel/ oyster reef	26.0	?	53°28' 03'' N 6°10' 09'' E
K	78	8.viii.2009	9:24	Eemshaven, in the littoral zone on the exposed side of the jetty	20.3	27	53°27' 43'' N 6°50' 05'' E
K	79	8.viii.2009	8:45	Eemshaven, in the littoral zone on the sheltered side of the jetty	20.0	25	53°26' 37'' N 6°49' 32'' E
K	80	8.viii.2009	10:02	Eemshaven, metal floating dock	20.0	25	53°26' 40'' N 6°49' 28'' E
L	81	7.viii.2009	20:17	Nieuwdorp, littoral mussel/ oyster reef	-	27	53°24' 12'' N 6°53' 06'' E
L	82	8.viii.2009	7:54	Delfzijl, in the littoral zone on the exposed side of the jetty	18.3	22	53°20' 37'' N 6°54' 50'' E
L	83	7.viii.2009	16:43	Delfzijl, harbour, floating dock	23.0	11	53°19' 49'' N 6°55' 51'' E

Table 2. Wadden Sea inventory totals.
Tabel 2. Waddenzeeinventarisatie totalen.

Total number of localities searched	83
Variation in salinity measurements	10-32 ppt
Variation in water temperature	16,5-25,5 °C
Estimate of the number of species that could have been found with the methods used, in the season concerned	150 (fig. 3)
Number of species found	129
Native species	102
Cryptogenic species and species of non-native origin	29
Species new for the Dutch Wadden Sea	11
Max. number of species per locality	36 (table 1: loc. 16)
Max. number of species per area	97 (Texel; fig. 4)

Table 3. Scientific and vernacular names of the 129 species that were recorded, the minimum and maximum salinities of the localities where they were found and the total number of localities where they were found. * Although Wijsman & De Mesel (2009) consider *Mastocarpus stellatus* to be non-native, it is considered to be a native here (see species description for explanation), ** *Himanthalia elongata* is here considered native, although it has only been found washed ashore, never attached along the Dutch coast.
Tabel 3. Wetenschappelijke en Nederlandse namen van de 129 soorten die zijn gescoord, de minimale en maximale saliniteit waarbij deze soorten gevonden zijn, en het aantal locaties waar de soorten werden waargenomen. * Hoewel Wijsman & De Mesel (2009) aangeven dat *Mastocarpus stellatus* uitheems is, wordt hier aangenomen dat deze soort inheems is (zie soortbeschrijving voor argumentatie), ** *Himanthalia elongata* wordt hier als inheems beschouwd, hoewel er alleen waarnemingen van aangespoelde exemplaren zijn, nooit van vastzittende planten.

Species	Dutch venacular name	Origin	min ppt	max ppt	# localities
ALGAE - ALGAL SPECIES - ALGEN					
Acrosiphonia arcta (Dillwyn) Gain, 1912		Native	27	31	2
Antithamnionella spirographidis (Schiffner) E.M. Wollaston, 1968		Non-native	28	31	3
Ascophyllum nodosum (Linnaeus) Le Jolis, 1863	Knotswier	Native	13	32	22
Blidingia marginata (J. Agardh) P.J.L.Dangeard ex Bliding, 1958		Native	15	32	4
Blidingia minima (Nägeli ex Kützing) Kylin, 1947		Native	19	31	6
Bryopsis sp.	Vederwier	Native	32	32	1
Ceramiaceae (Cryptogenic)		Cryptogenic	25	25	1
Ceramium cimbricum H.E. Petersen, 1924		Cryptogenic	30	32	2
Ceramium deslongchampsii Chauvin ex Duby, 1830	Hollands hoorntjeswier	Native	28	31	5
Ceramium virgatum Roth, 1797		Native	23	31	14
Chondrus crispus Stackhouse, 1797	Iers mos	Native	23	30	2
Cladophora laetevirens (Dillwyn) Kützing, 1843		Native	30	30	1
Cladophora sp.		Native	25	32	3
Cladophora vagabunda (Linnaeus) van den Hoek, 1963		Native	31	31	1
Codium fragile ssp. *atlanticum* (A.D. Cotton) P.C. Silva, 1955	Viltwier	Non-native	32	32	1
Elachista fucicola (Velley) Areschoug, 1842		Native	15	32	4
Enteromorpha sp.	Darmwier	Native	11	31	9
Fucus spiralis Linnaeus, 1753	Kleine zeeëik	Native	19	29	11
Fucus vesiculosus Linnaeus, 1753	Blaaswier	Native	15	31	36
Gracilaria gracilis (Stackhouse) Steentoft, L.M. Irvine & Farnham, 1995		Native	27	27	1
Gracilaria sp.		Native	22	30	10
Gracilaria vermiculophylla (Ohmi) Papenfuss, 1967		Non-native	19	31	11
Gracilaria/opsis sp.		Native	32	32	1
Himanthalia elongata (Linnaeus) S.F. Gray, 1821	Riemwier	Native **	31	31	1
Mastocarpus stellatus (Stackhouse) Guiry, 1984	Kernwier	Native *	27	31	5
Polysiphonia harveyi J. Bailey, 1848	Violet buiswier	Non-native	19	32	13
Polysiphonia stricta (Dillwyn) Greville, 1824		Native	15	15	1
Porphyra purpurea (Roth) C. Agardh, 1824		Native	30	32	2
Porphyra umbilicalis (Linnaeus) Kützing, 1843	Navelwier	Native	12	29	6

Species	Dutch venacular name	Origin	min ppt	max ppt	# localities
Salicornia sp. (Higher plants: Spermatophyta)	Zeekraal	Native	22	29	2
Sargassum muticum (Yendo) Fensholt, 1955	Japans bessenwier	Non-native	23	32	14
Stylonema alsidii (Zanardini) K.M. Drew, 1956		Native	27	27	1
Ulva compressa Linnaeus, 1753	Darmwier	Native	30	32	3
Ulva curvata (Kützing) De Toni, 1889	Zeesla	Native	19	31	11
Ulva flexuosa Wulfen, 1803	Darmwier	Native	12	31	7
Ulva intestinalis Linnaeus, 1753	Darmwier	Native	15	31	3
Ulva linza Linnaeus, 1753	Darmwier	Native	25	32	5
Ulva pertusa Kjellman, 1897	Zeesla	Non-native	19	31	4
Ulva prolifera O.F. Müller, 1778	Darmwier	Native	19	32	12
Ulva rigida C. Agardh, 1823	Zeesla	Native	29	29	1
Ulva sp.	Zeesla	Native	10	32	13
Ulva torta (Mertens) Trevisan, 1841	Darmwier	Native	23	32	4
Undaria pinnatifida (Harvey) Suringar, 1872	Wakame wier	Non-native	32	32	1
ARTHROPODA VARIOUS - ARTHROPODS - GELEEDPOTIGEN					
Anurida maritima (Guerin, 1838)	Blauwe springstaart	Native	27	27	1
Nymphon gracile Leach, 1814	Sierlijke zeespin	Native	17	17	1
Halacaroidea sp.	Zeemijt	Native	22	22	1
ANNELIDA - SEGMENTED WORMS - RINGWORMEN					
Emplectonema echinoderma (Marion, 1873)	Snoerworm	Native	30	30	1
Emplectonema gracile (Johnston, 1837)	Snoerworm	Native	32	32	1
Ficopomatus enigmaticus (Fauvel, 1923)	Trompet-kokerworm	Non-native	15	30	2
Harmothoe Kinberg, 1856	Schubworm	Native	19	31	7
Hydroides norvegicus Gunnerus, 1768	kalkkokerworm	Native	28	31	2
Lanice conchilega Pallas, 1766	Schelpkokerworm	Native	23	32	3
Nemertina sp.	Snoerworm	Native	29	29	1
Neodexiospira brasiliensis (Grube, 1872)	Krulkokerworm	Non-native	29	29	1
Hediste cf *diversicolor*	Veelkleurige duizendpoot	Native	12	32	11
Pomatoceros triqueter (Linnaeus, 1758)	Kalkkokerworm	Native	28	28	1
Spiroribidae sp.	Krulkokerworm	Native	29	29	1
ASCIDIACEA - SEA SQUIRTS - ZAKPIJPEN					
Aplidium glabrum (Verrill, 1871)	Glanzende bolzakpijp	Cryptogenic	32	32	1
Botrylloides violaceus Oka, 1927	Gewone slingerzakpijp	Non-native	19	32	9
Botryllus schlosseri (Pallas, 1766)	Sterretje	Native	19	32	14
Ciona intestinalis (Linnaeus, 1758)	Doorschijnende zakpijp	Native	25	32	2
Didemnum vexillum Kott, 2002	Druipzakpijp	Non-native	32	32	2
Molgula socialis Alder, 1863	Europese ronde zakpijp	Cryptogenic	12	32	31
Styela clava (Herdman, 1881)	Japanse knotszakpijp	Non-native	19	32	11

Species	Dutch venacular name	Origin	min ppt	max ppt	# localities
BRYOZOA - BRYOZOANS - MOSDIERTJES					
Alcyonidium mytili Dalyell, 1848	Mosdiertje	Native	31	31	1
Bugula stolonifera Ryland, 1960	Mosdiertje	Non-native	27	32	4
Cryptosula pallasiana (Moll, 1803)	Mosdiertje	Native	29	29	1
Conopeum reticulum (Linnaeus, 1767)	Zeekantwerk	Native	10	32	41
Scrupocellaria scruposa (Linnaeus, 1758)	Steencelpoliep	Native	29	32	5
CNIDARIA - CNIDARIANS - NETELDIEREN					
Chrysaora hysoscella (Linnaeus, 1767)	Kompaskwal	Native	15	31	5
Diadumene cincta Stephenson, 1925	Rode baksteenanemoon	Non-native	27	31	1
Ectopleura larynx (Ellis & Solander, 1786)	Gorgelpijp	Native	29	29	2
Metridium senile (Linnaeus, 1761)	Zeeanjelier	Native	10	32	35
Obelia dichotoma (Linnaeus, 1758)	Lange zeedraad	Native	28	32	4
Obelia geniculata (Linnaeus, 1758)	Geknoopte zeedraad	Native	10	31	13
Obelia longissima (Pallas, 1766)		Native	10	31	33
Obelia sp.		Native	13	29	9
Rhizostoma pulmo (Macri, 1778)	Zeepaddestoel	Native	29	32	8
Sagartia elegans (Dalyell, 1848)	Sierlijke slibanemoon	Native	28	31	3
Sagartia troglodytes (Price in Johnston, 1847)	Gewone slibanemoon	Native	27	32	8
Sagartiogeton undatus (Müller, 1778)	Weduweroos	Native	27	31	3
Scyphozoa sp. hydroidpoliepen	Kwalpoliepjes	Native	29	32	6
Urticina felina (Linnaeus, 1761)	Zeedahlia	Native	29	31	2
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN					
Balanus crenatus Bruguiére, 1789	Gekartelde zeepok	Native	13	32	41
Balanus improvisus Darwin, 1854	Brakwater zeepok	Cryptogenic	10	31	27
Cancer pagurus Linnaeus, 1758	Noordzeekrab	Native	27	30	2
Caprella mutica Schurin, 1935	Spookkreeftje	Non-native	25	32	12
Carcinus maenas (Linnaeus, 1758)	Gewone strandkrab	Native	10	32	72
Corophium sp.	Slijkgarnaal	Native	11	25	4
Corophium volutator (Pallas, 1766)	Slijkgarnaal	Native	11	32	8
Crangon crangon (Linnaeus, 1758)	Gewone garnaal	Native	17	29	7
Diogenes pugilator (Roux, 1829)	Kleine heremietkreeft	Native	29	29	1
Elminius modestus Darwin, 1854	Nieuw Zeelandse zeepok	Non-native	12	32	49
Eriocheir sinensis H. Milne-Edwards, 1853	Chinese wolhandkrab	Non-native	14	20	5
Gammarus locusta (Linnaeus, 1758)	Sprinkhaanvlokreeft	Native	12	32	36
Hemigrapsus sanguineus (De Haan, 1853)	Blaasjeskrab	Non-native	19	32	18
Hemigrapsus takanoi Asakura & Watanabe, 2005	Penseelkrab	Non-native	12	31	19
Hyale prevosti (Milne-Edwards 1830)	Glasvlo	Native	29	29	1
Isopod sp.	Zeepissebed	Native	25	29	2
Jaera sp.	Zeepissebed	Native	29	29	2
Jassa marmorata (Holmes, 1903)	Marmerkreeftje	Non-native	25	30	4
Liocarcinus depurator (Linnaeus, 1758)	Blauwpoot zwemkrab	Native	30	30	1

Species	Dutch venacular name	Origin	min ppt	max ppt	# localities
Neomysis integer (Leach, 1814)	Brakwater aasgarnaal	Native	19	32	8
Pagurus bernhardus (Linnaeus, 1758)	Gewone heremietkreeft	Native	10	27	2
Palaemon adspersus Rathke, 1837	Roodsprietgarnaal	Native	29	31	2
Palaemon serratus (Pennant, 1777)	Gezaagde steurgarnaal	Native	31	31	1
Semibalanus balanoides (Linnaeus, 1758)	Gewone zeepok	Native	12	32	36
CTENOPHORA - COMB JELLYFISH - RIBKWALLEN					
Mnemiopsis leidyi A. Agassiz, 1865	Amerikaanse langlobribkwal	Non-native	15	31	15
Pleurobrachia pileus (Müller, 1776)	Zeedruifje	Native	30	30	1
ECHINODERMATA - ECHINODERMS - STEKELHUIDIGEN					
Asterias rubens Linnaeus, 1758	Zeester	Native	10	32	25
Ophiura ophiura (Linnaeus, 1758)	Slangster	Native	29	29	1
MOLLUSCA - MOLLUSCS - WEEKDIEREN					
Crassostrea gigas (Thunberg, 1793)	Japanse oester	Non-native	15	32	54
Crepidula fornicata (Linnaeus, 1758)	Muiltje	Non-native	10	32	19
Ensis sp.	Zwaardschede	Native	25	30	3
Hydrobia ulvae (Pennant, 1777)	Wadslakje	Native	23	31	12
Lepidochitona cinerea (Linnaeus, 1767)	Asgrauwe keverslak	Native	27	32	36
Littorina littorea (Linnaeus, 1758)	Alikruik	Native	19	32	3
Littorina obtusata (Linnaeus, 1758)	Stompe alikruik	Native	19	29	11
Littorina saxatilis (Olivi, 1792)	Ruwe alikruik	Native	23	32	66
Mytilus edulis Linnaeus, 1758	Mossel	Native	11	32	1
Patella vulgata Linnaeus, 1758	Hoedje	Native	29	30	12
Tergipes tergipes (Forskål, 1775)	Slanke knotsslak	Native	19	31	8
PORIFERA - SPONGES - SPONZEN					
Halichondria bowerbanki Burton, 1930	Sliertige broodspons	Native	19	32	14
Halichondria panicea (Pallas, 1766)	Gewone broodspons	Native	29	32	7
Haliclona oculata (Pallas, 1766)	Geweispons	Native	28	31	2
Haliclona xena De Weerdt, 1986	Paarse buisjesspons	Native	30	30	1
Leucosolenia variabilis (Haeckel, 1870)	Witte buisjesspons	Native	29	32	2
Porifera sp. oranje	Oranje korstspons	Native	30	31	2
Sycon ciliatum (Fabricius, 1780)	Zakspons	Native	32	32	1

Table 4. Distribution records of the species that were found. The numbers indicate the localities (figure 1, table 1). The codes M and S refer to monitoring records of the MOO project and the SETL project. *, the voucher specimens and/or photos could not be identified with certainty. Species of non-native or unknown origin are indicated in bold.
Tabel 4. Ruwe verspreidingsdata van de organismen die zijn aangetroffen. De cijfers geven de locaties aan (figure 1, tabel 1). De codes M en S verwijzen naar waarnemingen van het MOO-projecten het SETL-project. *, het referentiemateriaal kon niet met zekerheid worden geïdentificeerd. Soorten van uitheemse of onbekende oorsprong zijn vet aangegeven.

	A (1-20) Texel	B (21-24) Den Helder	C (25-33) Afsluitdijk	D (34-38) Harlingen	E (39-50) Wadden Sea (open sea)	F (51-55) Vlieland
ALGAE - ALGAL SPECIES - ALGEN						
Acrosiphonia arcta	-	-	-	-	46*	55*
Antithamnionella spirographidis	5,9	-	-	-	-	-
Ascophyllum nodosum	4-5,7-8,16	-	27,29,33	35-36,38	45	51,53-55
Blidingia marginata	-	-	27,31	-	-	-
Blidingia minima	-	-	-	-	-	-
Bryopsis sp.	-	-	-	-	-	-
Ceramiaceae sp.	-	-	-	-	-	-
Ceramium cimbricum	16	-	-	-	-	-
Ceramium deslongchampsii	5,7,9	21,23	-	-	-	-
Ceramium virgatum	6,9,13,19	-	-	-	42,45-48	-
Chondrus crispus	18	-	31	-	-	-
Cladophora laetevirens	17	-	-	-	-	-
Cladophora sp.	-	21	-	-	-	-
Cladophora vagabunda	-	23	-	-	-	-
Codium fragile* ssp. *atlanticum	-	-	-	-	-	-
Elachista fucicola	20	-	27	-	-	-
Enteromorpha sp.	2,7	-	25,29	34-35	47	54
Fucus spiralis	2,4	-	29,31*	36*	-	-
Fucus vesiculosus	1*,2-5,7,15, 17,19*,20	-	27*,29	35-36,38*	45	51*,53, 54*,55
Gracilaria gracilis	-	-	-	-	46	-
Gracilaria sp.	1,3,15,19-20	-	-	-	48,5	-
Gracilaria vermiculophylla	2,5	-	-	-	-	51,53
Gracilaria/opsis sp.	-	-	-	-	-	52
Himanthalia elongata	-	-	-	-	-	54*
Mastocarpus stellatus	4,12,15,18	22	-	-	-	-
Polysiphonia harveyi	5-6,9,15-18	-	-	-	-	55
Polysiphonia stricta	-	-	26	-	-	-
Porphyra purpurea	-	-	-	-	-	51-52
Porphyra umbilicalis	11	-	30	38	-	-
Salicornia sp. (Higher plants)	2	-	29	-	-	-
Sargassum muticum	4-5,14-18	-	-	-	45	53,55
Stylonema alsidii	-	-	-	-	46	-
Ulva compressa	17	-	30	-	-	-
Ulva curvata	6	-	-	-	48*	51,55

	G (56-62) Terschelling	H (63-68) Ameland	I (69-74) Holwerd - Lauwersoog	J (75-77) Schier-monnikoog	K (78-80) Eemshaven	L (81-83) Eems
ALGAE - ALGAL SPECIES - ALGEN						
Acrosiphonia arcta	-	-	-	-	-	-
Antithamnionella spirographidis	60	-	-	-	-	-
Ascophyllum nodosum	56,58	-	-	-	79-80	81-82
Blidingia marginata	59	-	73	-	-	-
Blidingia minima	-	-	69,74	76	78	82
Bryopsis sp.	58	-	-	-	-	-
Ceramiaceae sp.	-	-	-	-	80	-
Ceramium cimbricum	57	-	-	-	-	-
Ceramium deslongchampsii	-	-	-	-	-	-
Ceramium virgatum	62	65	-	75,77	80	-
Chondrus crispus	-	-	-	-	-	-
Cladophora laetevirens	-	-	-	-	-	-
Cladophora sp.	57	-	-	-	80	-
Cladophora vagabunda	-	-	-	-	-	-
Codium fragile* ssp. *atlanticum	57	-	-	-	-	-
Elachista fucicola	59	-	74	-	-	-
Enteromorpha sp.	-	-	-	-	-	83
Fucus spiralis	-	64,68	73	-	79	82*
Fucus vesiculosus	56*,59*,60	65-67	69*,70*, 73-74	76,77*	78-79	81-82
Gracilaria gracilis	-	-	-	-	-	-
Gracilaria sp.	61	-	-	-	-	81-82
Gracilaria vermiculophylla	-	65,68	71*,72-73	75*,77*	-	-
Gracilaria/opsis sp.	-	-	-	-	-	-
Himanthalia elongata	-	-	-	-	-	-
Mastocarpus stellatus	-	-	-	-	-	-
Polysiphonia harveyi	59	65-66	73	77	-	-
Polysiphonia stricta	-	-	-	-	-	-
Porphyra purpurea	-	-	-	-	-	-
Porphyra umbilicalis	-	65*	69	-	78	-
Salicornia sp. (Higher plants)	-	-	-	-	-	-
Sargassum muticum	56-57,59,61	-	-	-	-	-
Stylonema alsidii	-	-	-	-	-	-
Ulva compressa	58	-	-	-	-	-
Ulva curvata	-	66	71,73	75,77	80	81

	A (1-20) Texel	B (21-24) Den Helder	C (25-33) Afsluitdijk	D (34-38) Harlingen	E (39-50) Wadden Sea (open sea)	F (51-55) Vlieland
Ulva flexuosa	-	-	-	-	40,48,50	55
Ulva intestinalis	5	S	27	-	-	53
Ulva linza	17	23	-	-	45	53
Ulva pertusa	15	-	-	-	45	55
Ulva prolifera	1,3,19-20	-	31	36	-	51-52
Ulva rigida	-	-	-	-	-	-
Ulva sp.	4-5,8,11,14	24	31	-	39,41-42,46	52
Ulva torta	-	-	-	-	-	52,54
Undaria pinnatifida	-	-	-	-	-	-
ANNELIDA - WORMS - WORMEN						
Emplectonema echinoderma	14	-	-	-	-	-
Emplectonema gracile	-	-	-	-	-	-
Ficopomatus enigmaticus	17	S	-	37	-	-
Harmothoe sp.	16	-	-	-	49-50	55
Hydroides norvegicus	5	-	-	-	-	55
Lanice conchilega	20, M	-	-	-	42	52
Nemertina sp.	19	-	-	-	-	-
Neodexiospira brasiliensis	15	-	-	-	-	-
Hediste cf *diversicolor*	13	-	-	34,36-37	40,42,46	51-52
Pomatoceros triqueter	5	-	-	-	-	-
Spiroribidae sp.	3	-	-	-	-	-
ARTHROPODA various - ARTHROPODS - GELEEDPOTIGEN						
Anurida maritima	-	-	-	-	-	-
Nymphon gracile	-	-	-	-	39	-
Halacaroidea sp.	-	-	-	-	-	-
ASCIDIACEA - SEA SQUIRTS - ZAKPIJPEN						
Aplidium glabrum	-	-	-	-	-	-
Botrylloides violaceus	5-7,9,16	-	-	-	-	55
Botryllus schlosseri	5-7,9,14,16	21,23-24, S	-	-	-	55
Ciona intestinalis	-	-	-	-	-	-
Didemnum vexillum	-	-	-	-	-	-
Molgula socialis	5-6,11,13,16	21,23-24	32-33	34-37	39-40,42-48	55
Styela clava	6,9,16, M	S	-	-	47-48	55
BRYOZOA - BRYOZOANS - MOSDIERTJES						
Alcyonidium mytili	-	-	-	-	-	55
Bugula stolonifera	6,16	-	-	-	-	-
Cryptosula pallasiana	6	-	-	-	-	-
Conopeum reticulum	3,5,11,13-16,19	21,23-24, S	32-33	34,37	39-41,43-50	52,55
Scrupocellaria scruposa	6,16	S	-	-	-	53,55

	G (56-62) Terschelling	H (63-68) Ameland	I (69-74) Holwerd - Lauwersoog	J (75-77) Schier-monnikoog	K (78-80) Eemshaven	L (81-83) Eems
Ulva flexuosa	61	63	-	77	-	-
Ulva intestinalis	-	-	-	-	-	-
Ulva linza	58	-	-	-	-	-
Ulva pertusa	-	-	73	-	-	-
Ulva prolifera	-	64,67	74	-	80	-
Ulva rigida	-	-	70	-	-	-
Ulva sp.	60	-	-	-	S	-
Ulva torta	56,59	-	-	-	-	-
Undaria pinnatifida	57	-	-	-	-	-
ANNELIDA - WORMS - WORMEN						
Emplectonema echinoderma	-	-	-	-	-	-
Emplectonema gracile	59	-	-	-	-	-
Ficopomatus enigmaticus	-	-	-	-	S	-
Harmothoe sp.	-	66	73	-	80, S	-
Hydroides norvegicus	-	-	-	-	-	-
Lanice conchilega	-	-	-	-	M	-
Nemertina sp.	-	-	-	-	-	-
Neodexiospira brasiliensis	-	-	-	-	-	-
Hediste cf *diversicolor*	-	-	73	75	-	-
Pomatoceros triqueter	-	-	-	-	S	-
Spiroribidae sp.	-	-	-	-	-	-
ARTHROPODA various - ARTHROPODS - GELEEDPOTIGEN						
Anurida maritima	-	65	-	-	-	-
Nymphon gracile	-	-	-	-	-	-
Halacaroidea sp.	-	-	-	-	-	82
ASCIDIACEA - SEA SQUIRTS - ZAKPIJPEN						
Aplidium glabrum	57	-	-	-	-	-
Botrylloides violaceus	57	66	-	75	-	-
Botryllus schlosseri	57	66	73	75	M, S	-
Ciona intestinalis	57	-	-	-	80	-
Didemnum vexillum	57,59	-	-	-	-	-
Molgula socialis	57	65-66	73	75	80	81
Styela clava	57	66	73	75	80, M, S	-
BRYOZOA - BRYOZOANS - MOSDIERTJES						
Alcyonidium mytili	-	-	-	-	-	-
Bugula stolonifera	57	66	-	-	-	-
Cryptosula pallasiana	-	-	-	-	-	-
Conopeum reticulum	56-62	65-66	69,71,73	-	S	83
Scrupocellaria scruposa	57	-	-	-	-	-

	A (1-20) Texel	B (21-24) Den Helder	C (25-33) Afsluitdijk	D (34-38) Harlingen	E (39-50) Wadden Sea (open sea)	F (51-55) Vlieland
CNIDARIA - CNIDARIANS - NETELDIEREN						
Chrysaora hysoscella	1, M	-	26	-	-	55
Diadumene cincta	M	23, S	-	-	-	-
Ectopleura larynx	7	-	-	-	-	-
Metridium senile	3-4,6,9-14, 16, M	21,23-24, S	33	-	39-41,43-44, 46-50	55
Obelia dichotoma	16	24	-	-	-	52-53
Obelia geniculata	6,9,14,16	21,23, S	-	-	41-42,44	51
Obelia longissima	6-7,9,11, 13-14,16	23-24, S	33	34	39-41,43-48	53,55
Obelia sp.	3	-	26,31,33	34	43,47-48	-
Rhizostoma pulmo	3,14-15	-	-	-	49	51,54-55
Sagartia elegans	12, M	23-24, S	-	-	-	-
Sagartia troglodytes	3,10,17-18, 20, M	-	-	-	-	52
Sagartiogeton undatus	3, M	S	-	-	-	55
Scyphozoa sp. hydroids	6, 9, M	21,23	-	-	-	55
Urticina felina	6, M	21	-	-	-	-
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN						
Balanus crenatus	3,5,7,12-13, 17,20	21-24	32-33	36,38	39,43-47,50	51,52, 54,55
Balanus improvisus	13-14,16,19	23, S	25-28,30	34-37	40-42,44	53
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN						
Cancer pagurus	16, M	-	-	-	-	-
Caprella mutica	6,9,14,16	-	-	-	45	53,55
Carcinus maenas	1-6,8,10-12, 14-17,19,20, M	21-23, S	26-27	34-37	39-42,44-49	51-55
Corophium sp.	-	-	25,27-28	36	-	-
Corophium volutator	9,16	23, S	25	34,37	45	-
Crangon crangon	10, M	-	-	-	39,42,46	-
Diogenes pugilator	3	-	-	-	-	-
Elminius modestus	1-5,14-16, 18-20	21,23-24, S	29,31-33	34-36,38	39-40	51-54
Eriocheir sinensis	-	-	26,28	34-35,37	-	-
Gammarus locusta	1,3,5-6,9,15, 17-20	S	26-28,30-31	34-36,38	39,42,45	51,55
Hemigrapsus sanguineus	1,3-4,13, 15-16,19	23	-	-	42	52-53
Hemigrapsus takanoi	15,18-20	22-23	29-30	36	50	-
Hyale prevosti	20	-	-	-	-	-
Isopod sp.	-	-	-	-	-	-

	G (56-62) Terschelling	H (63-68) Ameland	I (69-74) Holwerd - Lauwersoog	J (75-77) Schier-monnikoog	K (78-80) Eemshaven	L (81-83) Eems
CNIDARIA - CNIDARIANS - NETELDIEREN						
Chrysaora hysoscella	56	-	-	75	M	-
Diadumene cincta	-	66	-	-	M, S	-
Ectopleura larynx	-	-	70	-	M	-
Metridium senile	57,60-61	63,65-66	73	75	79-80, M	-
Obelia dichotoma	-	-	-	-	S	-
Obelia geniculata	-	65-66	72	-	-	-
Obelia longissima	60	63,65-66	70-73	75,77	80, S	-
Obelia sp.	-	-	69	-	-	-
Rhizostoma pulmo	58	-	-	-	-	-
Sagartia elegans	-	-	-	-	-	-
Sagartia troglodytes	-	65	72	-	M	-
Sagartiogeton undatus	-	66	-	-	M	-
Scyphozoa sp. hydroids	57	-	-	-	M	-
Urticina felina	-	-	-	-	M	-
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN						
Balanus crenatus	56-61	64,66	69,71,73-74	75-76	-	82
Balanus improvisus	-	63,66	70,73	77	79-80, S	82
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN						
Cancer pagurus	-	65	-	-	M	-
Caprella mutica	57	66-67	70	-	80	-
Carcinus maenas	56-62	64-68	69-74	75-77	78-80, M	81-83
Corophium sp.	-	-	-	-	-	-
Corophium volutator	57	-	-	-	-	-
Crangon crangon	-	65	70,72	-	M	-
Diogenes pugilator	-	-	-	-	-	-
Elminius modestus	56,58-59,61	63,65-66,68	69-74	75-77	78-79, S	81-82
Eriocheir sinensis	-	-	-	-	-	-
Gammarus locusta	57-58,61	63,66,68	70,72,74	75,77	80	-
Hemigrapsus sanguineus	56,59	65-66	69,74	-	78	-
Hemigrapsus takanoi	-	65,67	69,71,74	76	79	81-82
Hyale prevosti	-	-	-	-	-	-
Isopod sp.	-	-	70	-	80	-

	A (1-20) Texel	B (21-24) Den Helder	C (25-33) Afsluitdijk	D (34-38) Harlingen	E (39-50) Wadden Sea (open sea)	F (51-55) Vlieland
Jaera sp.	19-20	-	-	-	-	-
Jassa marmorata	6-7,16	-	-	-	45	-
Liocarcinus depurator	16	-	-	-	-	-
Neomysis integer	6,12	-	-	-	-	-
Pagurus bernhardus	M	-	-	-	41,48	-
Palaemon adspersus	-	S	-	-	-	-
Palaemon serratus	M	-	-	-	-	-
Semibalanus balanoides	1-2,4,7,15, 17-20	21-23	29-30	36,38	-	51-54
CTENOPHORA - COMB JELLYFISH - RIBKWALLEN						
Mnemiopsis leidyi	16, M	21-22,24	-	34,37	49	55
Pleurobrachia pileus	16, M	-	-	-	-	-
ECHINODERMATA - ECHINODERMS - STEKELHUIDIGEN						
Asterias rubens	3,10,13,16, 18, 20, M	23-24, S	-	-	39,41, 43-44,46-50	52-53,55
Ophiura ophiura	20	-	-	-	-	-
MOLLUSCA - MOLLUSCS - WEEKDIEREN						
Crassostrea gigas	1-5,7, 13-20, M	21-22, S	29,31	35-38	44,46-49	51,52, 54,55
Crepidula fornicata	3,16,19, M	S	-	-	39,41,43-44, 46-49	52
Ensis sp.	-	-	-	-	43,48	51
Hydrobia ulvae	1-2,19-10	-	31	36	42	51
Lepidochitona cinerea	3-4,18	-	-	-	48	52
Littorina littorea	1-5,15,17-20	22	29,31	35-36,38	-	51-54
Littorina obtusa	1,4,15	-	-	-	-	-
Littorina saxatilis	15,19	-	-	36,38	-	52
Mytilus edulis	1-4,10-12, 14-20, M	21,23-24, S	26,32-33	34,36-38	39-50	51,52, 54,55
Patella vulgata	15	-	-	-	-	-
Tergipes tergipes	6-7,16, M	24, S	-	-	-	55
PORIFERA - SPONGES - SPONZEN						
Halichondria bowerbanki	5-7,9,16	21,23-24	-	-	-	55
Halichondria panicea	6-7,9,16, M	23, S	-	-	-	-
Haliclona oculata	M	23-24	-	-	-	-
Haliclona xena	16	-	-	-	-	-
Leucosolenia variabilis	6, M	-	-	-	-	-
Porifera sp. oranje	16	21	-	-	-	-
Sycon ciliatum	-	-	-	-	-	-

	G (56-62) Terschelling	H (63-68) Ameland	I (69-74) Holwerd - Lauwersoog	J (75-77) Schier-monnikoog	K (78-80) Eemshaven	L (81-83) Eems
Jaera sp.	-	-	-	-	-	-
Jassa marmorata	-	-	-	-	-	-
Liocarcinus depurator	-	-	-	-	-	-
Neomysis integer	57	66	70,73	75	80	-
Pagurus bernhardus	-	-	-	-	M	-
Palaemon adspersus	-	-	70	75	M	-
Palaemon serratus	-	-	-	75	M	-
Semibalanus balanoides	57	63-65,67-68	69,71,73-74	75-77	78-79	81
CTENOPHORA - COMB JELLYFISH - RIBKWALLEN						
Mnemiopsis leidyi	-	63,65-66	70,73	-	80, M	82
Pleurobrachia pileus	-	-	-	-	M	-
ECHINODERMATA - ECHINODERMS - STEKELHUIDIGEN						
Asterias rubens	59-60,62	65-66	-	-	M	-
Ophiura ophiura	-	-	-	-	M	-
MOLLUSCA - MOLLUSCS - WEEKDIEREN						
Crassostrea gigas	56,58-59,61-62	63-67	70-74	75-77	78-80, S	81-82
Crepidula fornicata	59-62	65	73	77	-	-
Ensis sp.	-	-	-	-	-	-
Hydrobia ulvae	61	68	71-72	-	-	-
Lepidochitona cinerea	58-59	65,68	71-72	-	78, M	-
Littorina littorea	56,58-59	64-65,67-68	69,71,74	76-77	78-79	81-82
Littorina obtusa	-	-	-	-	-	-
Littorina saxatilis	-	64,67	69	-	78-79	81
Mytilus edulis	56-62	63,65-67	69-74	75-77	78-80, M, S	81-83
Patella vulgata	-	-	-	-	-	-
Tergipes tergipes	-	65-66	73	-	M	-
PORIFERA - SPONGES - SPONZEN						
Halichondria bowerbanki	57	66	73	75	80, M, S	-
Halichondria panicea	57	-	72	-	M	-
Haliclona oculata	-	-	-	-	-	-
Haliclona xena	-	-	-	-	M	-
Leucosolenia variabilis	57	-	-	-	S	-
Porifera sp. oranje	-	-	-	-	-	-
Sycon ciliatum	57	-	-	-	-	-

Table 5. Species that were not found during the survey, but were recorded in the Dutch Wadden Sea in the MOO-project and SETL-project. Species of non-native or unknown origin are indicated in bold.
Tabel 5. Soorten die bij de inventarisatie niet zijn aangetroffen, maar wel in de Waddenzee zijn waargenomen binnen het MOO-project en SETL-project. Soorten van uitheemse of onbekende oorsprong zijn vet aangegeven.

	Eemshaven	Den Helder	Texel
ANNELIDA - WORMS - WORMEN			
Anaitides maculata		S	
ASCIDIACEA - SEA SQUIRTS - ZAKPIJPEN			
Ascidiella aspersa	S		
Ascidiella scabra	M		
Molgula manhattensis			
* zie *Molgula socialis* (4.2.3.)	M, S	S	M
BRYOZOA - BRYOZOANS - MOSDIERTJES			
Electra pilosa	S		
CNIDARIA - CNIDARIANS - NETELDIEREN			
Alcyonium digitatum	M		
Aurelia aurita	M, S	S	M
Cyanea lamarckii	M		M
Gonionemus vertens	M		
Halecium halecinum	M		
Haliplanella lineata	M		M
Hydractinia echinata	M		
Sarsia tubulosa	M		
Tubularia indivisa	M		M
CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN			
Hemimysis lamornae	M		
Hippolyte varians	M		M
Liocarcinus holsatus	M		M
Liocarcinus navigator			M
Necora puber			M
Palaemon elegans	M		M
Pandalus montagui	M		
Praunus flexuosus	M		M
CTENOPHORA - COMB JELLYFISH - RIBKWALLEN			
Beroe gracilis	M		M
ECHINODERMATA - ECHINODERMS - STEKELHUIDIGEN			
Ophiothrix fragilis			M

	Eemshaven	Den Helder	Texel
MOLLUSCA - MOLLUSCS - WEEKDIEREN			
Acanthodoris pilosa	M		M
Aeolidia papillosa	M		M
Coryphella gracilis			M
Cuthona gymnota	M		M
Dendronotus frondosus	M		M
Eubranchus exiguus	M		M
Facelina bostoniensis	M		M
Onchidoris bilamellata			M
Ostrea edulis	M		
Sepiola atlantica	M		
PISCES - FISH - VISSEN			
Anguilla anguilla	M		M
Atherina presbyter	M		
Belone belone	M		
Callionymus lyra	M		
Ciliata mustela	M		
Clupea harengus	M		
Cyclopterus lumpus	M		
Dicentrarchus labrax	M		M
Gadus morhua	M		M
Gasterosteus aculeatus	M		
Gobius niger	M		
Limanda limanda	M		
Liparis liparis	M		M
Merlangius merlangus	M		
Myoxocephalus scorpius	M		M
Pholis gunnellus	M		M
Platichthys flesus	M		M
Pleuronectes platessa	M		
Pollachius pollachius	M		M
Solea solea	M		M
Syngnathus rostellatus	M		
Taurulus bubalis	M		M
Trisopterus luscus	M		M
Trisopterus minutus	M		
Zoarces viviparus			M
PORIFERA - SPONGES - SPONZEN			
Cliona celata			M

Table 6. Review of all 64 species of non-native or unknown origin that have been recorded during the present study and/or in literature. * these species are not included in the present list as non-native or cryptogenic even though they are considered as such in literature.
Tabel 6. Overzicht van alle 64 soorten van uitheemse of onbekende oorsprong waarvan gevestigde individuen of kolonies zijn aangetroffen en/of vermeld zijn in de literatuur. * deze soorten staan in de literatuur als exoot in de Waddenzee vermeld, maar worden in deze tabel niet meegeteld.

	Species	Source of occurrence in the Dutch Wadden Sea	Origin and remarks
	ALGAE - ALGAL SPECIES - ALGEN		
1	*Alexandrium tamarense*	Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
*	*Alaria esculenta*	Wijsman & De Mesel 2009	* The record referred to in Wijsman & De Mesel (2009) probably concerns a specimen that washed ashore in the Wadden Sea. In our non-native species list we only include algae that were found attached to the substrate, i.e. settled.
2	*Acrochaetium densum*	Stegenga 2002, Wijsman & De Mesel 2009	Pacific (Stegenga & Vroman 1976)
3	*Antithamnionella spirographidis*	This survey	North Pacific (Maggs & Stegenga 1999)
4	*Botrytella* sp.	Stegenga & Mol 1996, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
5	*Ceramium cimbricum*	This survey	Cryptogenic; possibly not native to NW Europe
6	Ceramiaceae sp.	This survey	Cryptogenic; probably not native to NW Europe
7	*Chattonella marina*	Vrieling et al. 1995, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
8	*Chattonella antiqua*	Vrieling et al. 1995, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
9a	*Codium fragile* ssp. *atlanticum*	This survey	NW Pacific (Silva 1955)
9b	*Codium fragile* ssp. *tomentosoides* synoniem voor *Codium fragile* ssp. *fragile*	Stegenga & Prud'homme van Reine 1998, Wijsman & De Mesel 2009	NW Pacific (Chapman 1999)
*	*Colpomenia peregrina*	Wijsman & De Mesel 2009, Wolff 2005	* NW Atlantic (Wolff 2005); Assuming that *C. sinuosa* is a synonym of *C. peregrina*, Wolff (2005) refers to Van Goor (1923) as the source of the Wadden Sea sighting. See remarks of *C. sinuosa*.
10	*Colpomenia sinuosa*	Van Goor, 1923	Pacific (South & Tittley 1986); Wolff (2005) considers this species to be a synonym of *Colpomenia peregrina* without further argumentation. We consider *C. peregrina* and *C. sinuosa* to be two valid species.
11	*Coscinodiscus wailesii*	Edwards et al. 2001, Wijsman & De Mesel 2009	North Pacific (Edwards et al. 2001)
12	*Fibrocapsa japonica*	Vrieling et al. 1995, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
13	*Gracilaria vermiculophylla*	This survey	Pacific (Gollasch & Nehring 2006)

	Species	Source of occurrence in the Dutch Wadden Sea	Origin and remarks
14	*Heterosigma akashiwo*	Wijsman & De Mesel 2009	Pacific? (Minchin 2007b)
*	*Mastocarpus stellatus*	This survey, Wijsman & De Mesel 2009	* Cryptogenic; This species has been recorded in the Wadden Sea since the early 19th century and there are no indications that it may have been introduced by humans. We therefore consider that it is unlikely that *M. stellatus* is an exotic species as is indicated by Wijsman & De Mesel (2009).
15	*Odontella sinensis*	Leewis 1985, Wijsman & De Mesel 2009	Indian Ocean (Eno et al. 1997)
16	*Pleurosigma simonsenii*	Kat 1982, Wijsman & De Mesel 2009	Indian Ocean (Eno et al. 1997)
17	*Polysiphonia harveyi*	This survey, Maggs & Stegenga 1999, Wijsman & De Mesel 2009	North Pacific (Maggs & Stegenga 1999)
18	*Prorocentrum triestinum*	Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
19	*Sargassum muticum*	This survey, Prud'homme van Reine & Nienhuis 1982, Wijsman & De Mesel 2009	NW Pacific (Wallentinus 1999)
20	*Ulva pertusa*	This survey, Stegenga & Mol 2002, Wijsman & De Mesel 2009	N Pacific (Stegenga & Mol 2002)
21	*Undaria pinnatifida*	This survey, Ruijter 2008	NW Pacific (Stegenga 1999)
	ANNELIDA - WORMS - WORMEN		
22	*Aphelochaeta marioni*	Wijsman & De Mesel 2009	Cryptogenic, possibly native (Wolff 2005)
23	*Ficopomatus enigmaticus*	This survey	SW Pacific (Grosholz & Ruiz, 1996)
24	cf *Neodexiospira brasiliensis*	This survey	Tropics, including Brasil (Eno et al. 1997)
25	*Marenzelleria* cf. *viridis*	Dekker 1991, Essink & Tydeman 1985, Wijsman & De Mesel 2009	W Atlantic (Bick & Zettler 1997)
26	*Alitta virens*	Horst 1920, Wijsman & De Mesel 2009	N Atlantic or N Pacific (Nehring & Leuchs 1999)
	ASCIDIACEA - SEA SQUIRTS - ZAKPIJPEN		
27	*Aplidium glabrum*	This survey	Cryptogenic, possibly native to NE Atlantic (Wolff 2005)
28	*Botrylloides violaceus*	This survey	NW Pacific (Minchin 2007a)
29	*Didemnum vexillum*	This survey, R. Dekker, NIOZ, pers. comm.	NW Pacific (Stefaniak et al. 2009)
30	*Molgula socialis*	This survey	NE Atlantic (Monniot 1969)
31	*Styela clava*	This survey, Huwae 1974, Wijsman & De Mesel 2009	NW Pacific (Lützen 1999)

	Species	Source of occurrence in the Dutch Wadden Sea	Origin and remarks
	BRYOZOA - BRYOZOANS - MOSDIERTJES		
32	*Bowerbankia gracilis*	Wijsman & De Mesel 2009	Cryptogenic (Wolff 1999)
33	*Bowerbankia imbricata*	Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
34	*Bugula stolonifera*	This survey, D'Hondt & Cadée 1994, Wijsman & De Mesel 2009	NW Atlantic (Cohen & Carlton 1995)
	CNIDARIA - CNIDARIANS - NETELDIEREN		
35	*Diadumene cincta*	This survey, Pax 1936, Wijsman & De Mesel 2009	Pacific (Gollasch & Nehring 2006)
36	*Haliplanella lineata*	Van Urk 1956, Wijsman & De Mesel 2009	NW Pacific (Gollasch &Riemann-Zürneck 1996)
37	*Nemopsis bachei*	Wijsman & De Mesel 2009	NW Atlantic (Faasse & Ates 1998)
	CRUSTACEA - CRUSTACEANS - KREEFTACHTIGEN		
38	*Balanus improvisus*	This survey, Huwae 1985, Wijsman & De Mesel 2009	Cryptogenic, possibly native to NE Atlantic (Gollasch 2002)
39	*Callinectes sapidus*	Wijsman & De Mesel 2009, Wolff 2005	NW Atlantic (Christiansen, 1969)
40	*Caprella mutica*	This survey, Cook et al. 2007	Pacific (Schrey & Buschbaum 2006)
41	*Elminius modestus*	This survey, Huwae 1985, Wijsman & De Mesel 2009	SW Pacific (Harms 1999)
42	*Eriocheir sinensis*	This survey, Adema 1991, Wijsman & De Mesel 2009	NW Pacific (Adema 1991)
43	*Hemigrapsus sanguineus*	This survey, Wijsman & De Mesel 2009	NW Pacific (Breton et al. 2002)
44	*Hemigrapsus takanoi*	This survey, Wijsman & De Mesel 2009	NW Pacific (Asakura & Watanabe 2005)
45	*Jassa marmorata*	This survey, Stock 1993, Dankers & van Moorsel 2001	NW Atlantic (pers. comm. Conlan) (Conlan 1990)
46	*Limnoria lignorum*	Hubrecht et al. 1893, Wijsman & De Mesel 2009	Cryptogenic, possibly native to NE Atlantic (Wolff 2005)
47	*Mytilicola intestinalis*	Korringa 1952, Wijsman & De Mesel 2009	Mediterranean (Steuer 1902); In 2009 a high percentage of especially relatively old mussels was found to be infested by this mussel parasite (pers. comm. Nico Laros). Even though *M. intestinalis* has caused a lot of ecological and economical damage in the mussel industry in the past, its effect on the mussel population dynamics in recent year is unstudied and therefore unknown.
48	*Palaemon macrodactylus*	Ruijter 2008, Wijsman & De Mesel 2009	NW Pacific (d'Udekem d'Acoz et al. 2005)

	Species	Source of occurrence in the Dutch Wadden Sea	Origin and remarks
49	*Platorchestia platensis*	Den Hartog 1961, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
50	*Rhithropanopeus harrisii*	Tesch 1922, Wijsman & De Mesel 2009	W Atlantic (Eno et al. 1997)
51	*Sinelobus stanfordi*	F. Bennema, pers. comm.	Cryptogenic (Haaren & Soors 2009)
	CTENOPHORA - COMB JELLYFISH - RIBKWALLEN		
52	*Mnemiopsis leidyi*	This survey, Gittenberger 2008b, Tulp 2006	W Atlantic (Gittenberger 2008b)
	MOLLUSCA - MOLLUSCS - WEEKDIEREN		
53	*Corambe obscura*	Butot 1984, Wijsman & De Mesel 2009	W Atlantic (Swennen & Dekker 1987); This species probably went extinct in the Wadden Sea after the Zuiderzee was closed (Butot 1984).
54	*Crassostrea gigas*	This survey, Drinkwaard 1999, Wijsman & De Mesel 2009	This survey, Drinkwaard 1999; Wijsman & De Mesel 2009
55	*Crepidula fornicata*	This survey, Korringa 1942, Wijsman & De Mesel 2009	NW Atlantic (Nehring & Leuchs 1999)
56	*Ensis directus*	Essink & Tydeman 1985, Wijsman & De Mesel 2009	NW Atlantic (De Bruyne & De Boer 1984)
57	*Mytilopsis leucophaeata*	Van Benthem Jutting 1943, Wijsman & De Mesel 2009	NW Atlantic (Gittenberger & Janssen 1998)
58	*Mya arenaria*	Wijsman & De Mesel 2009	NW Atlantic & N Pacific (Cohen & Carlton 1995)
59	*Petricola pholadiformis*	Van Benthem Jutting 1943, Wijsman & De Mesel 2009	NW Atlantic (Eno et al. 1997)
60	*Teredo navalis*	Van Benthem Jutting 1943, Wijsman & De Mesel 2009	Cryptogenic (Wolff 2005)
	NEMATODA - NEMATODS - NEMATODEN		
61	*Anguillicola crassus*	Wijsman & De Mesel 2009, Wolff 2005	NW Pacific (Minchin 2007b)
	PISCES - FISH - VISSEN		
62	*Atherina boyeri*	Kloosterman & Schrieken 2003, Wijsman & De Mesel 2009	NE Atlantic (Wolff 2005)
63	*Trinectes maculatus*	Wijsman & De Mesel 2009, Wolff 2005	NW Atlantic (Wolff 2005); Only one specimen was recorded. This species has probably not established itself in The Wadden Sea.
	PORIFERA - SPONGES - SPONZEN		
64	*Haliclona* (*Soestella*) *xena*	Soest et al. 2007	Cryptogenic (De Weerdt 1986, Soest et al. 2007)

AANWIJZINGEN VOOR AUTEURS

De Nederlandse Faunistische Mededelingen publiceert artikelen en korte mededelingen over ongewervelde dieren in Nederland. Het tijdschrift is het publicatiemedium voor de werkgroepleden van EIS-Nederland en andere onderzoekers, met als doel het leveren van een bijdrage aan de kennis van de Nederlandse biodiversiteit.

De volgende onderwerpen komen in aanmerking voor opname: faunistiek en ecologie van een soort of soortgroep, naamlijsten, korte monografieën, determinatietabellen etc. Naast korte stukken kunnen ook grotere artikelen (eventueel als extra nummer) worden gepubliceerd. Ook kan een geografische ingang gekozen worden (bespreking van de fauna van een gebied), mits de gegevens in een landelijke context worden geplaatst. De voorkeur gaat uit naar rijk geïllustreerde artikelen waarin verschillende aspecten naar voren komen: bijvoorbeeld verspreiding, biologie, ecologie en/of bescherming.
Het gepresenteerde moet nieuwe gegevens bevatten, of op een nieuwe manier gebundeld zijn. In de rubriek 'Waarnemingen en Mededelingen' is ook plaats voor overzichten en elders gepubliceerde gegevens.

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Diagrammen, tabellen en digitale figuren worden in aparte bestanden aangeleverd. Tabellen dienen zonder opmaak aangeleverd te worden, de kolommen slechts gescheiden door één tab (zeker geen spaties gebruiken!). Illustraties bij voorkeur als orgineel aanleveren. Digitale illustraties bij voorkeur in TIFF-formaat (zeker niet in een WORD-document ingevoegd) met een hoge resolutie en ongecomprimeerd.

Voor de opbouw van artikelen zie een recent nummer (vanaf nummer 18). De artikelen zijn gesteld in het Nederlands (nieuwe spelling), bij een duidelijke internationale context in het Engels. Elk artikel wordt vooraf gegaan door een leader waarin de inhoud kort wordt samengevat en afgesloten met een Engelstalige samenvatting. Bijschriften van figuren en tabellen worden in het Nederlands en het Engels gesteld.

Soortnamen van ongewervelde dieren dienen tenminste éénmaal volledig met auteur en jaartal weergegeven te worden. Bij hogere planten wordt de spelling uit de meest recente versie van de Heukel's Flora van Nederland (Van der Meijden) gevolgd en kan de auteursnaam worden weggelaten. Bij andere soortgroepen (zoals gewervelde dieren, mossen, korstmossen) kan de auteursnaam weggelaten worden, als verwezen wordt naar een toegankelijk standaardwerk. Nederlandse namen beginnen met een kleine letter (zie verder de richtlijnen van het NIBI, Bionieuws 1997 (20): 16).

Referenties zijn conform de volgende voorbeelden opgebouwd. Let op het ontbreken van de komma tussen auteur en jaartal en de volledig uitgeschreven naam van het tijdschrift.

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