

Annex 6: WGITMO Input to REGNS

WGITMO input to REGNS - Introduced aquatic species of the North Sea coasts and adjacent brackish waters

Stephan Gollasch¹, Deniz Haydar², Dan Minchin³, Wim J. Wolff² & Karsten Reise⁴

¹ GoConsult, Bahrenfelder Str. 73a, 22765 Hamburg, Germany, sgollasch@aol.com

² Groningen University, Department of Marine Biology, P.O.Box 14, 9750 AA Haren, The Netherlands

³ Marine Organism Investigations, 3 Marina Village, Ballina, Killaloe, Co Clare, Ireland

⁴ Alfred Wegener Institute for Polar and Marine Research, Wadden Sea Station List, Sylt, Germany

Considerable new literature is available on introduced (aquatic) species in north-western Europe because such species are of increasing concern in the regulatory and scientific community. One of the first summaries of aquatic invaders in the region was made by Gollasch (1996), with a focus on the German North- and Baltic Sea coasts. In 1997 Eno *et al.* published a summary of aquatic alien species in the United Kingdom. In 1999 Nehring and Leuchs published an overview of “neobiota” of the German coast. In the same year Reise *et al.* published an overall summary of invaders in the North Sea region. Nehring (2005) updated the inventory of introduced aquatic species in Germany, Jensen and Knudsen (2005) published an inventory of introduced species in Denmark. A comprehensive inventory of alien species in Dutch coastal waters was also published in 2005 by Wolff. An update of the 1999 summary of introduced species in the North Sea is in press (Gollasch *et al.*, in press). It forms the basis of this overview.

In total 219 non-native taxa (including cryptogenic species) were reported in the North Sea. 95 % of these taxa are introduced by man, predominantly with shipping and intentional introductions for stocking or aquaculture purposes (Table 1), 16 % of these taxa are cryptogenic species and 6 % have most likely reached the North Sea by their own means: drifting with currents, swimming, or by other ways of natural range expansion. The most recently recorded species are *Rapana venosa* and *Neogobius melanostomus*, which were both recorded for the first time in the North Sea in 2005 (Kerckhof *et al.*, 2006, van Beek, 2006).

More than half of the invaders known have established self-sustaining populations. For the rest of the recorded introduced species the population status is unknown. Some species were only recorded for a certain time period and became locally extinct thereafter. With 193 species (88%) marine taxa are dominating. However, the share of marine vs. brackish water invaders varies by country - but marine species are dominating in each country. The dominating vectors of introduction are the shipping-associated vectors hull fouling and ballast water release, and species introductions for aquaculture purposes and their associated biota (thus target and non-target species) (Figure 1).

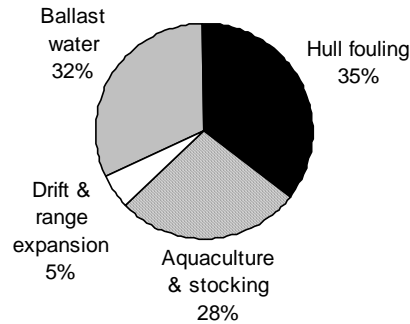


Figure 1. Key vectors of introduction for nonindigenous species found in the North Sea.

Resume

It is interesting to note that 13 species have reached the North Sea by drift or range expansion – a possible indication of a changing climate regime as several of these species are known from warmer climate regions and have now been found in colder waters. Wiltshire (pers. comm.) and Franke and Gutow (2004) stated that several nonindigenous species were newly recorded in the North Sea near Helgoland which were previously known to have an eastwards distribution limit in the English Channel or were known only from the Mediterranean Sea. It is assumed that the increasing number of records of species from warmer waters might be a consequence of increasing water temperatures.

Reise *et al.* (1999) concluded that in the North Sea introduced species in most cases are more "additive" without causing major unwanted impacts. However, the introduced Pacific oyster *Crassostrea gigas* has recently spread in the coastal waters of the North Sea (Reise *et al.*, 2005) with competitive impact on mussel beds of the native blue mussel *Mytilus edulis*. The spread is likely promoted due to (a) the recent warm summers which support the recruitment of the Pacific oyster (Diederich *et al.*, 2005) and also (b) due to the lack of cold winters which are required for good recruitment of *M. edulis*. It is assumed that the current success of *C. gigas* may reverse in case water temperatures change (Diederich, 2005). In other European regions devastating effects of introduced species are known [e.g. the comb jelly *Mnemiopsis leidyi* in the Black Sea (GESAMP, 1997) or the green alga *Caulerpa taxifolia* in the Mediterranean Sea (Boudouresque *et al.*, 1992)]. However, negative impacts of the above mentioned species may be temporary only and are also subject of controversy. In general terms, biological and habitat impacts of introduced species are difficult to assess and monetary impact calculations are not available. It should also be noted that impacts of recently introduced species are often not immediately apparent

The rate of invasions has increased in the North Sea, as it has increased worldwide, and it will probably continue to increase due to the effects of climate change. There is a need for biological and monetary impact assessments and knowledge of the invasion process is essential in designing management plans to cope with the potential detrimental effects of invasive species, and to attempt to prevent their large-scale spread

Acknowledgements

The authors express their grateful thanks to a large number of colleagues who contributed to this inventory, the list being too numerous to be mentioned here.

References

- Anger, K. 1990. Der Lebenszyklus der Chinesischen Wollhandkrabbe (*Eriocheir sinensis*) in Norddeutschland: Gegenwärtiger Stand des Wissens und neue Untersuchungen. *Seevögel*, 11 (2): 32-37 pp.
- Bjærke, M.R. and Rueness J 2004. Effects of temperature and salinity on growth, reproduction and survival in the introduced red alga *Heterosiphonia japonica* (Ceramiales, Rhodophyta). *Botanica Marina*, 47, 373–380.
- Blanchard M 1997. Spread of the slipper limpet *Crepidula fornicata* (L. 1758) in Europe. Current state and consequences. *Scientia Marina*, 61(Supplement 2): 109–118.
- Boettger CR 1933. Die Ausbreitung der Wollhandkrabbe in Europa. *Sitzungber. Ges. naturforsch. Freunde, Berlin 1933.*, 399–415 pp.
- Campbell S and Nijland R 2004. De blaasjeskrab, *Hemigrapsus sanguineus* (De Haan, 1835) voor het eerst op het Nederlandse strand. *het Zeepaard*, 64, 40–45.
- Carlton JT and Cohen AN 2003. Episodic global dispersal in shallow water marine organisms; the case history of the European shore crabs *Carcinus maenas* and *C. aestuarii*. *Journal of Biogeography*, 30, 1809–1820.
- Carlton JT 1996. Biological invasions and cryptogenic species. *Ecology*, 77, 1653–1655.
- Carlton JT 2003. Community assembly and historical biogeography in the North Atlantic Ocean: the potential role of human-mediated dispersal vectors. *Hydrobiologia*, 503, 1–8.
- Clark PFC, Rainbow PS, Robbins RS, Smith B, Yeomans, WE, Thomas M and Dobson G 1998. The alien Chinese mitten-crab, *Eriocheir sinensis* (Crustacea: Decapoda: Brachyura), in the Thames catchment. *Journal of the marine biological Association of the United Kingdom*, 78: 1215–1221
- Cohen AN and Carlton JT .1995. Biological study: Non-Indigenous aquatic species in a United States estuary: a case study of the biological invasions of the San Francisco Bay and Delta. US Fisheries and Wildlife and National Sea Grant College Program Report PB96-166525, Springfield, Virginia, USA, 273 pp
- de Blauwe H and Faasse M 2004. *Smittoidea prolifica* Osburn, 1952 (Bryozoa, Cheilostomatida), a Pacific bryozoan introduced to The Netherlands (Northeast Atlantic). *Bull.Kon.Belg.Inst.Natuurwet.Biologie*, 74, 33–39.
- de Lafontaine Y 2005. First Record of the Chinese Mitten Crab (*Eriocheir sinensis*) in the St. Lawrence River, Canada. *J. Great Lakes Res.*, 31: 367–370
- Deslous-Paoli J-M 1985. *Crepidula fornicata* L. (Gastropode) dans la bassin de Marennes-Oleron: structure, dynamique et production d'une population. *Oceanologica Acta*, 8: 453–460.
- Diederich, S., Nehls, G., van Beusekom, J.E.E., Reise, K. 2005. Introduced Pacific oysters (*Crassostrea gigas*) in the northern Wadden Sea: invasion accelerated by warm summers? *Helgol. Mar. Res.*, 59: 97–106
- Drinkwaard, A.C. 1999. Introductions and developments of oysters in the North Sea area: a review. *Helgolander Meeresunters.*, 52: 301–308.
- Eno, N.C., Clark, R.A., and Sanderson, W.G. (eds.). 1997. *Non-native marine species in British waters: a review and directory*. JNCC, Peterborough.
- Fletcher, R.L. and Farrell, P. 1999. Introduced brown algae in the North East Atlantic, with particular respect to *Undaria pinnatifida* (Harvey) Suringar. *Helgolander Meeresunters.*, 52: 259–275.
- Franke, H.-D. and Gutow, L. 2004. Long-term changes in the macrozoobenthos around the rocky island of Helgoland (German Bight, North Sea). *Helgol. Mar. Res.*, 58: 303–310

- Franke, H.D., Gutow, L. and Janke, M. 1999. The recent arrival of the oceanic isopod *Idotea metallica* Bosc off Helgoland (German Bight, North Sea): an indication of a warming trend in the North Sea? *Helgolander Meeresunters.*, 52, 347–357.
- Gollasch, S. and Rosenthal, H. (in prep.) The Kiel Canal. In: Gollasch, S., Galil, B.S. and Cohen, A. (eds.) *Bridging Divides. Maritime Canals as Invasion Corridors.*
- Gollasch, S., Haydar, D., Minchin, D., Wolff, W. and Reise, K.. Introduced aquatic species of the North Sea coasts and adjacent brackish waters. In: Rilov, G and J Crooks (eds) *Marine Bioinvasions, Ecology, Conservation and Management Perspectives.* Springer Academic Publishers. (in press).
- Gomoiu, M.-T., Alexandrov, B., Shadrin, N. and Zaitsev, Y. 2002. The Black Sea – A recipient, donor and transit area for alien species. In: E. Leppäkoski, S. Gollasch and S. Olenin (eds.) – *Invasive aquatic species of Europe. Distribution, impacts and management.* Kluwer, Dordrecht: 341–350.
- Hayward, P.J. and Ryland, J.S. 1990. *The Marine Fauna of the British Isles and North-West Europe. Volume 1: Introduction and Protozoans to Arthropods.* Clarendon Press, Oxford.
- Hoppe, K.N. 2002. *Teredo navalis* – the cryptogenic shipworm. In: E. Leppäkoski, S. Gollasch and S. Olenin (eds.) — *Invasive aquatic species of Europe. Distribution, impacts and management.* Kluwer, Dordrecht: 116–119.
- Ichiki, M., Suzumiya, H., Hayakawa, K., Imai, J.I. and Nawa, Y. 1989. Two cases of *Paragonimiasis westermani* with pleural effusion in young girls living in the southern part of Miyazaki Prefecture, Japan. *Jap. J. Parasitol.*, 38(6): 392–395
- Jensen, K.R. and Knudsen, J. 2005. A summary of alien marine benthic invertebrates in Danish waters. *Oceanological and Hydrobiological Studies*, 34 Supplement 1: 137–162.
- Kerckhof, F. 2002. Barnacles (Cirripedia, Balanomorpha) in Belgian waters, an overview of the species and recent evolutions, with emphasis on exotic species. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique – Biologie*, 72-suppl.: 93–104.
- Kerckhof, F., Vink, R.J., Nieweg, D.C. and Post, J.J.N. 2006. The veined whelk *Rapana venosa* has reached the North Sea. *Aquatic Invasions*, (2006) 1: 35–37
- Kühl, H. 1977. *Mercierella enigmatica* (Polychaeta: Serpulidae) an der deutschen Nordseeküste. *Veröff. Inst. Meeresforsch. Bremerh.*, 16: 99–104
- Lambert, G. 2001. A global overview of ascidian introductions and their possible impact on the endemic fauna. *The biology of ascidians* (ed. by H. Sawada, H. Yokosawa, and C. C. Lambert), pp. 249–257. Springer-Verlag, Tokyo.
- Luczak, C., Dewarumez, J.-M. and Essink, K. 1993. First record of the American jack knife clam *Ensis directus* on the french coast of the North Sea. *J.Mar.Biol.Ass.U.K.*, 73: 233–235.
- Maggs, C.A. and Hommersand, M.H. 1993. *Seaweeds of the British Isles: Volume 1 Rhodophyta, Part 3A Ceramiales*, 2 edn. Natural History Museum, London.
- Maggs, C.A. and Stegenga, H. 1999. Red algal exotics on North Sea coasts. *Helgolander Meeresunters.*, 52: 243–258.
- Martinet, J.F. 1778. *Katechismus der Natuur. Derde deel.* — Johannes Allart, Amsterdam, 387 p.
- Michaelis, H. and Reise, K. 1994. Langfristige Veränderungen des Zoobenthos im Wattenmeer. In: Lozán, J. L.; Rachor, E.; Reise, K.; Westernhagen, H. v. and Lenz, W. (eds.), *Warnsignale aus dem Wattenmeer. Bd. 2*, Blackwell Wissenschafts-Verlag, Berlin, 106–116 pp.

- Minchin, D., McGrath, D., and Duggan, C.B. 1995. The slipper limpet *Crepidula fornicata* (L.) in Irish waters, with a review of its occurrence in the north-east Atlantic. *Journal of Conchology*, London. 35: 247–254.
- Moll, F. 1914. Die Bohrmuschel (Genus *Teredo* Linné). — *Naturwiss. Z. Forst Landwirtschaft*, 12: 505–564.
- Montaudouin, X. de, Labarraque, D., Giraud, K. and Bachelet, G. 2001. Why does the introduced gastropod *Crepidula fornicata* fail to invade Arcachon Bay (France)? *Journal of the Marine Biological Association of the United Kingdom*, 81: 97–104.
- Nehring, S. 2005. International shipping – a risk for aquatic biodiversity in Germany. In: Nentwig, W., Bacher, S., Cock, M.J.W., Dietz, H., Gigon, A. and Wittenberg, R. (eds.): *Biological invasions – from ecology to control*. NEOBIOTA, 6: 125–143
- Nepszy, S.J. and Leach, J.H. 1973. First Records of the Chinese Mitten Crab, *Eriocheir sinensis*, (Crustacea: Brachyura) from North America. *J. Fish. Res. Bd. Canada*, 30(12): 1909–1910 pp.
- Panning, A. 1938. The Chinese Mitten Crab. *Smithsonian Rep.*, 361–375 pp.
- Panning, A. 1952. Die chinesische Wollhandkrabbe. *Die neue Brehm-Bücherei*, 70: 1–46 pp.
- Peters, N. 1933. B. Lebenskundlicher Teil. In: Peters, N. and Panning, A. (eds.), *Die chinesische Wollhandkrabbe (Eriocheir sinensis H. MILNE-EDWARDS) in Deutschland*. Akademische Verlagsgesellschaft mbH, Leipzig, 59–156 pp.
- Petersen, K.S., Rasmussen, J.B., Heinemeier, J. and Rud, N. 1992. Clams before Columbus? *Nature*, 359 : 679.
- Quiniou, F. and Blanchard, M. 1987. Etat de la prolifération de la crepidule (*Crepidula fornicata* L.) dans le secteur de Granville (Golfe Normano-Breton – 1985). *Haliotus*, 16: 513–526.
- Reise, K. 1991. Ökologische Erforschung des Wattenmeeres. *Biologie der Meere*. Spektrum Akad. Verl., Heidelberg, 68–79 pp.
- Reise, K., Dankers, N., Essink, K. 2005. Introduced species. In: Essink K *et al.* (eds) *Wadden Sea Quality Status Report 2004*. Wadden Sea Ecosystem No.19. Common Wadden Sea Secretariat, Wilhelmshaven, Germany: 155–161
- Reise, K., Gollasch, S. and Wolff, W.F. 1999. Introduced marine species of the North Sea coasts. *Helgoländer Meeresunters.*, 52: 219–234
- Rudnick, D.A., Halat, K.M. and Resh, V.H. 2000. Distribution, ecology and potential impacts of the Chinese mitten crab (*Eriocheir sinensis*) in San Francisco Bay. University of California, Berkeley, Water Resources Center, Contribution, 26. 74 pp
- Ryland, J.S. 1967. Polyzoa. *Oceanography and Marine Biology Annual Review*, 5: 343–369.
- Schnakenbeck, W. 1924 Ueber das Auftreten chinesischer Krabben in der Unterelbe. *Schr. für Süßwasser- und Meereskunde*, 5
- Stachowicz, J. J., Terwin JR, Whitlatch RB and Osman RW 2002. Linking climate change and biological invasions: Ocean warming facilitates nonindigenous species invasions. *Proceedings – National Academy of Sciences*, 99: 15497–15500.
- Stegenga, H. and Mol, I. 1983. *Flora van de Nederlandse zeevieren*. Hoogwoud: Koninklijke Nederlandse Natuurhistorische Vereniging.
- Stegenga, H. 2000. Nieuwe algen in Zuidwest-Nederlandse stagnante zoute en brakke wateren. *Gorteria*, 26: 1–8.
- Stegenga, H., Mol, I., Prud'Homme van Reine, W.F. and Lokhorst, G.M. 1997. Checklist of the marine algae of the Netherlands. pp. 1–57.

- Strasser, M. 1999. *Mya arenaria* – an ancient invader of the North Sea coast. Helgoländer Meeresunters., 52: 309–324.
- Sukopp, H. and Brande, A. 1984. Beiträge zur Landschaftsgeschichte des Gebietes um den Tegeler See. Sitzungsber. Ges. Naturforsch. Freunde Berlin, 24: 198–214/1–7 pp.
- van Beek, G.C.W. 2006. The Round goby *Neogobius melanostomus* first recorded in the Netherlands. Aquatic Invasions (2006) 1: 42–43
- Van Benthem Jutting, T. 1943. Mollusca. C. Lamellibranchia. — Fauna van Nederland 12: 1–477.
- Vrolik, W., Harting, P., Storm Buysing, D.J., van Oordt, J.W.L. and von Baumhauer, E.H. 1860. Verslag over den Paalworm, uitgegeven door de Natuurkundige Afdeeling der Koninklijke Nederlandsche Akademie van Wetenschappen, Amsterdam, 153 pp.
- Walne, P.R. 1956. The biology and distribution of the slipper limpet *Crepidula fornicata* in Essex Rivers. Fisheries Investigations, Series II 20(6): 50pp
- Weidema, I.R. 2000. Introduced species in the Nordic countries. Nordic Council of Ministers, Copenhagen. Nord Environment, 2000:13, 242 pp.
- Wolff, W.J. and Reise, K. 2002. Oyster imports as a vector for the introduction of alien species into Northern and Western European coastal waters. Invasive aquatic species of Europe. Distribution, impact and management. (ed. by E. Leppäkoski, S. Gollasch, and S. Olenin), pp. 193–205. Kluwer Academic Publishers, Dordrecht.
- Wolff, W.J. 1999. Exotic invaders of the meso-oligohaline zone of estuaries in the Netherlands: why are there so many? Helgoländer Meeresunters., 52: 393–400.
- Wolff, W.J. 2005. Non-indigenous marine and estuarine species in The Netherlands. Zoologische Mededelingen, Leiden, 79: 1–116.
- Zidowitz, H. 2004. Weißspitzen-Hochseehai im schwedischen Gullmarsfjord. Elasmoskop 8(1): 4–5

Table 1 Introduced marine and brackish species from the North Sea with an indication of records per country excluding cryptogenic species and species which arrived by drift or range expansion. BE = Belgium, DK = Denmark, GE = Germany, NL = The Netherlands, NO = Norway, SE = Sweden and UK = United Kingdom. A question mark indicates that the species most likely occurs in the country, but records are not yet confirmed. Species without vector indication means the introduction vector is unknown. Key references: Gollasch, 1996; Eno *et al.*, 1997; Reise *et al.*, 1999; Weidema, 2000; Jensen and Knudsen, 2005; Nehring, 2005; Wolff, 2005.

Species	Group	Country							Status	Habitat	Ballast	Fouling	Aquacult or stock.
		GE	DK		BE	NL	UK	SE					
<i>Acartia tonsa</i>	Copepod	GE	DK		BE	NL	UK	SE	establ.	marine	x		
<i>Agardhiella subulata</i>	Macroalga					NL	UK		establ.	marine		x	
<i>Aglaothamnion halliae</i>	Macroalga	GE		NO				SE	establ.	marine		x	
<i>Alexandrium angustitabulatum</i>	Dinoflagellate							SE	uncertain	marine	x		
<i>Alexandrium leei</i>	Dinoflagellate					NL			establ.	marine	x		x
<i>Alkmaria romijni</i>	Annelida		DK	NO		NL			establ.	marine	x	x	
<i>Ammothea hilgendorfi</i>	Pycnogonida						UK		establ.	marine		x	
<i>Anguillicola crassus</i>	Nematod	GE	DK	NO	?	NL	UK	SE	establ.	marine			x
<i>Anotrichium furcellatum</i>	Macroalga					NL	UK		establ.	marine		x	
<i>Antithamnionella spirographidis</i>	Macroalga				BE	NL	UK		establ.	marine		x	
<i>Antithamnionella ternifolia</i>	Macroalga	GE			BE	NL	UK		establ.	marine		x	
<i>Aphelochaeta marioni</i>	Polychaete	GE				NL	UK		establ.	marine	x	x	
<i>Asparagopsis armata</i>	Macroalga					NL	UK		establ.	marine		x	
<i>Asperococcus scaber</i>	Macroalga					NL	UK		establ.	marine		x	x
<i>Atherina boyeri</i>	Pisces					NL			establ.	marine		x	
<i>Aulacomya ater</i>	Bivalve						UK		unestabl.	marine		x	
<i>Balanus amphitrite amphitrite</i>	Cirriped				BE	NL	UK		establ.	marine		x	
<i>Balanus eburneus</i>	Cirriped					NL			extinct	marine		x	
<i>Bonamia ostreae</i>	Protozoa					NL			establ.	marine			x
<i>Bonnemaisonia hamifera</i>	Macroalga	GE	DK	NO	?	NL	UK	SE	establ.	marine		x	
<i>Botrylloides violaceus</i>	Tunicata					NL			establ.	marine		x	
<i>Bougainvillia macloviana</i>	Cnidaria	GE							extinct	marine		x	
<i>Brachynotus sexdentatus</i>	Crustacean						UK		uncertain	marine	x	x	
<i>Branchiomma bombyx</i>	Annelida					NL			extinct	marine	x	x	
<i>Callinectes sapidus</i>	Decapod	GE			BE	NL			establ.	marine	x		
<i>Calyptra chinensis</i>	Gastropod					NL			extinct	marine			x

Species	Group	Country							Status	Habitat	Ballast	Fouling	Aquacult or stock.
		GE		NO	BE	NL	UK						
Caprella mutica	Amphipod	GE		NO	BE	NL	UK		establ.	marine	x	x	
Cereus pedunculatus	Cnidaria	GE					UK		uncertain	marine	x	x	
Chattonella antiqua	Rhaphidophyceae	GE				NL			establ.	marine	x		
Chattonella marina	Rhaphidophyceae	GE				NL			establ.	marine	x		
Chelicorophium curvispinum	Amphipod	GE				NL			establ.	brackish	x		
Chionoecetes opilio	Decapod			NO					uncertain	marine	x	x	
Clavopsella navis	Cnidaria	?					UK		uncertain	brackish		x	
Clymenella torquata	Polychaete						UK		uncertain	marine	x	x	
Codium fragile ssp. atlanticum	Macroalga			NO		NL	UK		establ.	marine		x	
Codium fragile ssp. scandinavicum	Macroalga		DK	NO				SE	establ.	marine		x	
Codium fragile ssp. tomentosoides	Macroalga	GE	DK	NO	BE	NL	UK	SE	establ.	marine		x	
Colaconema dasyae	Macroalga					NL			establ.	marine		x	
Colpomenia peregrina	Macroalga	GE	DK	NO		NL	UK	SE	establ.	marine			x
Conchoderma auritum	Cirriped					NL			extinct	marine		x	
Corambe obscura (=batava)	Gastropod					NL			extinct	marine			
Cordylophora caspia	Cnidaria	GE	DK	NO	?	NL		SE	establ.	marine		x	
Corethron criophilum	Diatom	GE							establ.	marine	x		
Corophium (= Monocorophium) sextonae	Amphipod	GE		NO		NL	UK		establ.	marine	x	x	
Corynophlaea umbellata	Macroalga						UK		establ.	marine		x	
Coscinodiscus wailesii	Diatom	GE		NO	BE	NL	UK	SE	establ.	marine	x		x
Cotula coronopifolia	Tracheophyta	GE				NL			establ.	brackish			
Crassostrea gigas	Bivalve	GE	DK	NO	BE	NL	UK		establ.	marine			x
Crassostrea virginica	Bivalve	GE				NL	UK		unestabl.	marine			x
Crepidula fornicata	Gastropod	GE	DK	NO	BE	NL	UK	SE	establ.	marine			x
Dasya baillouviana	Macroalga	GE	DK	NO		NL		SE	establ.	marine		x	
Desdemona ornata	Polychaete						UK		uncertain	marine	x	x	
Diadumene lineata	Cnidaria	GE				NL	UK		establ.	marine		x	x
Dicroerisma psilonereiiella	Dinoflagellate							SE	establ.	marine	x		
Didemnum sp.	Tunicata					NL			establ.	marine			
Diplosoma listerianum	Tunicata					NL			establ.	marine		x	x

Species	Group	Country						Status	Habitat	Ballast	Fouling	Aquacult or stock.	
		GE	DK	NO	BE	NL	UK						SE
Elachista sp.	Macroalga					NL		establ.	marine				
Elminius modestus	Cirriped	GE	DK		BE	NL	UK	establ.	marine		x		
Ensis directus	Bivalve	GE	DK	NO	BE	NL	UK	SE	establ.	marine	x		
Eriocheir sinensis	Decapod	GE	DK	NO	BE	NL	UK	SE	establ.	marine	x		
Euplana gracilis	Turbellaria					NL		uncertain	marine		x		
Eurytemora americana	Copepod					NL	UK	establ.	brackish	x			
Eusarsiella zostericola	Ostracod						UK	establ.	brackish			x	
Fibrocapsa japonica	Rhaphidophyceae	GE				NL		establ.	marine	x			
Ficopomatus enigmaticus	Polychaete	GE			BE	NL	UK	establ.	marine		x		
Fucus evanescens	Macroalga		DK	NO			UK	SE	establ.	marine		x	
Gammarus tigrinus	Amphipod	GE				NL		SE	establ.	brackish		x	
Garveia (=Bimeria) franciscana	Cnidaria	GE			BE	NL		establ.	brackish		x		
Gonionemus vertens	Cnidaria	GE		NO	BE	NL	UK	SE	establ.	marine	x	x	x
Gracilaria vermiculophylla	Macroalga	GE	DK			NL		SE	establ.	marine		x	
Grandidierella japonica	Amphipod						UK	uncertain	marine	x			
Grateloupia filicina var. luxurians	Macroalga						UK	establ.	marine			x	
Grateloupia turuturu (= doryphora)	Macroalga					NL	UK	establ.	marine		x	x	
Gymnodinium catenatum	Dinoflagellate					NL		establ.	marine	x			
Gymnodinium cf. nagasakiense	Dinoflagellate			NO		NL		establ.	marine	x			
Gyrodinium corallinum	Dinoflagellate							SE	establ.	marine	x		
Haliclona (= Acervochalina) loosanoffi	Porifera	GE				NL		uncertain	marine		x		
Haplosporidium armoricanum	Protozoa					NL		extinct	marine			x	
Hemigrapsus penicillatus	Decapod				BE	NL		establ.	marine	x	x		
Hemigrapsus sanguineus	Decapod					NL		uncertain	marine	x			
Heterosiphonia japonica	Macroalga			NO		NL	UK	SE	establ.	marine		x	x
Homarus americanus	Decapod			NO				unestabl.	marine			x	
Hydroides dianthus	Polychaete						UK	establ.	marine	x	x		
Hydroides elegans	Polychaete	GE				NL	UK	establ.	brackish	x	x		
Hydroides ezoensis	Polychaete						UK	unestabl.	marine	x	x	x	

Species	Group	Country							Status	Habitat	Ballast	Fouling	Aquacult or stock.
<i>Imogine necopinata</i>	Turbellaria					NL			uncertain	brackish			x
<i>Incisocalloipe aestuarius</i>	Amphipod				BE	NL			establ.	brackish	x		
<i>Janua brasiliensis</i>	Polychaete					NL	UK		uncertain	marine		x	x
<i>Karenia (=Gymnodinium) aureolum</i>	Dinoflagellate	GE		NO			UK		establ.	marine	x		
<i>Karenia (=Gymnodinium) mikimotoi</i>	Dinoflagellate	GE	DK	NO	BE	NL	UK	SE	establ.	marine	x		
<i>Laminaria ochotensis</i>	Macroalga	GE							uncertain	marine		x	
<i>Leathesia verruculiformis</i>	Macroalga					NL			establ.	marine		x	
<i>Lebistes reticulatus</i>	Pisces	GE				NL			establ.	brackish			x
<i>Lepidopleurus cancellatus</i>	Polyplacophora					NL			extinct	marine			x
<i>Limulus polyphemus</i>	Xiphosura	GE	DK			NL			unestabl.	marine			x
<i>Marenzelleria viridis</i>	cf. Annelida	GE	DK			NL	UK	SE	establ.	brackish	x		
<i>Marenzelleria wireni</i>	cf. Annelida	GE	DK	NO	BE	NL			establ.	marine	x		
<i>Marsupenaeus (=Penaeus) japonicus</i>	Prawn			NO					unestabl.	marine			x
<i>Marteilia refringens</i>	Protozoa					NL			extinct	marine			x
<i>Megabalanus coccopoma</i>	Cirriped				BE	NL			establ.	marine		x	
<i>Megabalanus tintinnabulum</i>	Cirriped				BE				establ.	marine		x	
<i>Melita nitida</i>	Amphipod					NL			establ.	marine	x	x	
<i>Mercenaria mercenaria</i>	Bivalve					NL	UK		establ.	marine			x
<i>Micropogonias undulatus</i>	Pisces					NL			uncertain	marine	x		
<i>Muggiaea atlantica</i>	Cnidaria	GE							uncertain	marine	x		
<i>Mya arenaria</i>	Bivalve	GE	DK	NO	BE	NL	UK	SE	establ.	marine	x	x	
<i>Myicola ostreae</i>	Copepod					NL			uncertain	marine			x
<i>Mytilicola intestinalis</i>	Copepod	GE	DK			NL			establ.	marine			x
<i>Mytilicola orientalis</i>	Copepod					NL			establ.	marine			x
<i>Mytilopsis (=Congeria) leucophaeta</i>	Bivalve	GE			BE	NL	UK		establ.	brackish	x		
<i>Nematostella vectensis</i>	Cnidaria						UK		establ.	brackish		x	
<i>Nemopsis bachei</i>	Cnidaria	GE		NO		NL			establ.	brackish	x	x	
<i>Neogobius melanostomus</i>	Pisces					NL			establ.	brackish	x		

Species	Group	Country								Status	Habitat	Ballast	Fouling	Aquacult or stock.
		GE	DK	NO	BE	NL	UK	SE						
Neosiphonia (= Polysiphonia) harveyi	Macroalga									establ.	marine		x	
Ocenebra erinacea	Gastropod		DK		BE				UK	uncertain	marine			x
Odontella sinensis	Diatom	GE	DK	NO	BE	NL			UK	SE	establ.	marine	x	
Oncorhynchus gorbuscha	Pisces			NO							uncertain	marine		x
Oncorhynchus keta	Pisces			NO							extinct	marine		x
Oncorhynchus kisutch	Pisces					NL					extinct	marine		x
Oncorhynchus mykiss (=Salmo gairdneri)	Pisces	GE	DK	NO		NL					establ.	marine		x
Orchestia cavimana	Amphipod	GE			BE	NL					establ.	brackish	x	
Ostroumovia inkermanica	Cnidaria					NL					extinct	brackish	x	x
Palaemon macrodactylus	Shrimp				BE	NL			UK		establ.	marine	x	
Palinurus elephas	Decapod					NL					extinct	marine		x
Paralithodes camtschatica	Decapod			NO							establ.	marine		x
Pecten maximus	Bivalve					NL					extinct	marine		x
Petricola pholadiformis	Bivalve	GE	DK	NO	BE	NL			UK	SE	establ.	marine		x
Pileolaria berkeleyana	Polychaete								UK		establ.	marine		x
Pilumnus hirtellus	Crustacean									SE	unestabl.	marine	x	x
Pleurosigma planctonicum	Phytoplankton					NL			UK		establ.	marine	x	
Polydora hoplura	Annelida					NL					uncertain	marine		x
Polysiphonia senticulosa	Macroalga				BE	NL					establ.	marine		x
Porphyra miniata	Macroalga		DK								establ.	marine		x
Porphyra umbilicalis	Macroalga	GE									uncertain	marine		x
Porphyrostromium sp.	Macroalga					NL					uncertain	marine		
Prorocentrum redfieldii	Dinoflagellate	GE				NL					establ.	marine	x	
Pseudobacciger harengulae	Trematoda									SE	establ.	marine		x
Pseudodactylogyrus anguillae	Plathelminthes		DK	NO							establ.	brackish		x
Pseudodactylogyrus bini	Plathelminthes			NO							establ.	brackish		x
Pseudorasbora parva	Pisces								UK		uncertain	marine		x
Pterosiphonia pinnulata	Macroalga								UK		establ.	marine		x
Rapana venosa	Gastropod					NL			UK		uncertain	marine	x	x

Species	Group	Country								Status	Habitat	Ballast	Fouling	Aquacult or stock.
		GE	DK	NO	BE	NL	UK	SE						
<i>Rhithropanopeus harrisii</i>	Decapod	GE			BE	NL				establ.	brackish		x	
<i>Ruditapes (=Tapes) philippinarum</i>	Bivalve			NO						establ.	marine			x
<i>Sabellaria spinulosa</i>	Polychaete	GE								establ.	marine	x	x	
<i>Salmo (=Onchorhynchus) clarki</i>	Pisces		DK							establ.	marine			x
<i>Sargassum muticum</i>	Macroalga	GE	DK	NO	BE	NL		SE		establ.	marine		x	x
<i>Scytosiphon dotyi</i>	Macroalga						UK			establ.	marine			x
<i>Smittoidea prolifica</i>	Bryozoan					NL				establ.	marine			x
<i>Solidobalanus fallax</i>	Cirriped			NO	BE					uncertain	marine		x	
<i>Spartina anglica</i>	Anthophyta	GE			BE	NL	UK			establ.	marine			x
<i>Spartina townsendii</i>	x Anthophyta	GE	DK		BE	NL				establ.	marine			x
<i>Spisula solidissima</i>	Bivalve					NL				unestabl.	marine	x		
<i>Stephanopyxis palmeriana</i>	Diatom	GE			BE	NL	UK	SE		establ.	marine	x		
<i>Styela clava</i>	Tunicata	GE	DK		BE	NL	UK			establ.	marine		x	x
<i>Syllidia armata</i>	Polychaete					NL				extinct	marine			x
<i>Syllis gracilis</i>	Polychaete					NL				extinct	marine			x
<i>Telmatogeton japonicus</i>	Chironomid	GE	DK	NO	BE	NL	UK			establ.	marine	x	x	
<i>Teredo navalis</i>	Bivalve	GE	DK	NO	BE	NL	UK	SE		establ.	marine		x	
<i>Thalassiosira hendeyi</i>	Diatom	GE			BE	NL	UK			establ.	marine	x		x
<i>Thalassiosira punctigera</i>	Diatom	GE		NO	BE	NL	UK	SE		establ.	marine	x		x
<i>Thalassiosira tealata</i>	Diatom			NO	BE	NL	UK			establ.	marine	x		x
<i>Tharyx killariensis</i>	Polychaete	GE								establ.	marine	x	x	
<i>Thecadinium yashimaense mucosum</i> (=)	Dinoflagellate	GE								uncertain	marine	x		
<i>Thieliana navis</i>	Cnidaria					NL				establ.	brackish	x	x	
<i>Tricellaria inopinata</i>	Bryozoan				BE	NL	UK			establ.	marine		x	
<i>Trinectes maculatus</i> (=Achirus fasciatus)	Pisces					NL				unestabl.	marine	x		
<i>Ulva pertusa</i>	Macroalga					NL				establ.	marine			
<i>Undaria pinnatifida</i>	Macroalga				BE	NL	UK			establ.	marine			x
<i>Urosalpinx cinerea</i>	Gastropod						UK			uncertain	marine			x
<i>Verrucophora fascima</i> cf.	Dinoflagellate							SE		establ.	marine	x		