


Species Fact Sheets for the Wadden Sea Fish Strategy

Overview of 19 species in the Wadden Sea sampled in the Demersal Fish Survey

Engraulis encrasicolus

(MS - Marine Seasonal migrant)

 Anchovy

 Ansjovis

 Sardelle

 Ansjos

Occurrence in the Wadden Sea

Rarely found in DFS survey. Is less rare in German stow net survey¹ and found May-Oct in pelagic sampling net in Marsdiep^{2,3}. Used to spawn in brackish water in Zuiderzee, Western Wadden Sea and German Bight. Fish in spawning condition were observed again in Wadden Sea in 1994⁴. Anchovy also spawns again in the German Bight, after absence of 50 years⁵. Anchovy has also been observed in the WFD monitoring in the Ems estuary since 2006.

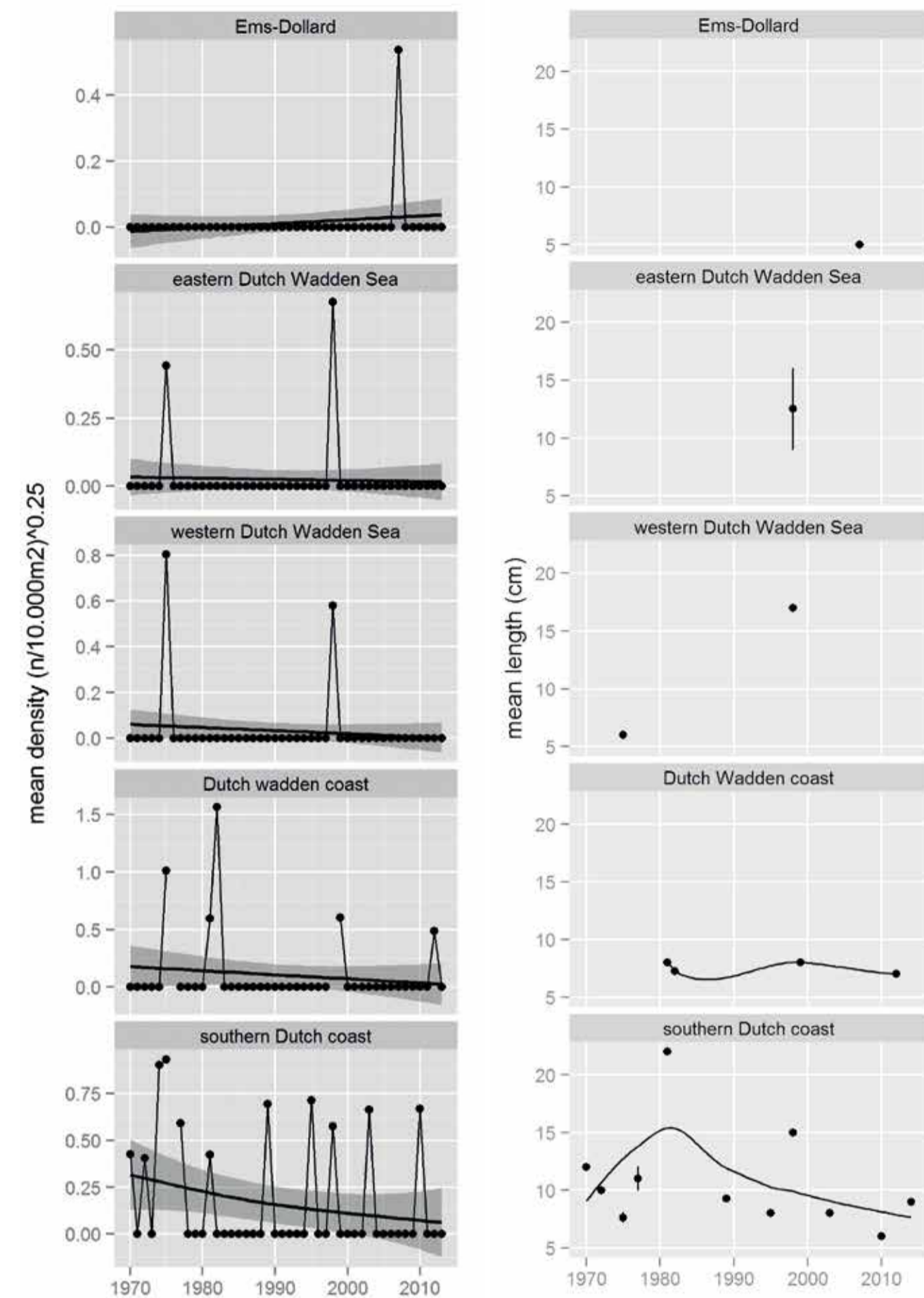
Commercial value

None in Wadden Sea - used to be important fisheries in Zuiderzee before closure and in the Dollard even before those times (Stratingh & Venema, 1855).

Policy objectives

Anchovy is a typical species for H1110A. N2000 states that there should an improvement in this habitat type. Species is classified as endangered or vulnerable in Dutch, German or trilateral Red List. No management measures are in place but when distribution is widespread minor targeted fisheries take place⁶.

Pelagic roundfish, small pelagic species, essentially a southern species; North Sea is northern limit. Generalist planktivores, feed on copepods, malacostracan larvae and fish larvae. Prey species for birds and mammals.



Trend

Recent increase in the North Sea.

Available information on drivers

Climate variability: periods of increase often coincide with warm phases of the Atlantic Multi-decadal Oscillation during the last century⁶.

Knowledge gaps

No good pelagic monitoring in Dutch Wadden Sea. Importance of Wadden Sea as spawning area and requirements for spawning spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

1 Bolle, L. J. et al. Trends in Wadden Sea fish fauna. Report No. C108/08, (Wageningen IMARES Report 2009). 2 Tulp, I. et al. Habitat use of juvenile pelagic fish in a shallow estuarine area: the Wadden Sea. (in prep). 3 Couperus, B. et al. Abundance and tidal behaviour of pelagic fish in the gateway to the Wadden Sea. (MS subm.). 4 Boddeke, R. & Vingerhoed, B. The anchovy returns to the Wadden Sea. ICES Journal of Marine Science 53, 1003-1007 (1996). 5 Kanstinger, P. & Peck, M. A. Co-occurrence of European sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*) and sprat (*Sprattus sprattus*) larvae in southern North Sea habitats: Abundance, distribution and biochemical-based condition. Scientia Marina 73, 141-152, doi:10.3989/scimar.2009.73s1141 (2009). 6 Petitgas, P. et al. Anchovy population expansion in the North Sea. Marine Ecology-Progress Series 444, 1-13, doi:10.3354/meps09451 (2012).

Myoxocephalus scorpius

(ER - Estuarine Resident)

 Bull rout

 Zeedonderpad

 Seeskorpion

 Almindelig ulk

Occurrence in the Wadden Sea

Bull routs are found in marine and brackish waters from 0 to 450 m depth with a southern limit around the bay of Biscay and a northern limit above the Arctic Circle. Vast majority occurs at depths of <40 m. Regularly found in Wadden Sea in DFS. Typically associated with inshore and coastal areas, often on rocky substrates, reefs and grounds with macroalgal cover, which allow these ambush predators to make optimal use of their camouflage. Spawning Dec-Mar. Bullrout presumably spawn in coastal waters throughout their range, wherever suitable habitats are available^{1,2}.

Commercial value in North Sea fisheries

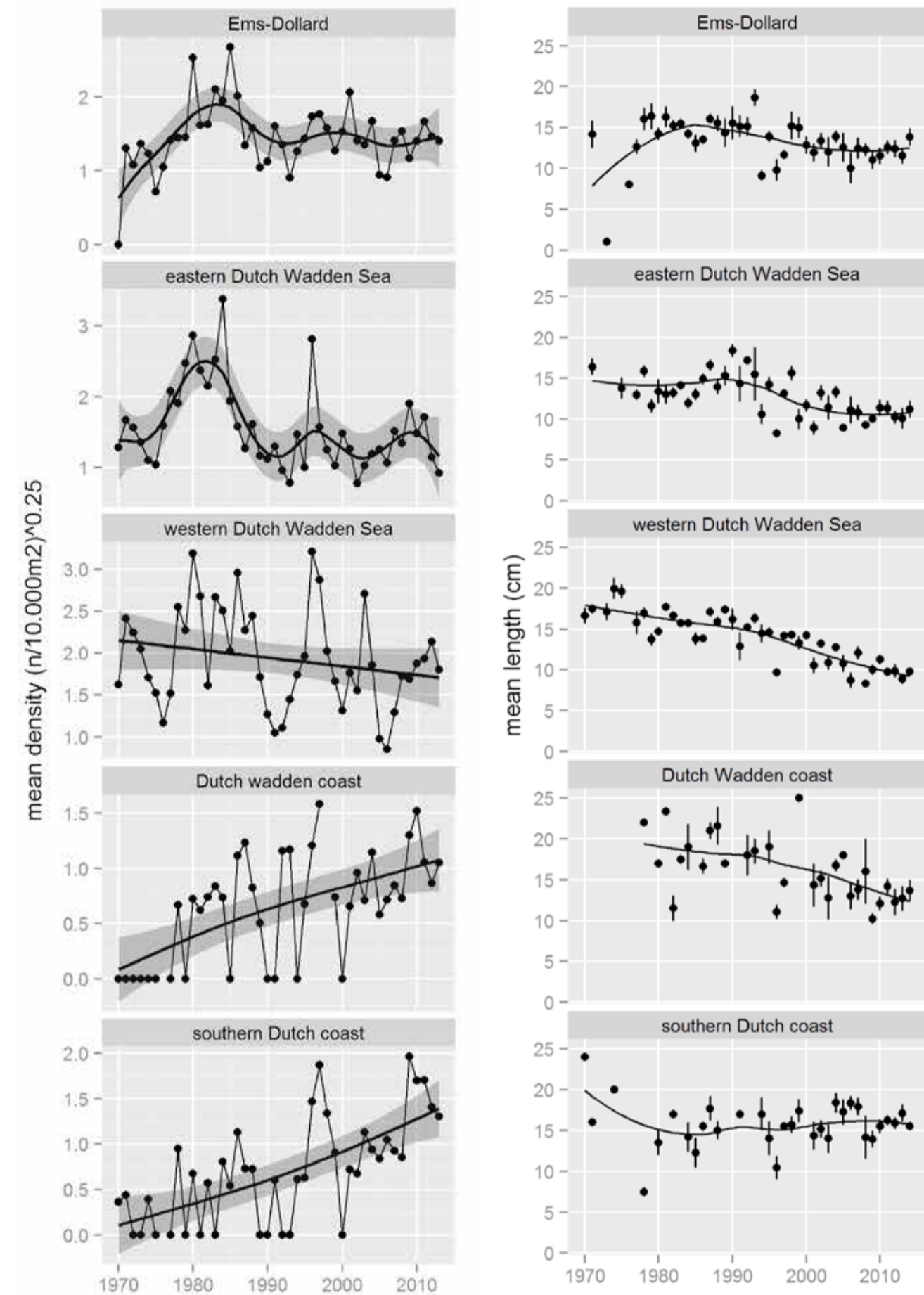
None. Caught (but not landed) as by-catch in shrimp fisheries (survival estimated at 90%³).

Policy objectives

Bull rout is a typical species for H1110A, N2000 states that there should an improvement in this habitat type.

Demersal roundfish, feeds on fishes, large crustaceans, occasionally polychaetes and amphipods.

Henk Heesen



Trend

Stable in Ems-Dollard and declining in Wadden Sea.

Available information on drivers

Habitat degradation (prefer rocky bottoms with sand or mud, can be found among seaweeds); local pressures e.g. fisheries – by-catch in shrimp fisheries.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat use.

1 Luksenburg, J. A., Pedersen, T. & Falk-Petersen, I. B. Reproduction of the shorthorn sculpin *Myoxocephalus scorpius* in northern Norway. *Journal of Sea Research* 51, 157-166, doi:10.1016/j.seares.2003.09.001 (2004). 2 Ennis, G. P. Reproduction and associated behaviour in shorthorn sculpin, *Myoxocephalus scorpius* in Newfoundland waters. *Journal of the Fisheries Research Board of Canada* 27, 2037-6 (1970). 3 Berghahn, R., Waltemath, M. & Rijnsdorp, A. D. Mortality of fish from the by-catch of shrimp vessels in the North Sea. *Journal of Applied Ichthyology* 8, 293-306 (1992).

Pholis gunnellus

(ER - Estuarine Resident)

 Rock gunnel

 Botervis

 Butterfisch

 Tangspræl

Occurrence in the Wadden Sea

Butterfish typically occur on rocky habitats in coastal waters, including intertidal zones, also commonly found in the Wadden Sea. Most commonly encountered in waters <50 m deep, as they often inhabit intertidal and shallow sublittoral zones.

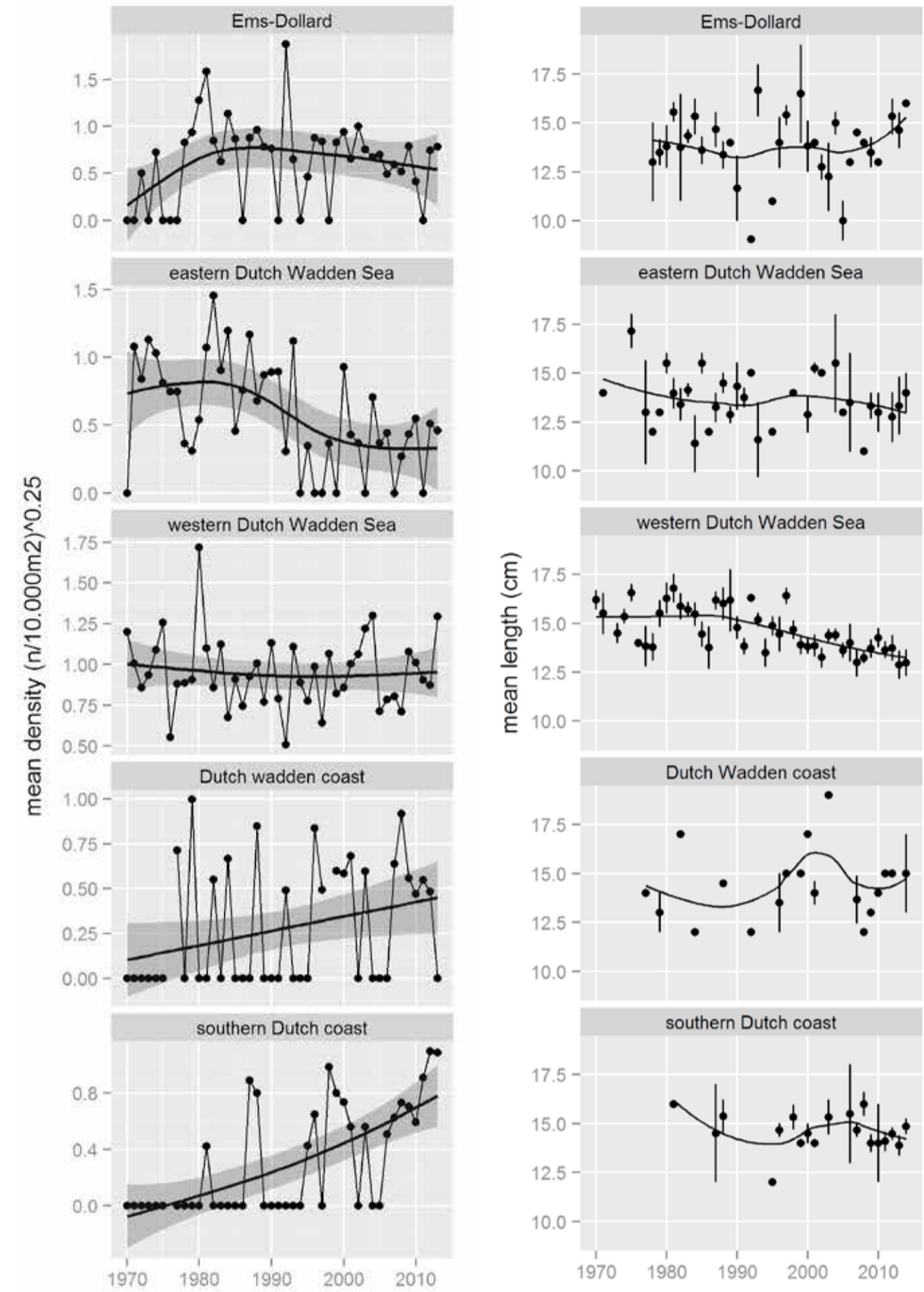
Commercial value in North Sea fisheries

None.

Policy objectives

Butterfish is a typical species for H1110A. N2000 states that there should an improvement in this habitat type.

Demersal fish, the diet comprises amphipods, shrimps and other small crustaceans, polychaetes and molluscs. Within the intertidal zone, they are prey for a variety of seabirds¹.



Trend

The species appears stable in the Ems and western Wadden Sea Fisheries: bycatch in shrimp fisheries.

Available information on drivers

Habitat degradation and local pressures².





Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Shorty, J. T. & Gannon, D. P. Habitat Selection by the Rock Gunnel, *Pholis gunnellus* L. (Pholidae). *Northeastern Naturalist* 20, 155-170 (2013). ² Bolle, L.J. Damm, U., Diederichs, B., Jager, Z., Luersen, G., Marencic, H., Neudecker, T., van Overzee, H., Scholle, J., & Vorberg, R. TMAP ad hoc Working Group Fish Progress report 2007. Report number C133/07, 62 pp (1997).

Gadus morhua

(MJ - Marine Juvenile)

-  Cod
-  Kabeljauw
-  Dorsch
-  Torsk

Occurrence in the Wadden Sea

Highest catch rates restricted to the Baltic Sea, the Kattegat/Skagerrak, and the German Bight. In the North Sea and south of the Dover Strait catches are lower, south of 49°N catches drop. Newly-settled demersal juveniles can be found close inshore even in depths <5 m. In the southern North Sea, immature cod aggregate in shallow water during winter and move to deeper water during summer¹. The distribution pattern in the North Sea has changed markedly during the last 30 years. In the 1980s, the highest concentrations were found in the southeast, along the continental coast, off northeast England and in the Skagerrak and Kattegat. Since then, the continental coast has almost completely lost its function as an important nursery area². Cod is a winter guest in the Wadden Sea.

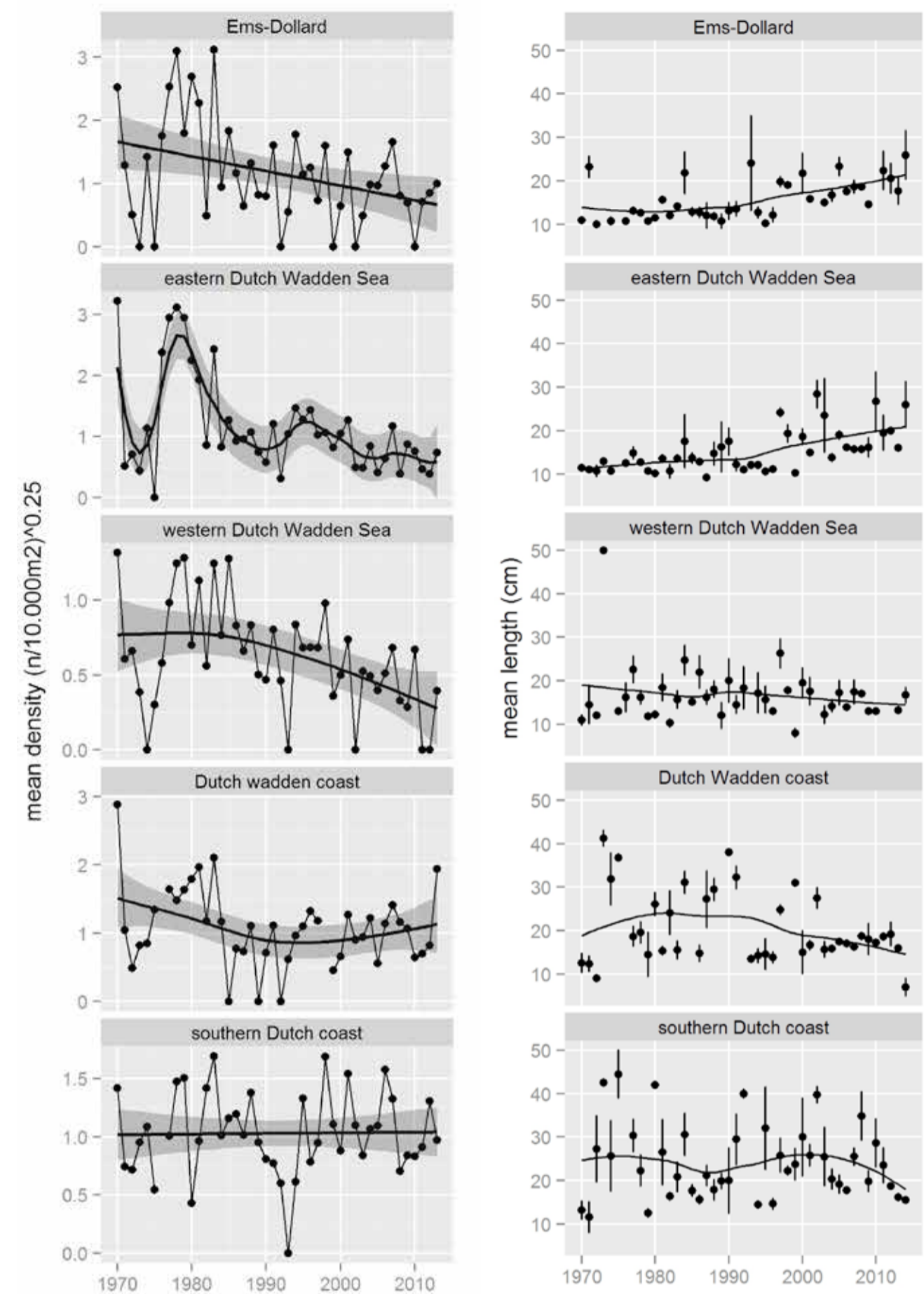
Commercial value in North Sea fisheries

High. Cod has been exploited on both sides of the Atlantic for centuries as an important target as well as a bycatch species in almost all gears used in demersal and pelagic fisheries throughout the area. Total catches (including discards) in the North Sea peaked at about 350 thousand t in the 1970s and early 1980s, during the time of the 'gadoid outburst'. Thereafter, catches gradually declined to a level of 50–70 thousand t during the 2000s.

Policy objectives

In an attempt to reverse the decline in spawning stock biomass in northern European seas an international Cod Recovery Plan was initiated in 2004. Measures introduced under the Common Fisheries Policy included increases in mesh size, seasonal area closures and a considerable reduction in fishing effort. Cod falls under the EU TAC and quota regulations. Cod is a typical species for H1110A. N2000 states that there should an improvement in this habitat type.

Demersal roundfish, predator and scavenger, eats invertebrates and, as size increases, also fish.



Trend

Declining in all Wadden Sea subareas.

Available information on drivers

Habitat requirements: no clear preferences for specific sediments but may be attracted to underwater structures (including wrecks). Occupy a wide range of salinities, from near-freshwater conditions in the Baltic Sea to about 35 psu³.

Climate: There is no evidence that cod have a particular preferred temperature range⁴, although larger ones seem to avoid shallow waters during summer. The thermal niche ranges from -1.5 to 19°C, but small 0-group cod in the Wadden Sea can tolerate temperatures up to 23°C.

Fisheries: bycatch in shrimp fisheries, demersal fisheries North Sea.





Knowledge gaps

The preference of 0- and 1-group for shallow water or for rough and/or weedy ground makes it difficult to obtain reliable indices of abundance from bottom-trawl surveys. Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

1 Heessen, H. J. L. 1983. Distribution and abundance of young cod and whiting in the south-eastern North Sea in the period 1980–1982. ICES Document CM 1983/G:30. 4pp. 2 Lewy, P., and Kristensen, K. 2009. Modelling the distribution of fish accounting for spatial correlation and over dispersion. Canadian Journal of Fisheries and Aquatic Sciences, 66: 1809–1820. 3 Heessen, H. J. L., and Daan, N. 1994. Cod distribution and temperature in the North Sea. ICES Marine Science Symposia, 198: 244–268. 4 Hedger, R., McKenzie, E., Heath, M., Wright, P., Scott, B., et al. J. 2004. Analysis of the spatial distribution of mature cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) abundance in the North Sea (1980–1999) using generalized additive models. Fisheries Research, 70 (1): 17–25.

Limanda limanda

(MJ - Marine Juvenile)

-  Dab
-  Schar
-  Kliesche
-  Ising

Occurrence in the Wadden Sea

Most abundant flat fish species in the North sea, found on sandy and soft substrates at depths of 2–150 m. Settlement of dab occurs in coastal areas, not in the Wadden Sea². Juvenile dab can occur over a wide depth range². In autumn, the 0-group migrate inshore and enter the Wadden Sea. Juvenile dab stay in the tidal gullies and are hardly ever found on the tidal flats of the Wadden Sea.

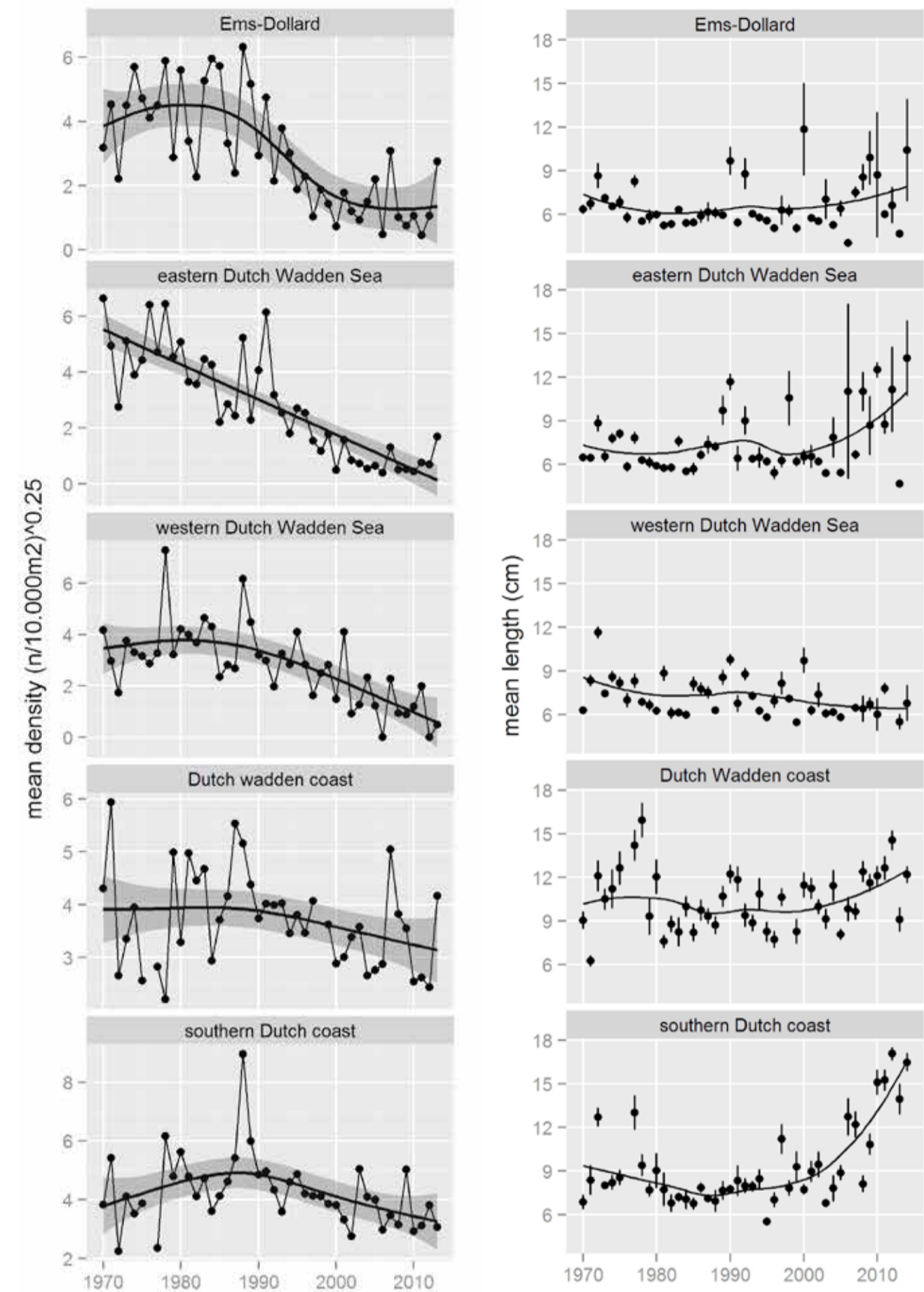
Commercial value

Limited; dab is a common bycatch but is not very valuable and a large proportion of the catch is discarded.

Demersal flatfish, eats polychaetes, small crustaceans, molluscs, brittle-stars, small sea urchins and fish.

Policy objectives

Dab is a typical species for Habitat 1110A. Natura 2000 states that there should be an improvement in this habitat type.



Trend

Dab has strongly decreased in all Wadden Sea areas¹.

Available information on drivers

Climate: likely similar to plaice: increasing water temperatures in recent decades make the Wadden Sea less suitable as nursery area and young fish move to deeper waters in the coastal area.

Fisheries: bycatch in shrimp fisheries. Possibly water visibility and nutrient levels.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Bolle, L. J., Dapper, R., Witte, J. I. & Van der Veer, H. W. Nursery grounds of dab (*Limanda limanda* L.) in the southern North Sea. *Netherlands Journal of Sea Research* 32, 299-307, doi:10.1016/0077-7579(94)90007-8 (1994). ² Bolle L et al. Trends in Wadden Sea Fish Fauna. Part I: Trilateral Cooperation. (IMARES, 2009).

Zoarces viviparus

(ER - Estuarine Resident)

 Eelpout

 Puitaal

 Aalmutter

 Ålekvaabbe

Occurrence in the Wadden Sea

Eelpout is a northern species and during summer, the eelpout is at its southernmost distribution area in the German Wadden Sea¹. Eelpout is a resident species in the Wadden Sea, with year-round presence.

Commercial value in North Sea fisheries

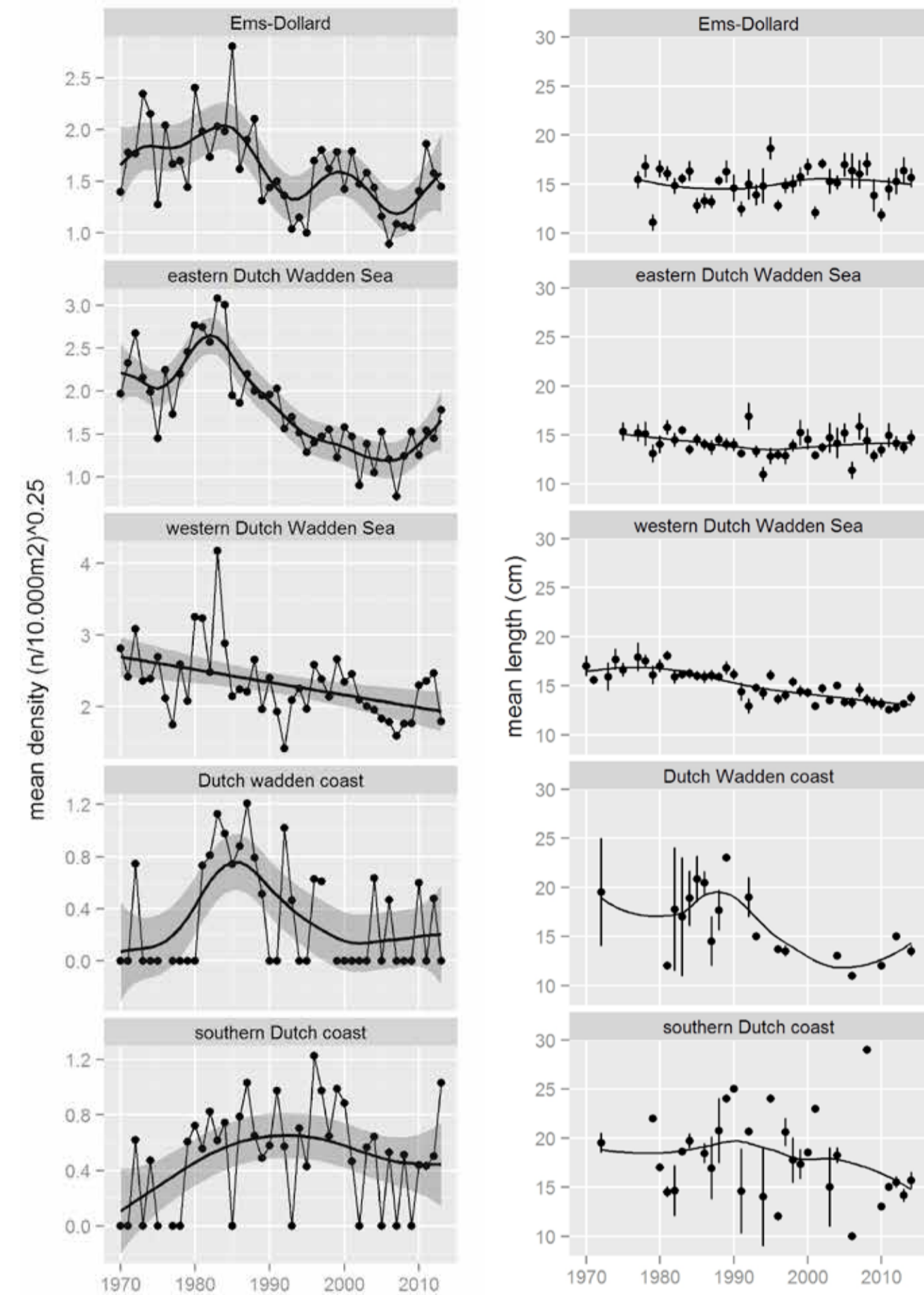
None. Caught as bycatch by shrimp fisheries.

Policy objectives

Eelpout is a resident species which is considered typical for H1110A. Natura 2000 states that there should be an improvement in this habitat type. This species falls under the Water Framework Directive (River Ems.) for the metric species composition.

Demersal roundfish feeds on fishes, large crustaceans, occasionally polychaetes and amphipods

Henk Heesen



Trend

Declining in Wadden Sea and fluctuating in Ems-Dollard.

Available information on drivers

Climate: The relative abundance of the non-migratory eelpout decreases upon warming, reflecting a higher mortality in hot summers¹. Growth also declines due to physiological constraints (Ref. Polte).

Habitat: preference for muddy bottoms and mussel beds.

Fisheries: bycatch in shrimp fishery.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Pörtner, H. O. & Knust, R. Climate change affects marine fishes through the oxygen limitation of thermal tolerance. Science 315, 95-97 (2007).

Platichthys flesus

(ER - Estuarine Resident / CA - Catadrome)

 Flounder

 Bot

 Butt/Flunder

 Skrubbe

Occurrence in the Wadden Sea

Flounder is a common flatfish in coastal, brackish and estuarine waters and is most abundant in the Baltic Sea. Species found from coast up to 50 m depth but preference for shallow seas outside spawning time (Feb – May); migrates to brackish and freshwater. Flounder can occur at great depths but are most abundant in the 0–5 m depth zone. The nursery areas are located in the shallow coastal zones and estuaries, including the Wadden Sea, where the larvae arrive from early April to early May to settle on the tidal flats. Year-class strength appears to have been largely determined before that time, when the larvae are still in the open sea. After settlement, a period of density-dependent mortality follows, the main predators being crustaceans¹. Immature flounder spend most of their first 2 to 3 years of life in freshwater or brackish littoral and coastal areas before joining the mature stock. Adults perform an annual spawning migration in late autumn or early winter to the offshore spawning grounds, and a feeding migration from May to November towards the coastal areas.

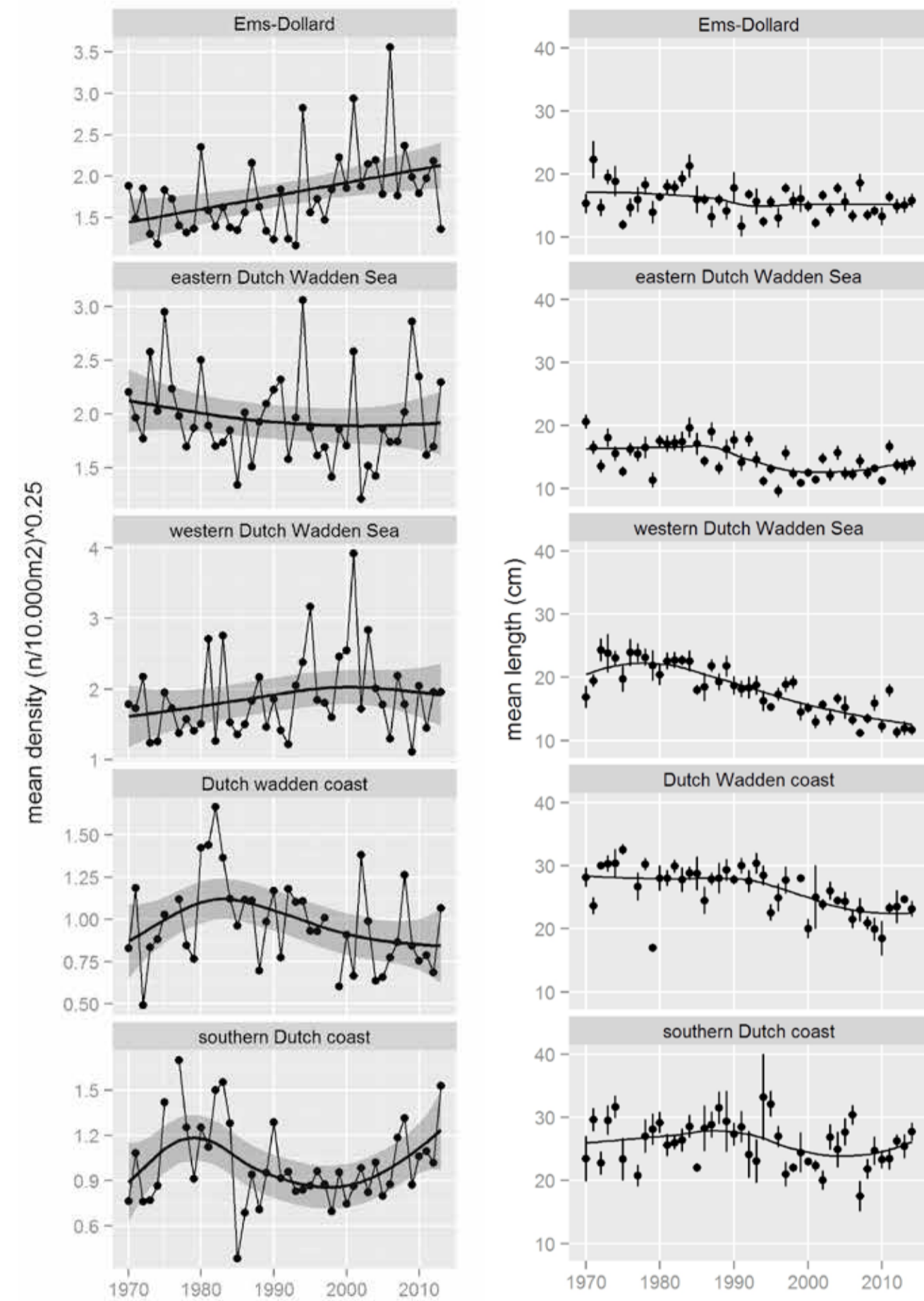
Commercial value

Limited; small scale passive gear fisheries in Wadden Sea and coastal waters.

Policy objectives

Flounder is a typical species for H1110A; this is one of the species for which the Wadden Sea is considered a nursery area. N2000 states that there should be an improvement in both H1110A and nursery area. Flounder falls under the EU TAC and quota regulations. The abundance of flounder is assessed as part of the WFD-fish index for transitional waters (River Ems).

Demersal flatfish, eats small invertebrates, mainly polychaetes, bivalves, and crustaceans, including small fish like smelt and gobies; in fresh and brackish water also eats insects and insect larvae; benthic habitat mud-sand; prey species for birds and mammals



Trend

Unclear.

Available information on drivers

Habitat degradation, in Wadden Sea and Eems, including opportunities for migration in Eems; Fisheries: bycatch in shrimp fisheries.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries.

¹ van der Veer, H. W., Dapper, R. & Witte, J. I. J. The nursery function of the intertidal areas in the western Wadden Sea for 0-group sole *Solea solea* (L.). *Journal of Sea Research* 45, 271-279 (2001).

Gobiidae

(ER - Estuarine Resident)

 Gobies

 Grondels

 Grundeln

 Kutlingefamilien

Occurrence in the Wadden Sea

Several species occur in the Wadden Sea. Various species prefer different habitats, some favour sandy bottoms in estuarine and inshore waters, such as the sand goby (*Pomatoschistus minutus*). Taxonomic species discrimination in monitoring is difficult.

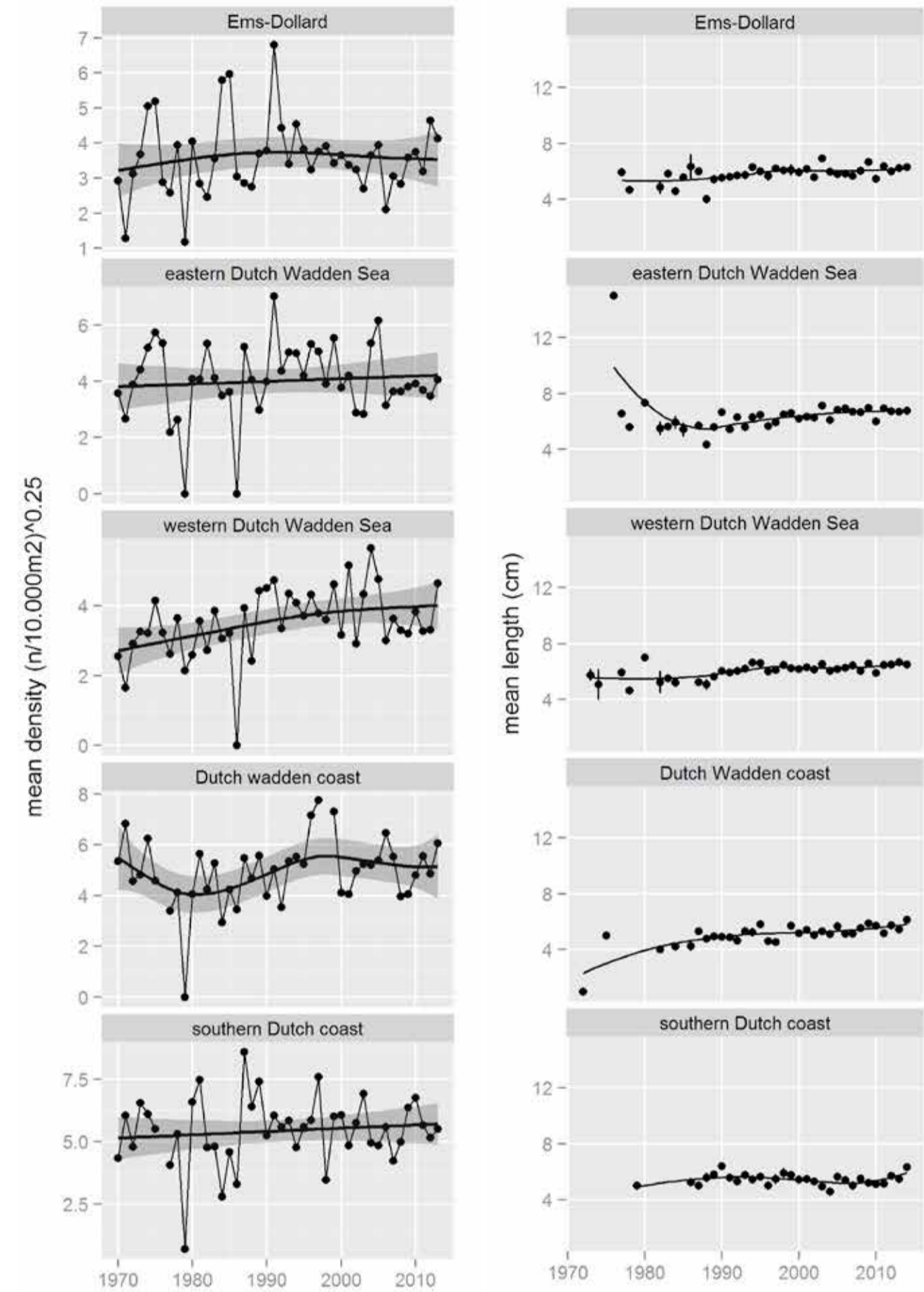
Commercial value

None.

Family with pelagic and demersal fish species most species prey on a variety of benthic and suprabenthic prey, including polychaetes, amphipods, mysids, isopods, ostracods, copepods, cumaceans, natantid shrimps, brachyurans, foraminiferans, small molluscs and larval fish. Important food resource for many fish species, also eaten by marine mammals.

Policy objectives

Gobies are considered typical species for H1110A. N2000 states that there should an improvement in this habitat type.



Trend

Stable or increasing.

Available information on drivers

Fisheries: bycatch in shrimp fisheries.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

- Species specific occurrence/stock size/habitat preferences/trends
- Species specific trends



Clupea harengus

(MJ - Marine Juvenile)

 Herring

 Haring

 Hering

 Sild

Occurrence in the Wadden Sea

Found across estuarine, euryhaline, coastal, and continental shelf areas. Herring is not sampled well by the DFS. Juvenile herring occur in the Wadden Sea in considerable numbers and use gullies and intertidal for growth. They originate from different autumn (and winter) spawning herring stocks (e.g. Channel). Abundance reflects the processes that act during the larval phase on the North Sea, is thus mainly determined outside the Wadden Sea. In 2001-2007, there was poor herring recruitment for 6 years in a row. Increase in herring abundance in 1970s reflects a period of recovery of collapsed North Sea herring populations after closure of fishery 1977-1983³. Occurs in Wadden Sea April-Oct^{4,5}. Together with sprat most abundant pelagic species⁵. In former times there was a spring-spawning herring population (Zuiderzeeharing) which has disappeared after closure of Lake IJssel. Spring-spawning populations may be present in other estuaries (Elbe).

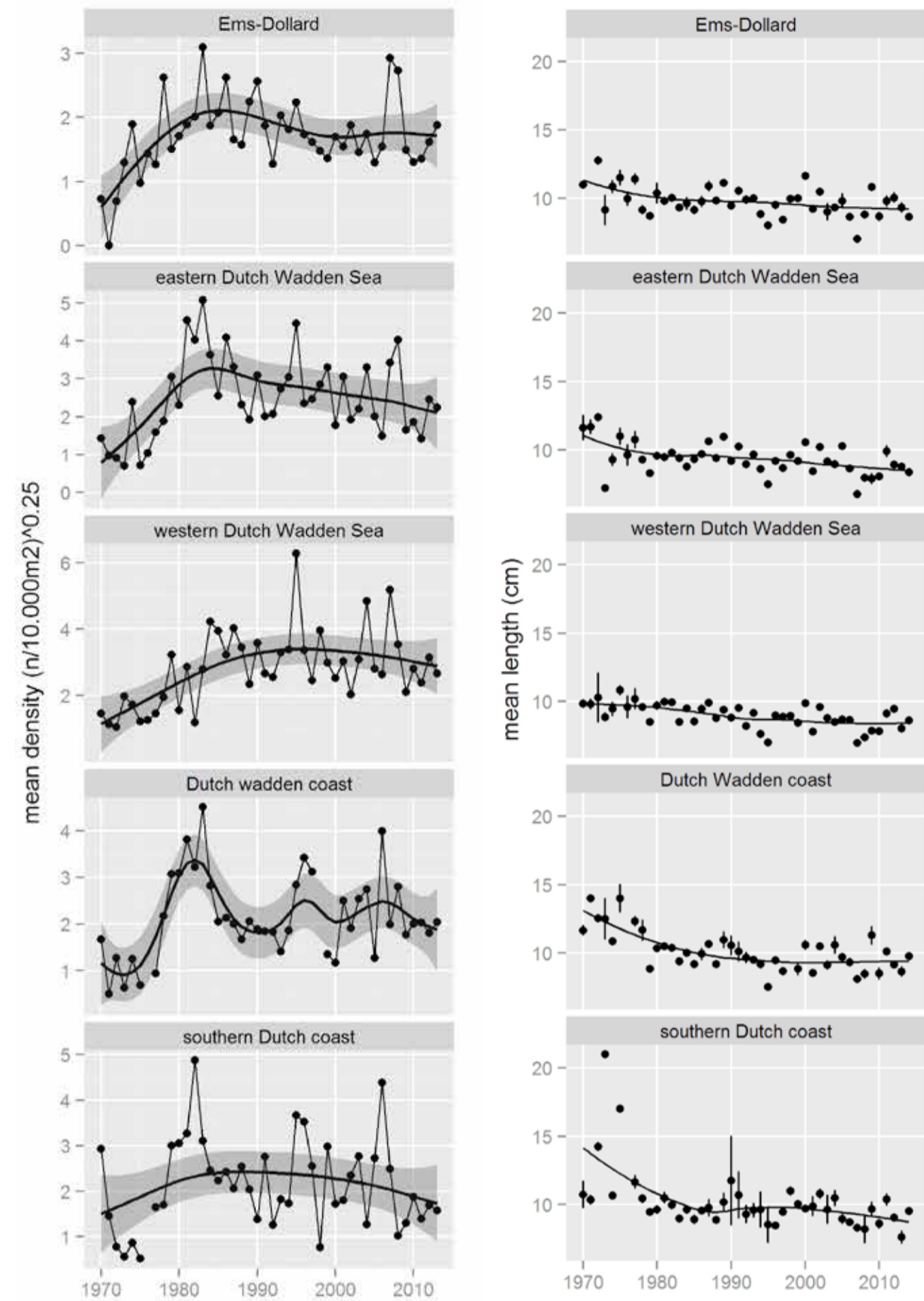
Commercial value

Commercially one of the most important pelagic species in several North Atlantic ecosystems and intensive exploitation goes back several centuries. No commercial fishing in Wadden Sea.

Policy objectives

Herring is a typical species for H1110A; N2000 states that there should an improvement in H1110A. Herring falls under the EU TAC and quota regulations. The abundance of juvenile herring is assessed as part of the Water Framework Directive fish index for transitional waters (Ems).

Pelagic roundfish, small pelagic species, essentially a southern species. Generalist planktivores, feed on copepods, malacostracan larvae and fish larvae including their own^{1,2}. Prey species for birds and marine mammals.



Trend

Stable or decreasing.

Available information on drivers

Probable causes: changes in the North Sea hydrography, and shift in the dominant food items. Abundance of herring varies as a result of natural variability in recruitment and human exploitation. Most stocks in the Northeast Atlantic have been overexploited, resulting in low abundance during the 1970s. By 2010, recovery to numbers close to the pre-collapse state⁶.

Knowledge gaps

No good pelagic monitoring in Dutch Wadden Sea. Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea and estuaries in life cycle, habitat preferences. Seasonal availability as food for birds (also condition, important for breeding success terns).

Henk Heessen



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1 Daan, N., Rijnsdorp, A. D. & Vanoverbeeke, G. R. Predation by North Sea herring *Clupea harengus* on eggs of plaice *Pleuronectes platessa* and cod *Gadus morhua*. *Transactions of the American Fisheries Society* 114, 499-506, doi:10.1577/1548-8659(1985)114<499:pbnshc>2.0.co;2 (1985). 2 Smith, C. & Reay, P. Cannibalism in teleost fish. *Reviews in Fish Biology and Fisheries* 1, 41-64 (1991). 3 Bolle, L. J. et al. Trends in Wadden Sea fish fauna. Report No. C108/08, (Wageningen IMARES Report 2009). 4 Tulp, I. et al. Habitat use of juvenile pelagic fish in a shallow estuarine area: the Wadden Sea. (in prep). 5 Couperus, B. et al. Abundance and tidal behaviour of pelagic fish in the gateway to the Wadden Sea. (MS subm.). 6 Dickey-Collas, M. et al. Lessons learned from stock collapse and recovery of North Sea herring: a review. *ICES Journal of Marine Science* 67, 1875-1886, doi:10.1093/icesjms/fsq033 (2010).

Syngnathus spp.


(*S. acus*, *S. rostellatus* and *S. typhle*)

(ER - Estuarine Resident)

 Greater Pipefish


 Nilsson's pipefish

 Deep-snouted pipefish

 Grote Zeenaald

 Kleine zeenaald

 Trompetterzeenaald

 Große Seenadel

 Kleine seenadel

 Grasnadel

 Stor Tangnål

 Lille tangnål

 Almindelig tangnål

Occurrence in the Wadden Sea

Pipefish are widely distributed, with relatively high densities along the continental North Sea coast and Wadden Sea. Pipefish are thought to be associated with seagrass and other seaweeds, they are certainly not restricted to this type of habitat, but include open water barren sandy and muddy grounds in shallow areas. They occur within the coastal zone down to 20 m. The channels in the Wadden Sea are used for growing by lesser pipefish². In the Wadden Sea, Nilsson's pipefish is the most abundant pipefish with a year-round occurrence. Deep-snouted pipefish became extinct with the disappearance of the submerged seagrass vegetations. In the DFS, only *S. rostellatus* and *S. marinus* are caught.

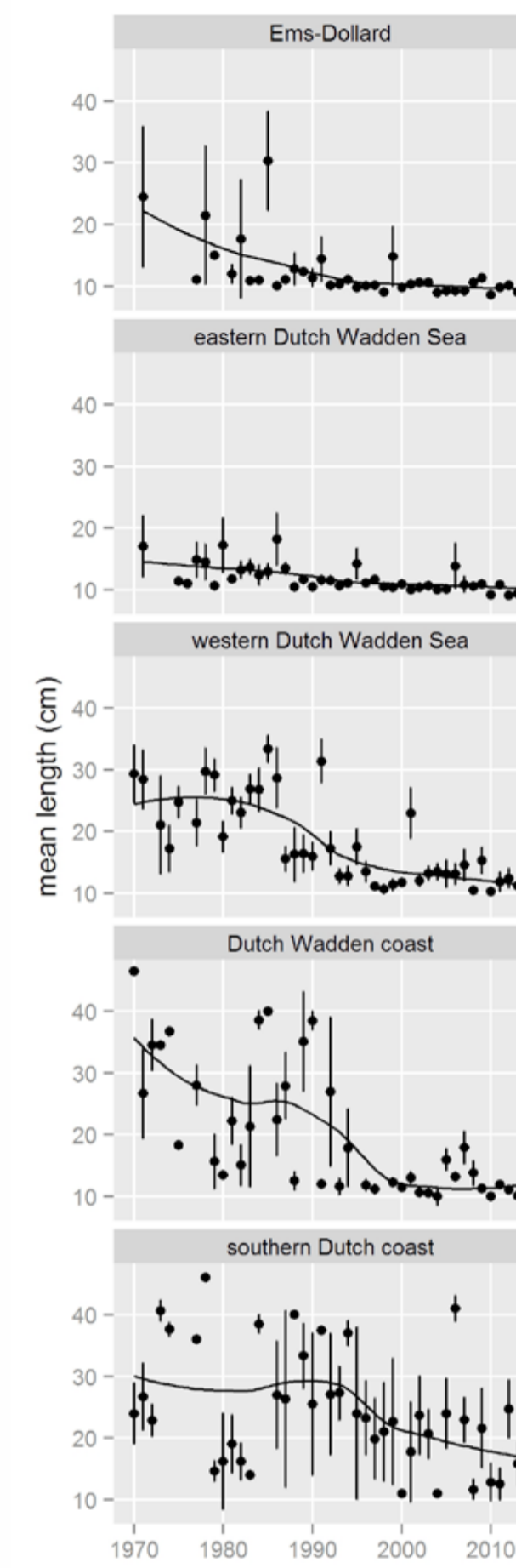
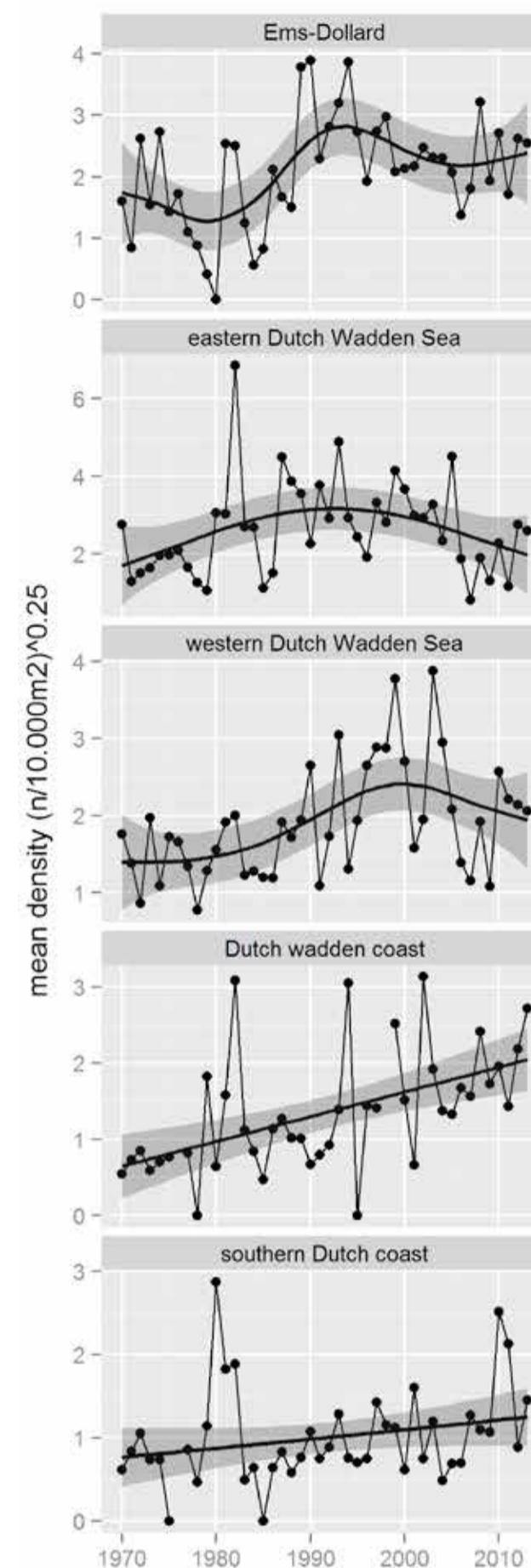
Commercial value

None.

Policy objectives

All species are estuarine residents and as such typical species for H1110A. N2000 states that there should an improvement in H1110A. Greater pipefish is endangered or vulnerable according to Red List (NL, D, DK).

Demersal fish, eats small planktonic organisms (mostly crustaceans), including larval fish. Eaten by seabirds and mammals but with potentially detrimental effects for the predators as they are of low nutritional value¹.



Trend

Variable.

Available information on drivers

Climate: increase in the Atlantic has been related to warming seawater^{3,4}.

Fisheries: bycatch in shrimp fisheries.

Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries and cooling water intake, diet, role Wadden Sea in life cycle, habitat preferences. Index of individual species of pipefishes.

¹ Harris, M. P., Newell, M., Daunt, F., Speakman, J. R. & Wanless, S. Snake Pipefish *Entelurus aequoreus* are poor food for seabirds. *Ibis* 150, 413-415, doi:10.1111/j.1474-919X.2007.00780.x (2008).

² Tulp, I., Bram Couperus, Willem Diderich, Hans Witte, Henk van der Veer & Adriaan Rijnsdorp. Habitat use of juvenile pelagic fish in a shallow estuarine area: the Wadden Sea (in prep).

³ Kirby, R. R., Johns, D. G. & Lindley, J. A. Fathers in hot water: rising sea temperatures and a Northeastern Atlantic pipefish baby boom. *Biology Letters* 2, 597-600, doi:10.1098/rsbl.2006.0530 (2006).

⁴ van Damme, C. J. G. & Couperus, A. S. Mass occurrence of snake pipefish in the Northeast Atlantic: result of a change in climate? *Journal of Sea Research* 60, 117-125 (2008).



Pleuronectes platessa

(MJ - Marine Juvenile)

 Plaice

 Schol

 Scholle

 Rødspætte

Occurrence in the Wadden Sea

Only juvenile plaice (0- and 1-group) occur in the Wadden Sea, mainly during spring and summer. Highest densities of adult plaice are recorded in the south-eastern North Sea and in the waters around Denmark and the British Isles. The distribution is size-dependent with the smaller plaice found in coastal areas. The Wadden Sea is described as a major nursery ground of plaice² with the abundance in the Wadden Sea reflecting the size of the North Sea population. In recent years however, juvenile plaice are found increasingly further offshore^{3,4} with numbers in the Wadden Sea declining despite a large North Sea population.

Commercial value in North Sea fisheries

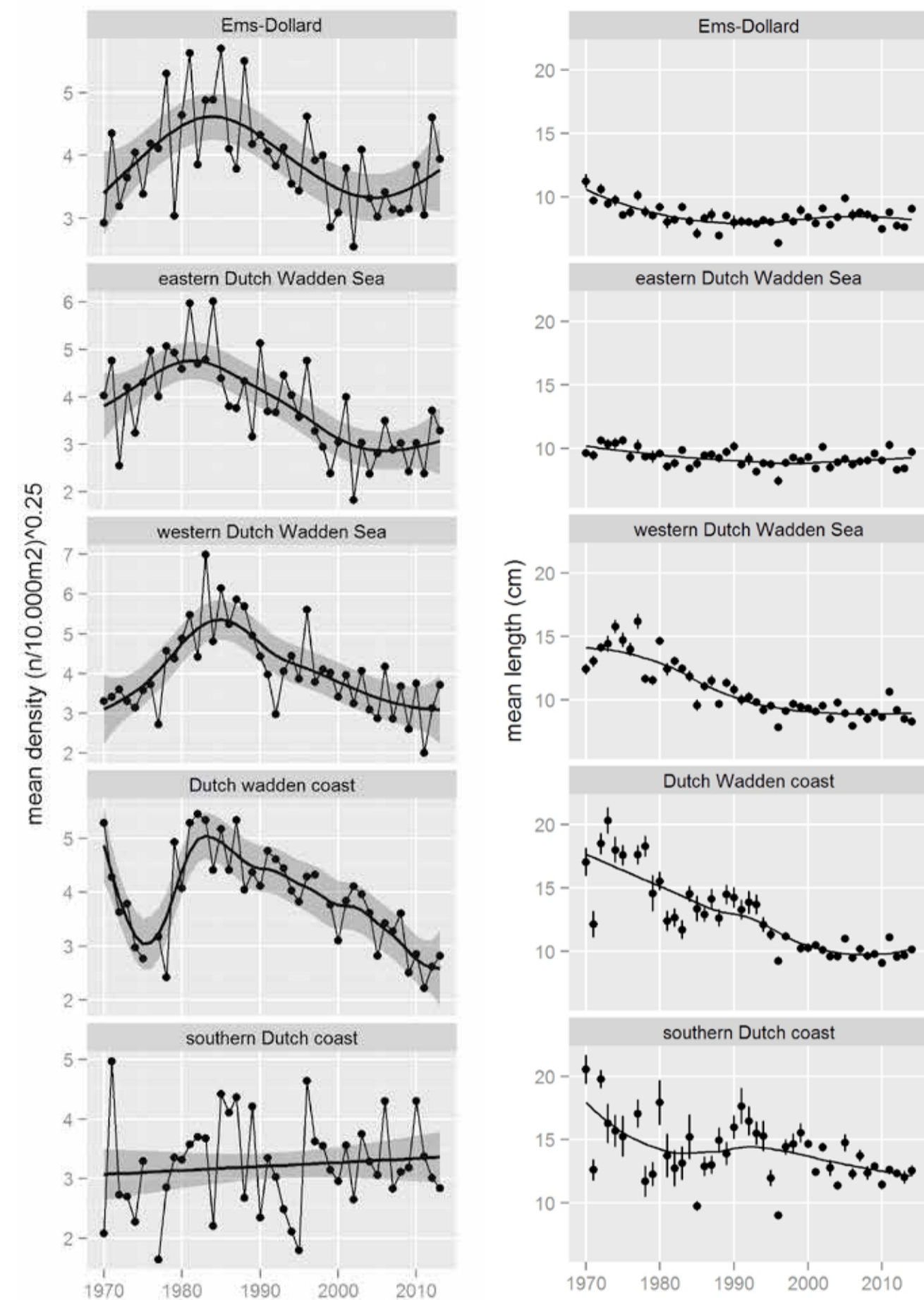
Landings culminated at about 170 thousand t in the 1980s, but subsequently fell to about 100 thousand t. Since the late 1990s the stock has recovered because fishing effort has been effectively reduced, even though discarding has continued. Plaice are caught in beam trawl (coast) as bycatch in sole fishery and shrimp trawl; net adaptation (use of inner net - 'zeeflap') in shrimp fisheries should exclude bycatch of >10cm fish.

Policy objectives

Plaice is a typical species for H1110A; this is one of the species for which the Wadden Sea is considered a nursery area. N2000 states that there should be an improvement in both H1110A and nursery area. Plaice falls under the EU TAC and quota regulations.

Demersal flatfish.

In nursery areas, juveniles feed on regenerating parts of invertebrates such as tail tips of the lugworm and siphons of bivalves 1. Larger individuals feed on invertebrate species such as polychaetes, bivalves and crustaceans (amphipods, mysids and small shrimps). Full grown plaice feed on molluscs and sandeels.



Trend

Increasing in Eems-Dollard after decline, Wadden Sea stable following decline.

Available information on drivers

Habitat requirements: Settlers and juveniles favour coastal and estuarine waters (20–32 psu⁵). Juvenile stages show a clear preference for fine sandy sediments, which allows them to bury themselves and hide for predators⁶. They undertake tidal migrations on the tidal flats.

Climate: increasing water temperatures in recent decades make the Wadden Sea less suitable as nursery area and young fish move to deeper waters in the coastal area⁴.

North Sea fisheries: could be detrimental to parent stocks; Wadden Sea fisheries-bycatch in shrimp fisheries.

Habitat degradation: smaller area for spawning (North Sea) and nursery (Wadden Sea).

Larval transport of North Sea to coastal areas: May not be affected.

Knowledge gaps

causal explanation of the changed distribution and reduced use of the Wadden Sea; spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

1 De Vlas, J. Annual food intake by plaice and flounder in a tidal flat area in the Dutch Wadden Sea, with special reference to consumption of regenerating parts of macrobenthic prey. Netherlands Journal of Sea Research 13, 117-153 (1979). 2 Kuipers, B. R. & Dapper, R. Nursery function of Wadden Sea tidal flats for the Brown Shrimp Crangon crangon. Marine Ecology Progress Series 17, 171-181 (1984). 3 van Keeken, O. A., van Hoppe, M., Grift, R. E. & Rijnsdorp, A. D. Changes in the spatial distribution of North Sea plaice (*Pleuronectes platessa*) and implications for fisheries management. Journal of Sea Research 57, 187-197 (2007). 4 Teal, L. R., van Hal, R., van Kooten, T., Ruurdij, P. & Rijnsdorp, A. D. Bio-energetics underpins the spatial response of North Sea plaice (*Pleuronectes platessa* L.) and sole (*Solea solea* L.) to climate change. Global Change Biology 18, 3291-3305, doi:10.1111/j.1365-2486.2012.02795.x (2012). 5 Jager, Z., Kleef, H. L. & Tydeman, P. The distribution of 0-group flatfish in relation to abiotic factors on the tidal flats in the brackish Dollard (Ems Estuary, Wadden Sea). Journal of Fish Biology 43, 41-43 (1993). 6 Gibson, R. N. Behaviour and the distribution of flatfishes. Journal of Sea Research 37, 241-256 (1997).

Lampetra fluviatilis

(CA - Anadromous)

 River lamprey

 Rivierprik

 Flussneunauge

 Flodlampret

Occurrence in the Wadden Sea

River lamprey larvae spend the first three years buried in the soil in fresh water. At 12-14 cm they migrate to sea, they stay ca 2 years at sea after which they return to the fresh water at lengths of 30-45 cm to spawn. In the Wadden Sea they are regularly caught in DFS survey and pelagic sampling¹ and as bycatch in shrimp fisheries². Wadden Sea probably used as growing habitat for juveniles and as passage to fresh water.

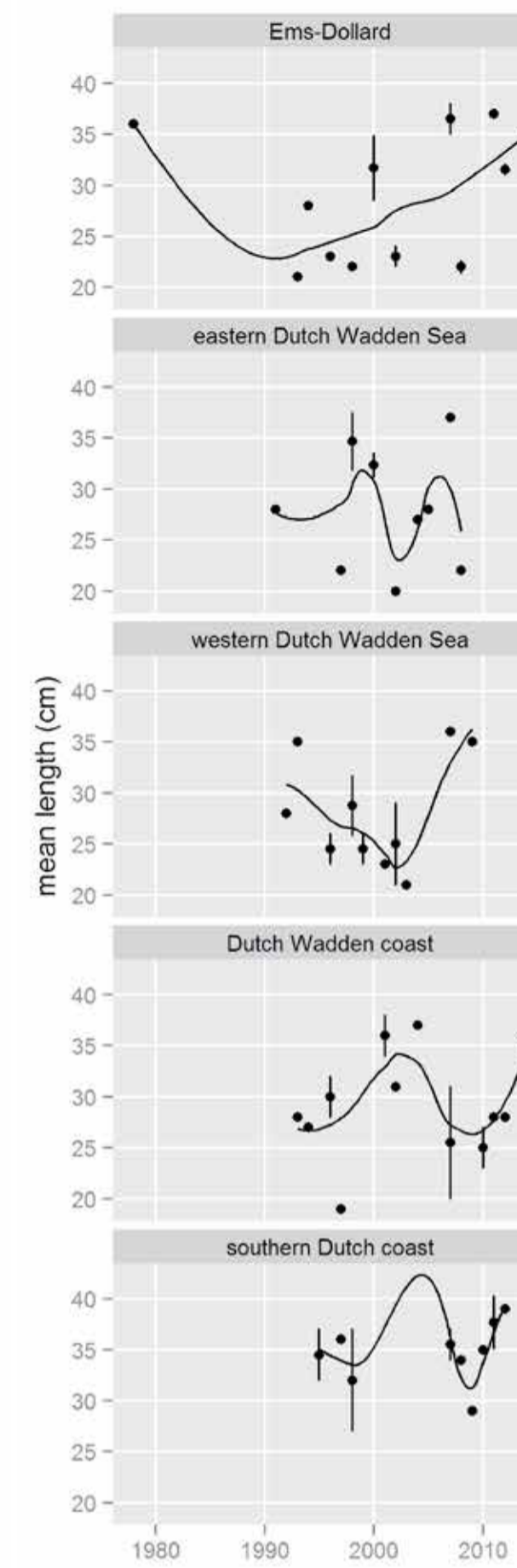
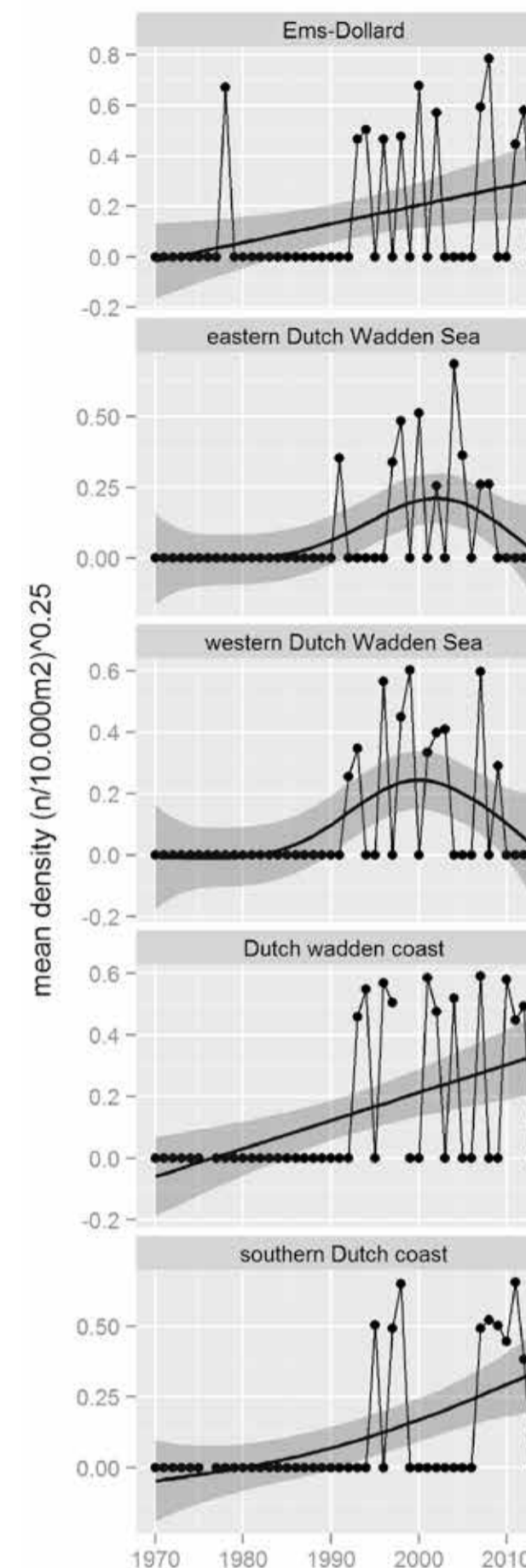
Commercial value

None.

Policy objectives

River lamprey is a Habitat Directive species for H1110A. N2000 states that the abundance of the species should improve and that there should be an improvement H1110A. It is classified as endangered or vulnerable in Dutch, German or trilateral Red Lists.

Pelagic jawless fish
Member of the jawless fishes
and distinct from other fish.
Eel-like fishes with seven
pairs of lateral gill-openings,
a single nostril between the
eyes. They have no bones
and no paired fins. Parasitic,
takes blood from other fish
and eats sprat and herring.
Larvae are benthic.



Trend

Not clear because of insufficient monitoring.

Available information on drivers

Hampered connectivity, loss of spawning habitat.

Knowledge gaps

Relationship Wadden Sea with spawning sites. No good pelagic monitoring. Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Couperus, B. et al. Abundance and tidal behaviour of pelagic fish in the gateway to the Wadden Sea. (MS subm.). ² Steenbergen, J., van der Hammen, T., Rasenberg, M. & Tulp, I. Tussenrapportage onderzoek "Effecten van garnalenvisserij" – onderdeel bijvangst. Report No. C047/13, (IMARES, 2013).

Ammodytes sp

(ER - Estuarine Resident)

Because of identification difficulties all species treated as one group

 Sandeel sp

 Zandspiering

 Sandaal

 Sandgrævling

Occurrence in the Wadden Sea

Distribution is closely linked to that of their preferred habitat: medium to coarse sand (0.25–2.0 mm grain size) in well-oxygenated waters²⁻⁴. Spawn during winter, and spend most of that season underground in a state of hibernation⁵. Schools of sandeel may extend from very close to the bottom, to 20–30 m into the pelagic domain, but also schools may be seen that are in the water column, completely off the ground (Hassel et al., 2003). Occurs in Wadden Sea April-Oct^{6,7}. After sprat and herring most abundant pelagic species⁷.

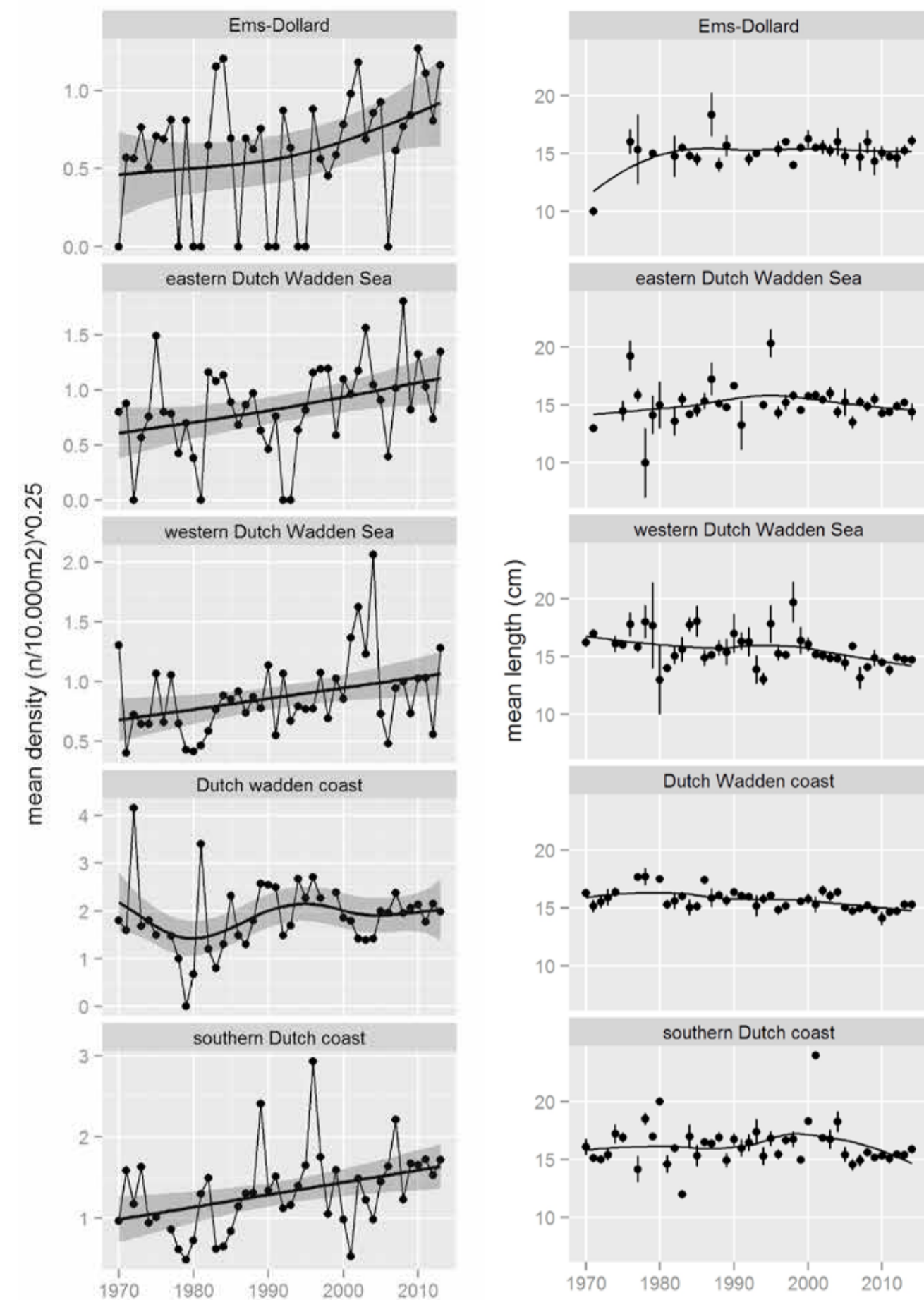
Commercial value

None in the Netherlands.

Policy objectives

Sandeel sp. is a typical species for H1110A. N2000 states that there should be an improvement in H1110A. Sandeel falls under the EU TAC and quota regulations.

Pelagic and partly benthic roundfish forming dense shoals, spend much of their life buried in the sand. Distinct diurnal behaviour: emerge from the sand in the morning, feed in the pelagic system during daylight and then bury themselves in the sand again during darkness¹. Forage in schools on zooplankton, including copepods, crangonids, gammarid amphipods, their pelagic larvae, polychaetes and fish. Major food resource for fish, marine mammals and seabirds.



Trend

Increasing in all areas.

Available information on drivers

Possibly habitat degradation (dredging, sand suppletions?), in Wadden Sea and Eems, over exploitation in the North Sea.

Knowledge gaps

Current monitoring DFS is not adequate to determine occurrence and abundance. spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

1 Winslade, P. Behavioural studies on the lesser sandeel *Ammodytes marinus* (Raitt) II. The effect of light on activity. *Journal of Fish Biology* 6, 577-586 (1974). 2 Wright, P. J., Jensen, H. & Tuck, I. The influence of sediment type on the distribution of the lesser sandeel, *Ammodytes marinus*. *Journal of Sea Research* 44, 243-256 (2000). 3 Holland, G. J., Greenstreet, S. P. R., Gibb, I. M., Fraser, H. M. & Robertson, M. R. Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. *Marine Ecology Progress Series* 303, 269-282 (2005). 4 van der Kooij, J., Scott, B. E. & Mackinson, S. The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research* 60, 201-209 (2008). 5 Hassel, A. et al. Reaction of sandeel to seismic shooting: A field experiment and fishery statistics study. *Fisken og Havet* 4 (2003). 6 Tulp, I. et al. Habitat use of juvenile pelagic fish in a shallow estuarine area: the Wadden Sea. (in prep). 7 Couperus, B. et al. Abundance and tidal behaviour of pelagic fish in the gateway to the Wadden Sea. (MS subm.).

Petromyzon marinus

(CA - Anadromous)

 Sea lamprey

 Zeeprik

 Meerneunauge

 Havlampret

Occurrence in the Wadden Sea

Roam outside Wadden Sea further offshore into the open sea. Upon reaching maturity enters rivers to spawn in June/July, they are between 70–120 cm and between 8 and 11 years old¹. Die after reproduction. Larvae spend several years buried in the sediment, upstream in rivers. In the Wadden Sea rarely caught in DFS survey and fyke sampling².

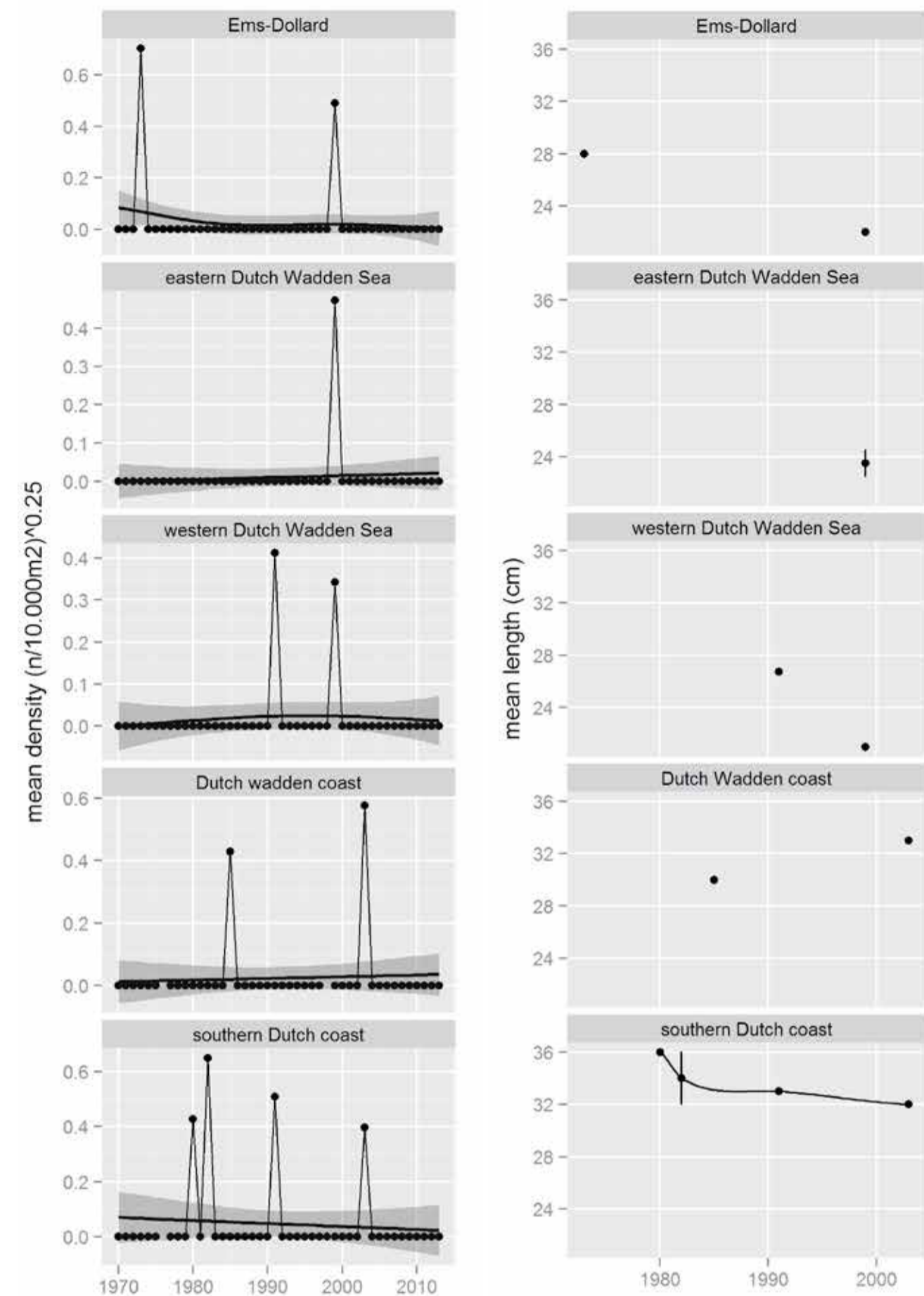
Commercial value

None.

Policy objectives

Sea lamprey is a typical species for H1110A, as well as one for which there is a specific objective to improve stocks in the Wadden Sea. N2000 states that there should be an improvement H1110A. Is classified as endangered or vulnerable in Dutch, German or trilateral Red Lists

Pelagic jawless fish, member of the jawless fishes and distinct from other fish. Eel-like fishes with seven pairs of lateral gill-openings, a single nostril between the eyes. They have no bones and no paired fins. Parasitic, takes blood from other fish. Attach themselves to larger species, including salmon, cod, basking shark and cetaceans.



Trend

Unclear.

Available information on drivers

Hampered connectivity, accessibility and quality of spawning habitat, quality of larval habitat.

Knowledge gaps

No good pelagic monitoring. Spatial and diurnal dynamics in distribution, diet (species is parasitic), role Wadden Sea in life cycle, habitat preferences, location of spawning areas.

¹ Vladikov, V. D. in Fishes of the North-eastern Atlantic and the Mediterranean Vol. 1, pp. 64-67. Ed. by P. J. P. Whitehead et al. UNESCO, Paris (1984). ² Van der Veer, H. W. et al. Long-term (50 years) changes in marine fish fauna of a temperate coastal sea: degradation of trophic structure and nursery function. Estuarine Coastal and Shelf Science (2015) (in press).

Osmerus eperlanus

(CA - Catadrome)

 Smelt

 Spiering

 Stint

 Smelt

Occurrence in the Wadden Sea

Smelt form dense spawning aggregations in the estuaries late winter and early spring, and migrate upstream depositing their eggs usually on hard substrates along the shores of rivers and lakes. In the Wadden Sea they are concentrated in areas with low salinities close to the mainland coast and in the Ems estuary. Probably no contribution of Wadden Sea smelt to landlocked IJsselmeer population².

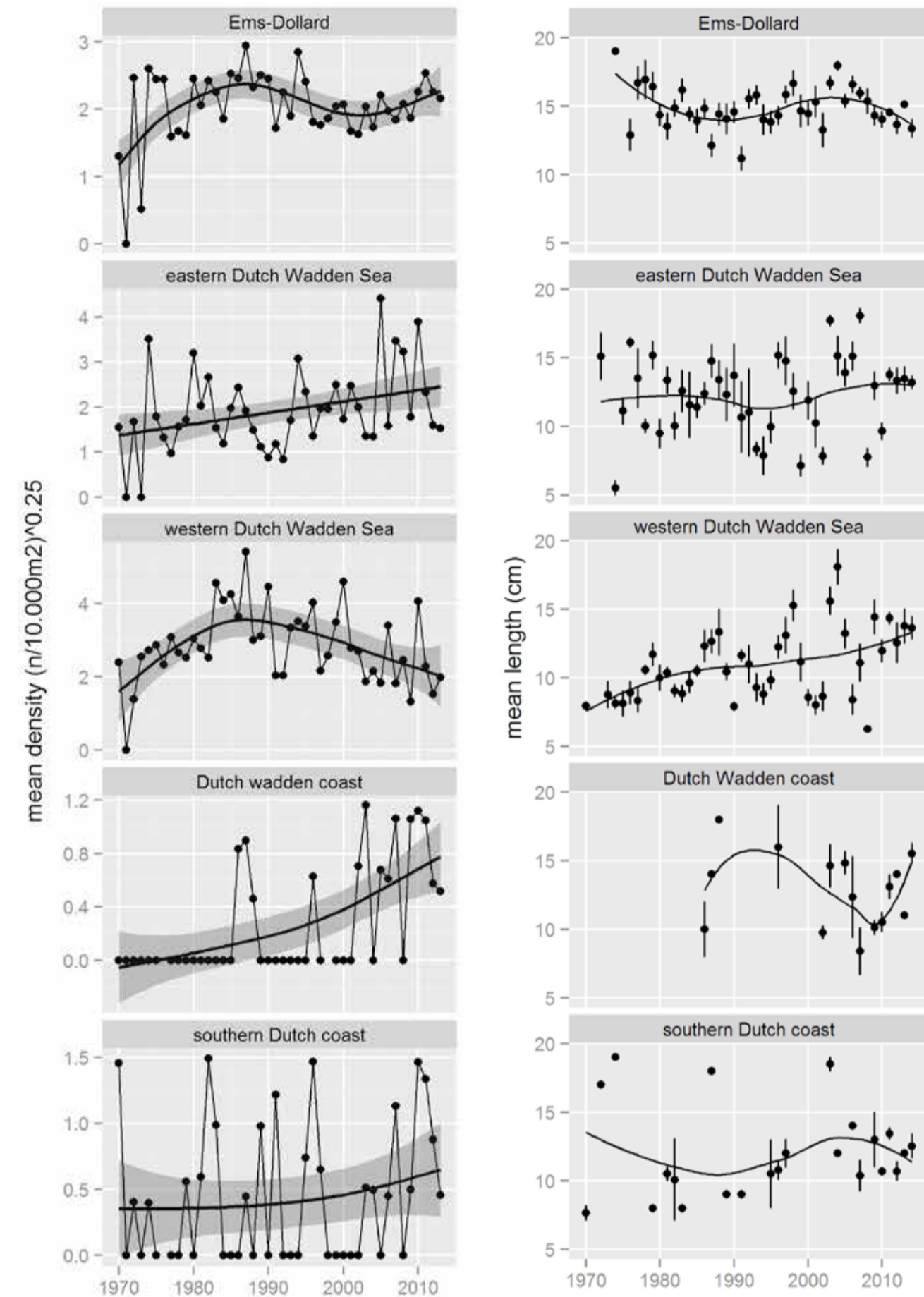
Commercial value

Limited small scale active gear on landlocked population in IJsselmeer/Markermeer. Small scale fisheries at sluices near Afsluitdijk, landed and marketed as whitebait.

Pelagic schooling fish that form two types of populations: anadromous and landlocked. Anadromous type resides in the Wadden Sea, while landlocked smelt inhabits IJsselmeer and Markermeer. Individuals <9 cm are mostly zooplanktivorous. Fish >9 cm piscivorous: piscivorous smelt are often cannibalistic¹. Important food source for birds.

Policy objectives

Smelt is a typical species for H1110A. N2000 states that there should an improvement in both H1110A. The abundance of juvenile herring is assessed as part of the Water Framework Directive fish-index for transitional waters (River Ems).



Trend

Variable.

Available information on drivers

Climate/nutrients: potentially in IJsselmeer, connectivity, water quality (estuary), habitat loss (spawning).

Knowledge gaps

Actual abundance is not well established in current (DFS) monitoring. Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in lifecycle, habitat preferences.

¹ Vinni, M., Lappalainen, J., Malinen, T. & Peltonen, H. Seasonal bottlenecks in diet shifts and growth of smelt in a large eutrophic lake. *Journal of Fish Biology* 64, 567-579 (2004). ² Tulp, I. et al. Connectivity between migrating and landlocked populations of a diadromous fish species investigated using otolith microchemistry. *PLoS ONE* 8, doi:doi:10.1371/journal.pone.0069796 (2013).



Joep de Leeuw

Solea solea

(MJ - Marine Juvenile)

 Sole

 Tong

 Seezunge

 Søtonge

Occurrence in the Wadden Sea

Juvenile sole occur in the Wadden Sea during the summer months. Highest catch rates are observed in the southern North Sea, Irish Sea, Bristol Channel and English Channel. Although sole may occasionally be recorded at depths down to 250 m, they are largely restricted to inner shelf waters <50 m deep and the depth distribution is related to size (smaller sole remain in shallower waters). Settlement of larval sole in the Wadden sea occurs from May onwards, whereby the timing of settlement is inversely related to water temperature in spring. Maximum densities are found around the end of June¹. Sole leave the Wadden Sea in autumn when water temperatures drop below 10 °C.

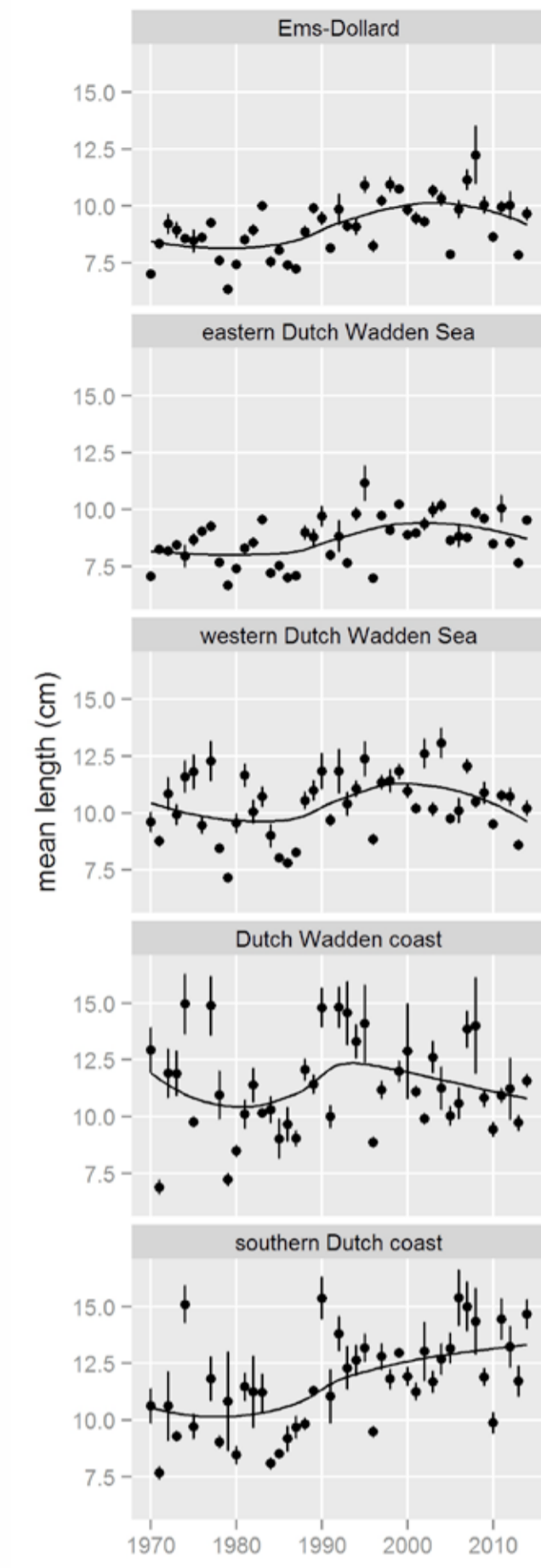
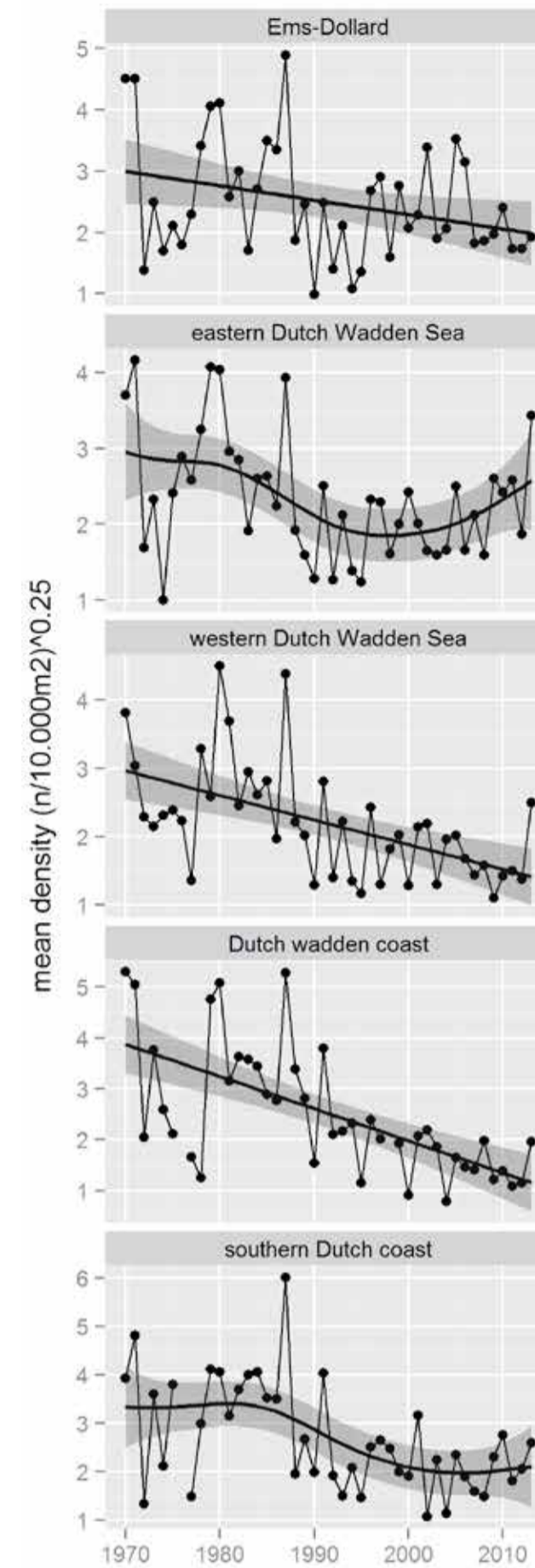
Commercial value in North Sea fisheries

Sole has always been a valuable commercial species that, up to the 1960s, was exploited by otter trawls and gill nets². Owing to quota restrictions, landings since 2000 have decreased to around 15 thousand t in the North Sea, 5000 t in the Bay of Biscay, 2000 t in the English Channel and less than 1000 t in the Irish Sea. Since the end of the 1990s, the fishing mortality on North Sea sole has also declined through a reduction of the fleet³. Year-class strength in the subtidal part of the western Wadden Sea has been shown to have a significant positive relationship with recruitment¹.

Policy objectives

Sole is a typical species for H1110A; N2000 states that there should an improvement in both H1110A. Sole falls under the EU TAC and quota regulations.

Demersal flatfish, eats polychaete worms, small soft-shelled bivalves, small fishes and crustaceans.



Trend

Variable

Available information on drivers

Habitat requirements: sole prefer sandy or sandy/muddy bottoms within which they can bury⁴.

Climate: sole are a southern species at their northern boundary in the North Sea. During winter they migrate offshore to warmer waters. Temperatures below 3°C are fatal for sole⁵.

Fisheries: the development of the pulse trawl has made catching sole more efficient for the fleet. Bycatch in shrimp fisheries.





Knowledge gaps

Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, location of spawning grounds.

1 van der Veer, H. W., Dapper, R. & Witte, J. I. J. The nursery function of the intertidal areas in the western Wadden Sea for 0-group sole *Solea solea* (L.). *Journal of Sea Research* 45, 271-279 (2001). 2 Horwood J. W. The Bristol Channel sole (*Solea solea* (L)) - a fisheries case-study. *Advances in Marine Biology* 29, 215-367 (1993). 3 ICES. Report of the ICES Advisory Committee. ICES Advice, 2011. Books 1 - 11. 1685 pp. (2011).

Sprattus sprattus

(MS - Marine Seasonal migrant)

-  Sprat
-  Sprot
-  Sprott
-  Brisling

Occurrence in the Wadden Sea

Most abundant in relatively shallow (20-40m) coastal waters and a wide tolerance of salinity¹, strongly affected by hydrographic conditions, resulting in large variations in distribution (and abundance) among years. Sprat spawn at temperatures of 8–15°C in coastal waters from spring until late summer, with a peak between May and August. Known spawning areas closest to the Wadden Sea: inner German Bight, off Jutland, along English coast². Migrates inshore for migrations for overwintering, though older fish remain offshore. Present in Wadden Sea April-Oct^{3,4}. Most abundant pelagic fish in Wadden Sea⁴.

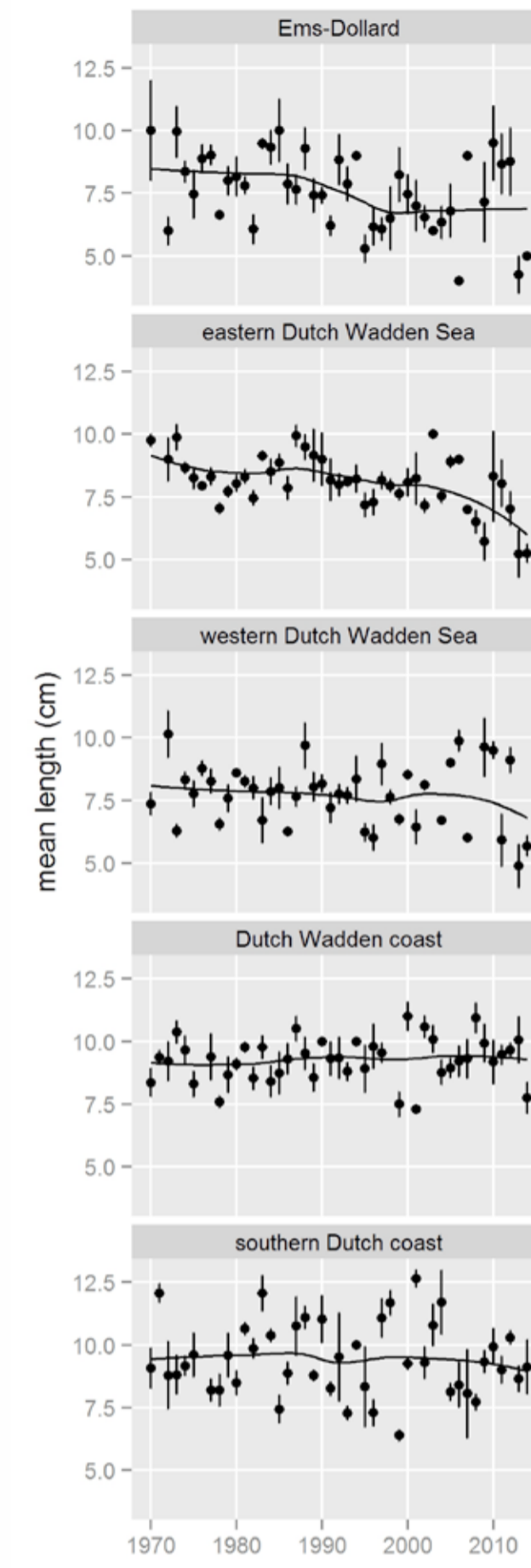
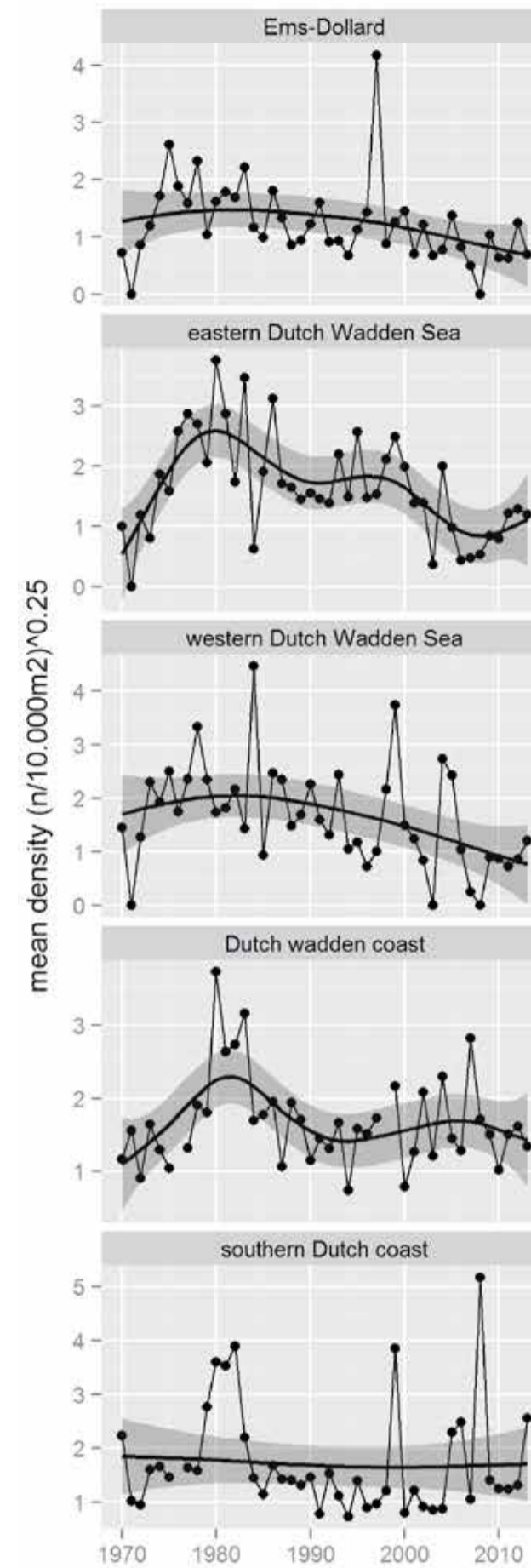
Commercial value in North Sea fisheries

Landed commercially from the North Sea, mainly used for fish meal. No commercial landings from Wadden Sea.

Policy objectives

Sprat is a typical species for H1110A; N2000 states that there should an improvement in both H1110A. Sprat falls under the EU TAC and quota regulations (plus by-catch regulation for herring affects sprat).

Pelagic roundfish, feed on zooplankton: cladocerans, Oikopleura, bivalve larvae, mysids, and euphausiids. Prey species for predatory fish, seabirds and marine mammals.



Trend

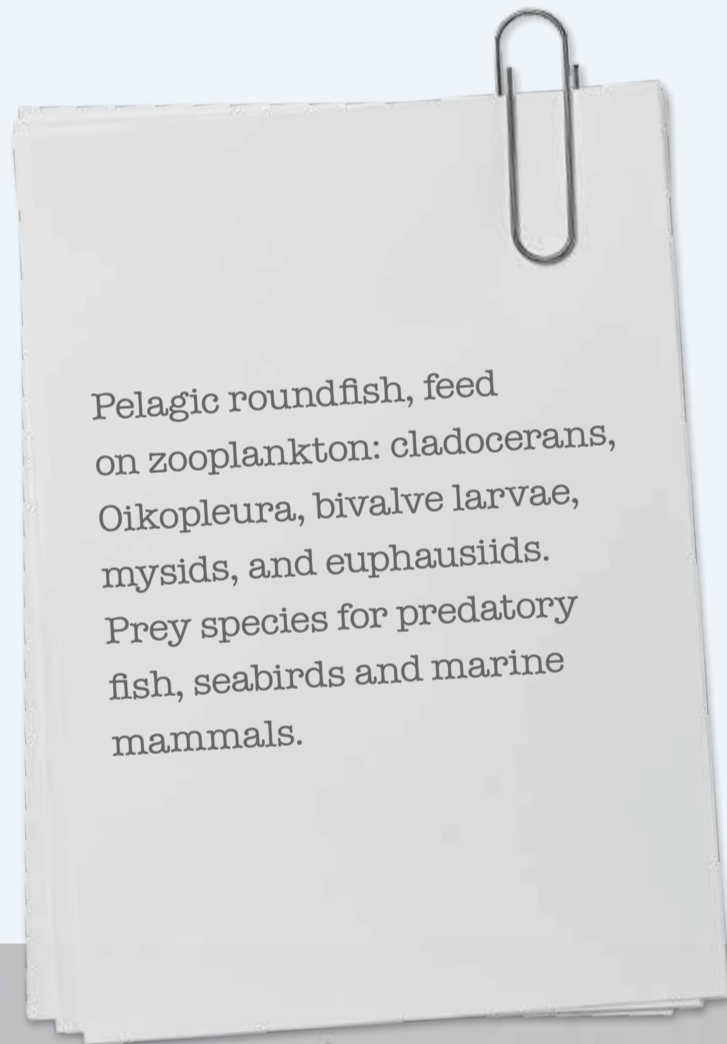
Declining.

Available information on drivers

Little known on drivers.

Knowledge gaps

Not well established in DFS, No pelagic monitoring in Dutch Wadden Sea. Spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences. Seasonal availability as food for birds.



1 Araujo, F. G. & Williams, W. P. Fish assemblages as indicators of water quality in the Middle Thames Estuary, England (1980-1989). Estuaries 23, 305-331 (2000). 2 Munk, P. et al. Spawning of North Sea fishes linked to hydrographic features. Fisheries Oceanography 18, 458-469, doi:10.1111/j.1365-2419.2009.00525.x (2009). 3 Tulp, I. et al. Habitat use of juvenile pelagic fish in a shallow estuarine area: the Wadden Sea (in prep). 4 Couperus, B. et al. Abundance and tidal behaviour of pelagic fish in the gateway to the Wadden Sea (MS subm.).

Allosa fallax

(CA - Catadrome)

 Twaité shad

 Fint

 Finte

 Brisling

Occurrence in the Wadden Sea

Juveniles migrate downstream to join the older fish in estuaries and coastal areas, and are occurring in the Wadden Sea from late summer to autumn and winter. Spawning in April/May in estuaries such as Ems-Dollard, Weser Elbe, Loire and Gironde¹. Generally only juveniles are found that presumably originate from spawning areas in Germany since the Ems estuary is assessed to be unsuitable for reproduction in its present state. Preferred depth 10-20m¹. Use area as a feeding area for juveniles and as passage to spawning areas.

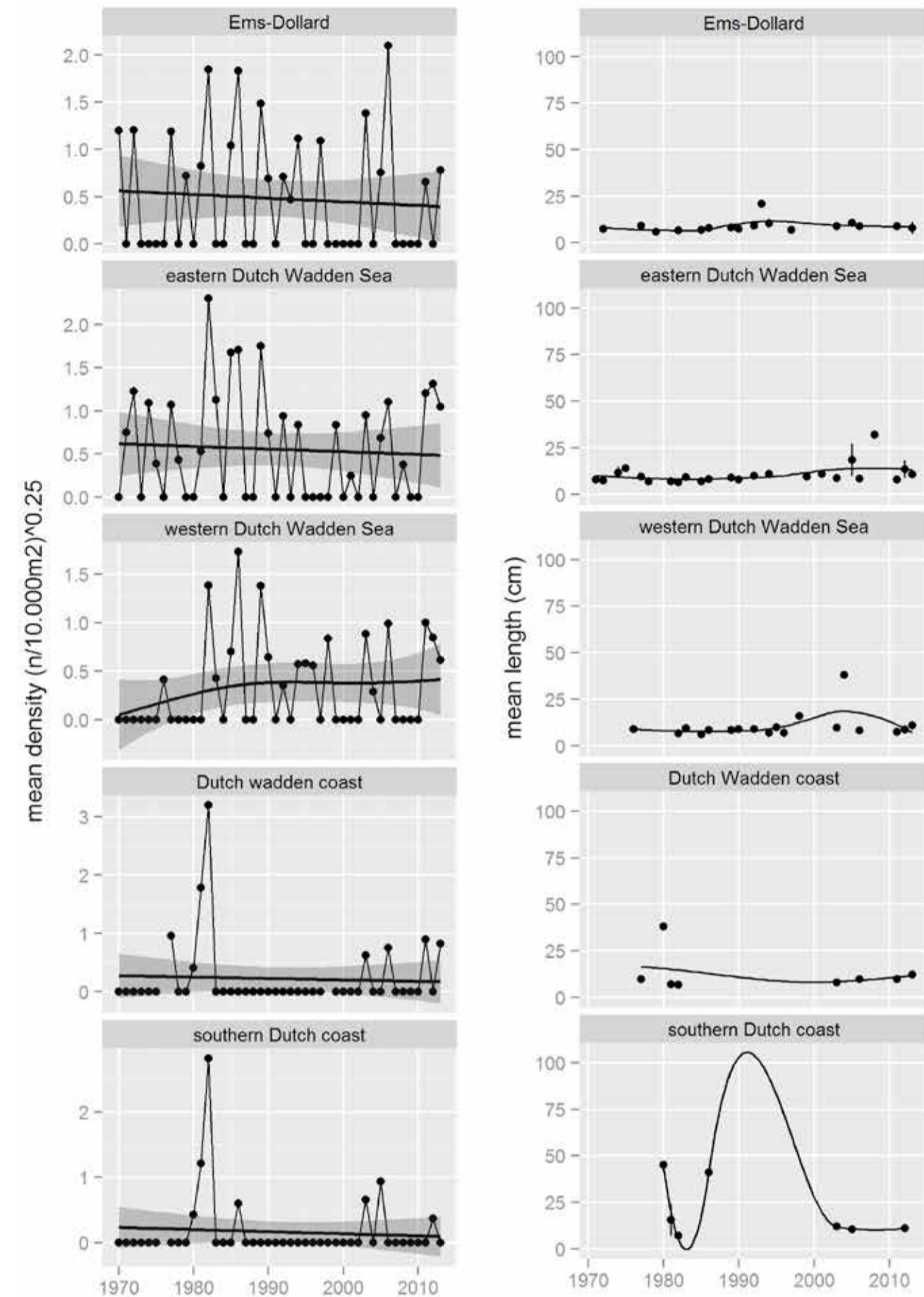
Commercial value in North Sea fisheries

None.

Policy objectives

Twaité shad is a Habitat Directives species has an objective to improve stocks under H1110A. WFD objective in Ems (abundance per age-group) and on Dutch, German and Trilateral Red Lists.

Pelagic roundfish anadromous, entering rivers and their tributaries for spawning (uses substrate that varies from sand to pebbles, at depths of 0.5-3.0 m, and with a current speed of 0.5-2.0 m/s)¹. Juveniles consume insect larvae in freshwater. In the marine environment, the diet is dominated by mysids and fish¹.



Trend

Declining.

Available information on drivers

Connectivity with fresh water and lack of feeding habitat for juveniles; estuarine water quality and the presence of suitable spawning habitat.

Knowledge gaps

Abundance is not well determined in DFS; pelagic monitoring is lacking. spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Arahamian, M. W. et al. Biology, status, and conservation of the anadromous Atlantic twaité shad *Allosa fallax fallax*. Am Fish Soc Symp 35, 103-124 (2003).

Merlangius merlangus

(MJ - Marine Juvenile)

 Whiting

 Wijting

 Wittling

 Hvilling

Occurrence in the Wadden Sea

Whiting enter the Wadden Sea in autumn, in pursuit of the shrimp as their main food item. It is found in high numbers throughout the North Sea, to the east in the Skagerrak/Kattegat and in the western part of the Baltic Sea, but also all along the shelf to the west of the British Isles. The depth distribution ranges from extremely shallow inshore waters (<10 m) to a maximum of 550 m, greatest numbers occur in the range 30–100 m. The Kattegat and the German Bight are hotspots for the juveniles. Older juveniles (0- and 1-group) are often abundant in coastal waters, including estuaries and Wadden Sea. Adults occur in deeper water, mainly over sandy and muddy substrates. Demersal juveniles (0-group) are found mainly in water <50 m deep, including estuaries. The locations where 0-group are concentrated vary on an annual basis and nursery areas do not seem to be fixed geographically. Whiting populations can fluctuate very much between years.

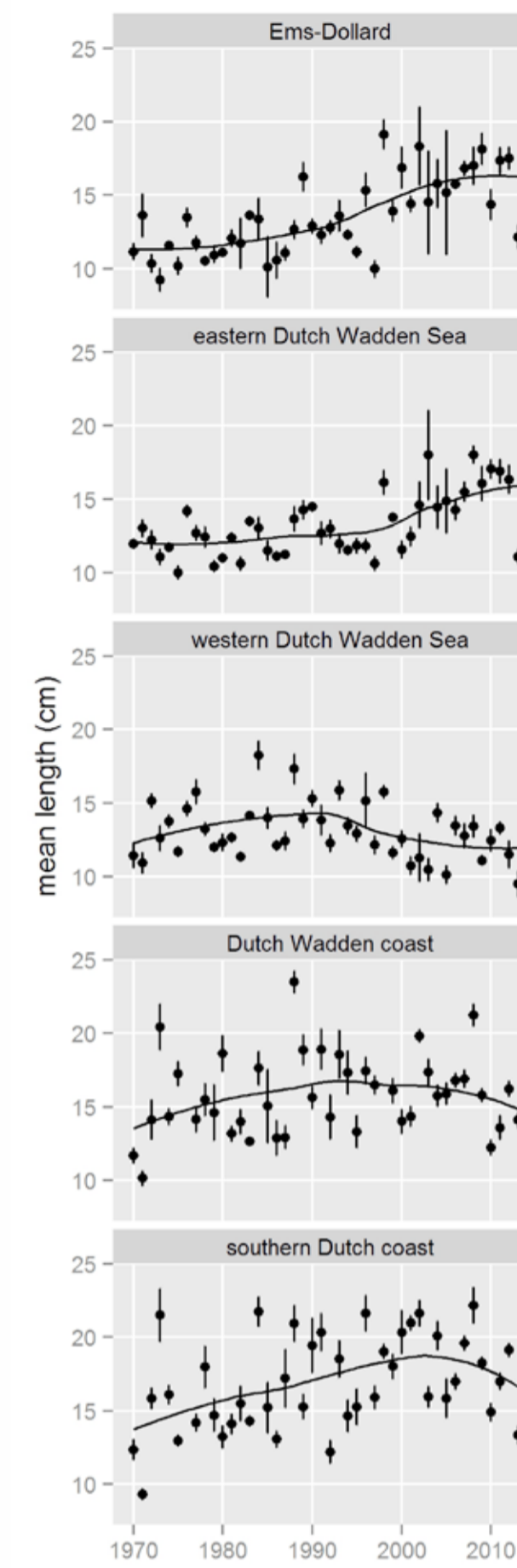
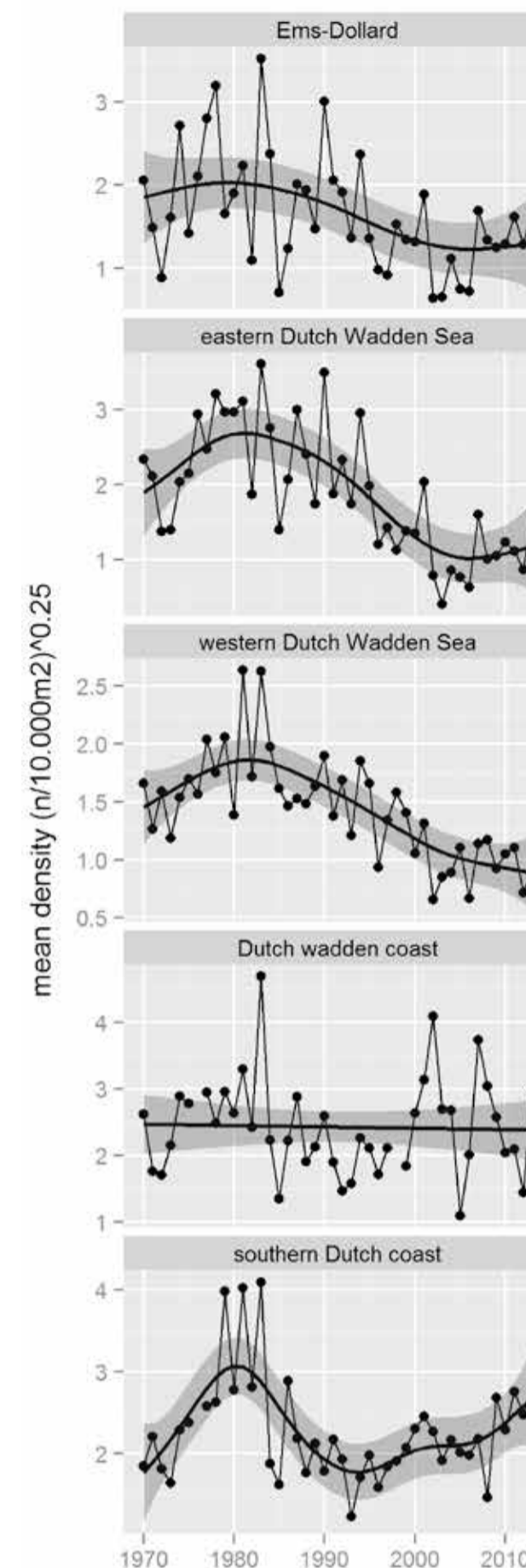
Commercial value in North Sea fisheries

Whiting are caught in mixed demersal roundfish or flatfish fisheries, Nephrops fisheries and as a bycatch in the industrial fisheries for sandeel and Norway pout. Most of the landed catch is for human consumption although undervalued, but substantial quantities, often larger than the landed catch¹, may be discarded at sea as whiting flesh is undervalued by most nations. Total catches (including discards) in the North Sea and eastern English Channel have decreased markedly during the last two decades – from about 50 thousand t per annum in the early 1990s to <20 thousand t since 2003.

Policy objectives

Whiting is a typical species for H1110A. Natura 2000 states an improvement in this habitat type. Whiting falls under the EU TAC and quota regulations. Whiting (abundance) is suggested as WFD-indicator for transitional waters, but it is not fully implemented yet.

Demersal roundfish.
Active predator, diet of adults includes shrimps, crabs, molluscs, small fish, polychaetes and cephalopods, proportion of fish in diet increases with size.



Trend

Decline.

Available information on drivers

See knowledge gaps.

Knowledge gaps

Recruitment, spatial and diurnal dynamics in distribution and in by-catch in shrimp fisheries, diet, role Wadden Sea in life cycle, habitat preferences.

¹ Daan, N. Report on discards of cod, haddock and whiting in the North Sea by the Dutch fleet 1958-1975. ICES Document CM 1976/F:8. (1976).

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Henk Heesen (IMARES); p.3, p.4, p.5, p.7, p.8, p.9, p.11, p.12, p.13, p.14, p.16, p.18, p.19, p.20, p.21

Oscar Bos (IMARES); p.6, p.10, p.15

Joep de Leeuw (IMARES); p.17

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- Jager, Z., L. Bolle, A. Dänhardt, B. Diederichs, T. Neudecker, J. Scholle, R. Vorberg. 2009. Quality Status Report 2009. Fish. Thematic Report No. 14. In: Marencic, H. & Vlas, J. de (Eds.), 2009. Quality Status Report 2009. Wadden Sea Ecosystem No. 25. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.
- Tulp, I., Bolle, L.J., Rijnsdorp, A.D. 2008. Signals from the shallows: In search of common patterns in long-term trends in Dutch estuarine and coastal fish. *J. Sea Res.* 60, 54-73.
- Tulp, I., Van der Veer, H.W., Bolle, L.J., Walker, P. 2015. Manuscript. Long-term fish trends in the dutch wadden sea and adjacent coastal areas (in prep.).



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