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# Fish abundance, fisheries, fish trade and consumption in sixteenth-century Netherlands as described by Adriaen Coenen

Floris P. Bennema <sup>a</sup>, Adriaan D. Rijnsdorp <sup>bc</sup>

<sup>a</sup> Vincent van Goghstraat 88, 8932 LK Leeuwarden, The Netherlands. [f.p.bennema@xs4all.nl](mailto:f.p.bennema@xs4all.nl)

<sup>b</sup> IMARES, Institute for Marine Resources and Ecosystem Studies, P.O. Box 68, 1970 AB IJmuiden, The Netherlands,

<sup>c</sup> Aquaculture and Fisheries Group, Wageningen University, P.O. Box 338, 6700 AH Wageningen, The Netherlands

## Abstract

Concern about fisheries impact on marine ecosystems has raised the interest in the reconstruction of the state of marine ecosystems and the nature of the human activities in the past. We present late 16<sup>th</sup> century information on the occurrence and relative abundance of biota in Dutch coastal and inland waters (50 marine fish, 13 diadromous or freshwater and 4 marine mammal species), as well as a description of the sea fisheries (target species, fishing grounds, gear), fish trade, export, and fish consumption in Holland as documented in the handwritten *Fish Book* by Adriaen Coenen (1577-1581). The species composition and abundances are compared to published trawl survey data from around 1900 and in the 1990's. Fish species that have disappeared almost completely, were already rare around 1900 and are characterised by a large body size (rays and sharks, sturgeon, ling), whereas currently abundant species were already abundant in the 16<sup>th</sup> century. Intensive fisheries for herring occurred near Orkney, Fairhill and Shetland. Coastal and freshwater fisheries provided fresh fish for local as well as export markets, but also provided bait for the massive offshore hook and line fishery for the production of salted cod, which remained largely unnoticed. Dried flatfish were exported to Germany. Consumption of fish and marine invertebrates differed between social classes. Coenen distinguished eight consumer categories, a refinement of the categories 'rich' and 'poor' used in archaeological studies.

## Keywords:

Environmental History, 16<sup>th</sup> century, North Sea, Marine mammals, Fishing methods, Fish trade

## 1. Introduction

There is worldwide concern about the adverse impact of fisheries on marine ecosystems in general and on exploited populations in particular (Jackson et al., 2001; Pauly et al., 1998). With the exception of some well-studied species such as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and plaice (*Pleuronectes platessa*) (see Eero, 2012; Pope and Macer, 1996; Rijnsdorp and Millner, 1996; Rose, 2004), the time series data on catch and effort needed to assess the level of exploitation

and trends in stock biomass are generally available for only a few decades (FAO, 2011). Since man has been fishing the seas for centuries (Barrett et al., 2004; Hoffman, 2005; Lotze, 2007; Fromentin and Powers, 2005), fish stocks and ecosystems may already have been heavily affected before systematic data collection started. Therefore, it seems worthwhile to investigate whether other sources of information could throw light on the historic developments in fisheries and in the state of fish stocks and marine ecosystems.

The North Sea has been exploited for centuries (Poulsen 2008; Engelhard 2008; Thurstan et al., 2013) and is now one of the most intensively exploited seas (ICES, 2012). Archaeological evidence showed a shift from inland to marine fishing in the 10<sup>th</sup> century AD (Barrett et al., 2004), although marine fish bones have been found in human settlements dating back to the stone age (Enghoff et al., 2007). In medieval times, extensive drift net fisheries developed for herring, hook and line fisheries targeted large predatory fish such as cod and ling in offshore waters, and bottom trawlers fished for a variety of demersal fish in shallow coastal waters (De Groot, 1984; Poulsen, 2008). The increasing demand in the growing urban centres in the 13<sup>th</sup> and 14<sup>th</sup> century led to the transport of fish over long distances while fishermen started to exploit distant waters (Barret et al., 2011). However, local fishermen also supplied fish to the growing towns (Ervynck et al, 2004). From the 17<sup>th</sup> century onwards, North Sea herring (Poulsen, 2008) and cod from Iceland and Newfoundland (Boelmans Kranenburg 1979b, Rose, 2007) started to dominate the market. During the 19<sup>th</sup> century, the fishery expanded in the wake of the industrial revolution, steam-powered vessels replacing sailing vessels (Engelhard, 2008; Smith, 1994). In the 20<sup>th</sup> century, fishing pressure further increased as a result of a large array of technological innovations that increased fishing power of individual vessels (Fock, 2014; Lescauwaet et al., 2010; Kerby et al., 2012; Rijnsdorp et al., 2008).

In trying to put recent developments in fish stocks and ecosystems in a historic perspective, scientists from different disciplines have joined efforts to reconstruct the composition of marine communities before intensive fisheries took their toll using a variety of data sources: such as in the project on the History of Marine Animal Populations (Holm, 2002; Ojaveer and MacKenzie, 2007), data sources used comprise of fish remains in archaeological excavations (Barrett et al., 2011; Enghoff et al., 2007; Lotze, 2007; Mossand Cannon, 2011; Tys and Pieters, 2009; Van Neer et al., 2002; Rose, 2007), analysis of historic archives (Engelhard, 2008; Poulsen, 2008; Rose, 2007), analysis of historic photographs (McClenachan, 2009); and a combination of data analysis and modelling (Rose, 2004).

Another source of information is provided by historic books, such as the 'Visboeck' by Adriaen Coenen (Coenensz van Schilperoort, 1577-1581). Adriaen Coenen (1514-1587) was the son of a fisherman from the fishing village of Scheveningen on the coast of Holland, and a self-made naturalist. During his life, in which he worked as fish auctioneer, official beachcomber, and as fish trader, he acquired detailed knowledge about fish species and fishing. In addition to his practical knowledge, he gained access to contemporary literature through acquaintances in the upper class (Egmond, 2005). Combining his own observations with information from local fishermen and fragments from literary sources, he produced three books, two on fish and one on whales. These books comprise essentially

of watercolour images with embedded texts on many aspects of both natural history of the species and their fisheries, as well as text fragments from publications of the ichthyologists Pierre Belon (1555) and Conrad Gessner (1563), the Swedish ecclesiastic Olaus Magnus (1555) and medieval bestiaries. Extensive information on Coenen's life and his books is given by Egmond et al. (2003) and Egmond (2005). Of the two *Fish Books*, the one he offered to William of Orange (Prince of Holland) is considered to be lost. The more than 800-page second Fish Book (1577-1581) is the focus of this paper. The *Whale Book* (1584-1585) is merely an extract from the second Fish Book. In 1585 or 1586, Coenen started with the *King of Herring Book* but this manuscript remained unfinished

The objective of this paper is to disclose the information on the fisheries and the state of the North Sea ecosystem in the second half of the 16<sup>th</sup> century provided by the second Fish Book. As the handwritten text in 'old Dutch' is hard to read even for Dutch scientists, we summarize the content in semi-quantitative terms and discuss the information against the current scientific knowledge about the North Sea fish community and the changes in fishing practices, thereby complementing archaeological studies (Pieters et al., 2013) and analysis of historical archives (Poulsen, 2008). The book describes 56 marine and 22 diadromous or freshwater fish species. In addition, information is given on cetaceans, seals and several invertebrates as well as on fishing areas, boats and gears, fish trade, markets and fish consumption. Although Coenen enthusiastically tried to describe the abundance of different species, it is not possible to translate his qualitative data into absolute figures. However, we can compare his broad abundance classes by species with the relative abundance recorded in excavations of fish bones and with trawl survey data to infer changes in species composition since the 16<sup>th</sup> century. From our viewpoint, the most valuable content lies in Coenen's own observations rather than in the parts he copied from other sources.

## **2. Methods and source check**

The only copy of the Fish Book is kept in the Koninklijke Bibliotheek (Dutch National Library) in Utrecht, but has been made accessible on the Internet in the form of high resolution images at [http://www.kb.nl/bladerboek/visboek/browse/index\\_1.html](http://www.kb.nl/bladerboek/visboek/browse/index_1.html) (accessed 6-8-2014). Coenen's own accounts cover folios 23 to 217 (as numerated by the library).

All species descriptions have been checked for 17 aspects concerning names, abundance, fishery, trade and consumption. These species-specific data have been summarized in three tables that were made available online (the hyperlink is provided in the on line supplementary material section). Data of more or less anecdotal nature are presented whenever considered relevant.

Species identification in the Fish Book was based on names, morphological and ecological data, and sizes, and facilitated by the figures or texts from Belon (1555) and Gessner (1563) added to the descriptions. In other cases, old names as available in the online 'Woordenboek der Nederlandsche taal' helped to determine the species. However, not all fish could be identified to the species level.

With regard to weevers (*Trachinus draco*, *Echiichthys vipera*), we assume that Coenen referred to the larger species (*T. draco*), which is a highly appreciated food fish and is commercially exploited.

The identifications were checked against Richter (2006). In several cases, our interpretation is different (e.g. *Pollachius virens*, koolvis in modern Dutch, for *koel*, and *Brosme brosme*, lom for *lommeken*), and missing species were added (see online table about fish). The *kooninck van de harinck* (King of herring) was interpreted as red mullet (*Mullus surmuletus*), in agreement with 10 out of 15 Dutch sources from 1567 till 1900 (Bennema, 2010).

The types of fishing gear and fishing boats were checked against Haalmeijer and Vuik (2007).

The Fish Book presents a lively mixture of early scientific knowledge, medieval fantasies and observations by fishermen and by Coenen himself. Although his citations of unreliable medieval sources could cast doubt on his trustworthiness, there are several arguments to consider his own text as a reliable primary source:

- When his texts on herring and gadid fisheries before 1581 are compared with later studies (after 1600; e.g. Boelmans Kranenburg, 1979a; Poulson, (2008), no dissimilarities are observed, except that Coenen provided additional information.
- Coenen was esteemed as an expert on marine species, who discussed marine life with several aristocrats, including William of Orange (Prince of Holland) and the vice-counsellor of the Leiden University.
- The texts about target species, bait and by-catch contain redundant information, but no inconsistencies were found, which would likely occur if texts were imprecise.
- Coenen was conscientious about naming his sources or referring to own observations.

In order to maintain a critical distance Coenen's findings were checked against recent literature as much as possible throughout the discussion section.

### **3. Coenen's account**

#### **3.1 Fish**

Although Coenen may not provide quantitative data according to our current perception, his descriptions give an impression of the wealth of animal life in the sea, rivers and ponds. On the whole, he was positive about the amount of fish present. Offshore herring (*Clupea harengus*) was the 'golden mountain of Holland' and dried plaice (*Pleuronectes platessa*) brought 'an innumerable amount of money to our country'. Speaking of other commercial fish like cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), salmon (*Salmo salar*) and allis shad (*Alosa alosa*), he repeatedly emphasized the great abundance of these species. Also, the abundance of tasty fish in rivers and ponds repeatedly motivated him to thank God for 'such a wealth'.

Coenen gave indications about the abundance of 50 marine fish species along the Dutch coast. Fishermen from his village caught fish and shrimps with various kinds of nets as well as long lines at different distances from the shore (Figure 3). The combination of all these fishing techniques should give a good impression of the abundance of most species. Coenen generally started his description of a species with stating whether it was known to local fishermen, and continued with remarks about their abundance. These remarks were used to make a distinction between four categories: absent, very rare (less than once in a year), rare (few per year), (rather) common and plentiful species (Table 1).

**Table 1.** Fish species in the Fish Book and their abundance. Interpretation (a. absent; vr. very rare (<1 a year); r. rare (< 10 a year); c. (rather) common; p. plentiful) added for comparison. For marine species in 20<sup>th</sup> century abundance categories based on standardized mean catch rate (number per hour fishing) of trawl survey data (OT20, and mean of GOV and BT8) along Dutch coast (IBTS standard roundfish area 6) copied from Rijnsdorp et al. (1996), +: <=0.05; 1: 0<1; 2: <10; 3: < 100; 4: <1000.

Marine fish		“known to fishers of Scheveningen”	Abundance along Dutch coast (Zijde)	Interpretation	1906- 1909	1990- 1995
<i>Scyliorhinus canicula</i>	Small-spotted catshark	well known	often caught	c.	0	1
<i>Scyliorhinus stellaris</i>	Nursehound				0	0
<i>Galeorhinus galeus</i>	Tope shark	well known	very seldom, sometimes one in 5, 6 or 8 years	vr.	0	+
<i>Sphyrna zygaena</i>	Smooth hammerhead		seems to be caught with tope shark	vr.	0	0
<i>Mustelus sp.</i>	Smooth hounds	well known	often caught in nets and on hook	c.	+	+
<i>Squalus acanthias</i>	Spiny dogfish		not close to the coast but in deeper water	c.	3	+
<i>Squatina squatina</i>	Angelshark	well known	5-6 in a year	r.	0	0
<i>Torpedo marmorata</i>	Marbled electric ray		unknown	a.	0	0
<i>Torpedo nobiliana</i>	Electric ray	not well known	only 1 caught during my lifetime	vr.	0	0
<i>Dipturus batis</i>	Skate	well known	often caught along the coast	c.	0	0
<i>Raja clavata</i>	Thornback ray	very well known	brought to market now that everything is expensive	c.	2	1
<i>Raja brachyura</i>	Blonde ray	very well known	One or two among common rays	c.	0	0
<i>Raja montagui</i>	Spotted ray				0	+
<i>Leucoraja naevus?</i>	Cuckoo ray				0	0

<i>Dasyatis pastinaca</i>	Common stingray	well known	brought to market now that everything is expensive	c.	0	0
<i>Conger conger</i>	Conger	well known	rare	r.	0	0
<i>Clupea harengus</i>	Herring		caught in autumn (slabherring) in C's youth		2	4
<i>Sprattus sprattus</i>	European sprat		large numbers	p.	3	4
<i>Sardina pilchardus</i>	Pilchard		they migrate along the shore just before slabherring	c.	0	1
<i>Lampris guttatus</i>	Opah		caught once in 1562	vr.	0	0
<i>Gadus morhua</i>	Cod	well known	plentiful	p.	2	3
<i>Merlangius merlangus</i>	Whiting	well known	big amounts	p.	4	4
<i>Melanogrammus aeglefinus</i>	Haddock	very well known	plentiful	p.	2	1
<i>Pollachius pollachius</i>	Pollack	well known	sometimes one among 1000 cods or one along several 1000s of whiting	c.	0	0
<i>Pollachius virens</i>	Saithe	well known	along 1000 cods sometimes one	c.	0	+
<i>Trisopterus luscus</i>	Pouting	well known	along 1000 whiting one	c.	2	2
<i>Molva molva</i>	Ling	very well known	sometimes one along several 100s of cod; sometimes 7 or 8 further offshore	c.	+	+
<i>Brosme brosme</i>	Tusk	well known	never caught along the coast	a.	0	0
<i>Lophius piscatorius</i>	Angler		rare, some years positive, some years not	vr.	0	1
<i>Chelon labrosus</i>	Thicklip grey mullet	well known	sometimes one in half a year	r.	0	+
<i>Belone belone</i>	Garfish	well known	one every 6 or 7 years	vr.	0	+
<i>Zeus faber</i>	John dory	well known	rarely caught, only 1 or 2 times a year	r.	+	0
<i>Syngnathus acus</i>	Greater pipefish				0	+

<i>Callionymus lyra</i>	Dragonet				2	3
<i>Chelidonichthys lucerna</i>	Tub gurnard	well known	changes in Coenen's life: In his youth up to 1600 in one trip, then a dip and now better again.	c.	3	2
<i>Myoxocephalus scorpius</i>	Bull rout		caught with shrimps	c.	1	2
<i>Cyclopterus lumpus</i>	Lumpfish	well known	rare, less than 10 a year	r.	0	+
<i>Dicentrarchus labrax</i> (+ <i>Argyrosoma regius</i> ?)	Sea bass (and Meagre)	well known	caught sometimes	c.	0	+
<i>Trachurus trachurus</i>	Atlantic horse mackerel		(Scotland)		2	4
<i>Pagellus sp.</i>	Red / Axillary seabream	very well known	very few caught, some fish 1-3 in May	r.	0	0
<i>Mullus surmuletus</i>	Red mullet		(England, Scotland)		0	2
<i>Zoarces viviparus</i>	Viviparous blenny				0	1
<i>Anarhichas lupus</i>	Wolffish	very well known	sometimes one	r.	0	+
<i>Hyperoplus lanceolatus</i>	Greater sandeel		sometimes caught with shrimps	c.	2	2
<i>Trachinus draco</i>	Greater weever	well known	plentiful	p.	4	0
<i>Scomber scombrus</i>	Mackerel		5 or 6 in plaice nets in early summer	r.	1	2
<i>Thunnus thynnus</i>	Bluefin tuna	unknown	Coenen saw 3 in his lifetime	vr.	0	0
<i>Xiphias gladius</i>	Swordfish		Coenen saw 2 in his lifetime	vr.	0	0
<i>Scophthalmus maximus</i>	Turbot	well known	caught by net with plaice in May and on the hooks	c.	2	2
<i>Scophthalmus rhombus</i>	Brill	well known	in summer up to 40-50 in one shipping trip for plaice	c.	+	1
<i>Pleuronectes platessa</i>	Plaice	well known	plentiful	p.	4	4
<i>Limanda limanda</i>	Dab		by catch with plaice and on hooks	c.	4	4
<i>Platichthys flesus</i>	Flounder	very well known	plentiful	p.	0	2

<i>Microstomus kitt</i>	Lemon sole	well known	along 100.000 dabs sometimes one	r.	1	2
<i>Hippoglossus hippoglossus</i>	Halibut	well known	cod fishers catch about 1 or 2	c.	0	0
<i>Solea solea</i>	Sole	well known	fished for in sole nets	c.	2	3
<i>Mola mola</i>	Ocean sunfish	unknown	Coenen saw two in his life	vr.	0	0
<b>Diadromous and fresh water species</b>		<b>“known to fishers of Scheveningen”</b>	<b>Abundance inland/ (at sea)</b>	<b>Interpretation</b>	<b>1906- 1909</b>	<b>1990- 1995</b>
<i>Petromyzon marinus</i>	Sea lamprey	Well known	Sometimes on a cod	r. at sea	0	+
<i>Lampetra fluviatilis</i>	Lampern		plentiful in Maas (Zuid Holland) and Gelderland	p. in rivers		
<i>Acipenser sturio</i>	Sturgeon	well known	Often caught in the North Sea)	c. at sea	0	0
<i>Alosa alosa</i>	Allis shad		Many in Maas river (Dordrecht) and IJssel river (Vollenhove)	p. in rivers		
<i>Alosa falax</i>	Twaite shad					
<i>Osmerus eperlanus</i>	European smelt		plentiful in rivers and ponds	p. in rivers/fresh w.		
<i>Coregonus oxyrinchus</i>	Houting		big amounts in late summer in Maas river between Dordrecht and Geertruidenberg	p. in rivers		
<i>Salmo salar</i>	Salmon		Number changed strongly at sea) Plentiful inland in Maas and IJssel river	c. at sea  p. in rivers	0	+
<i>Gasterosteus aculeatus</i>	Three spined stickleback					
<i>Esox lucius</i>	Pike					
<i>Rutilus rutilus / Scardinius erythrothalmus</i>	Common roach / rudd		plentiful	p. in fresh w.		
<i>Leuciscus idus</i>	Ide					
<i>Tinca tinca</i>	Tench		many	c. in fresh w.		
<i>Gobio gobio?</i>	Gudgeon					

<i>Barbus barbus</i>	Common barbel		
<i>Alburnus alburnus</i>	Common bleak		
<i>Blicca bjoerkna</i>	Silver bream		
<i>Abramis brama</i>	Common bream	in all waters of Holland	c. in fresh w.
<i>Cyprinus carpio</i>	Common carp	most important fish of fresh water	
<i>Siluris glanis</i>	Wels catfish	seldom caught	vr. in fresh w.
<i>Anguilla anguilla</i>	European eel	plentiful	p. in fresh w.
<i>Perca fluviatilis</i>	European perch		
<i>Gymnocephalus cernuus</i>	Ruffe		

Species considered to be plentiful were the commercially exploited species such as herring, cod, haddock, whiting (*Merlangius merlangus*), plaice, flounder (*Platichthys flesus*), dab (*Limanda limanda*) and weever. Among the common species, we find species such as European sardine (*Sardina pilchardus*), tub gurnard (*Chelidonichthys lucerna*), ling (*Molva molva*), turbot (*Scophthalmus maximus*), brill (*Scophthalmus rhombus*) as well as several species of sharks and rays which are regularly caught as by-catch in the fishery for herring, roundfish or flatfish. The species considered common or plentiful are known to occur in (but not necessarily restricted to) shallow waters, except ling. Species to be considered (very) rare comprise of species that mainly occur in offshore waters or are strayers from other areas.

The Fish Book also contains information on fish from brackish and fresh waters (Table 1). Many of these were abundant in rivers and ponds so that fresh water fishery was a source of living. Species that he noted as plentiful were: lampern (*Lampetra fluviatilis*), houting (*Coregonus oxyrinchus*), smelt (*Osmerus eperlanus*), roach/rudd (*Rutilus rutilus/Scardinius erythrophthalmus*), tench (*Tinca tinca*), bream (*Abramis brama*) and European eel (*Anguilla anguilla*).

Indications of overfishing, such as the existence of fishing regulations or large variations in catches, can only be found in Coenen's description of salmon. Salmon were fished intensively on the rivers Maas and IJssel, and to a lesser extent along the shore. 'Innumerable amounts' were caught in driftnets and hoop-nets exploited at the river mouth (after the fish had been concentrated by wooden weirs), near Maaslandse Sluis. But *zalmkuilen* (very narrow nets) were forbidden. Although not linking abundance to human activities, he describes a large fluctuation in numbers of salmon over several decades. When his parents were young, salmon were so rare that they had the same value as a sturgeon (*Acipenser sturio*). In his own youth, they were cheap, 1/4 *stuiver* (nickel) a pound, and in 1578 the price had increased again to 2 to 4 *stuiver* a pound.

### 3.2 Marine mammals

Coenen's description of vast numbers of migrating *potswallen* (sperm whales, *Physeter macrocephalus*) along the shore is almost unimaginable in our time. Once or twice a year, sperm whales migrated from north to south along the Dutch coast. Viewed from his native village Scheveningen, the sea could be full of whales for two or three hours, as far the eye could reach. To convince the reader, Coenen added that William of Orange, Prince of Holland, and Cornelis Suys, President of the court of Holland, once observed the migration near Petten (another coastal village). The Fish Book describes three strandings of sperm whales, including one where a group ran into trouble near the shore, resulting in the death of three individuals.



**Figure 1.** Sperm whales (*Physeter macrocephalus*) migrating south along the Dutch shore.

Harbour porpoises (*Phocoena phocoena*) were abundant as well. To the north of Scheveningen, they were caught in porpoise nets that were also used to catch cod. Common bottlenose dolphins (*Tursiops truncatus*) were unknown to the fishermen of Scheveningen but those fishing for herring in the North Sea saw them taking herrings out of their nets. Harbour seals (*Phoca vitulina*) seals were caught at the northern stretch of the coast of Holland, near Petten, and at the isles of Texel and Vlieland.

### 3.3 Fisheries

Fisheries off the Dutch coast targeted mainly on herring, gadids and flatfish. Local fishermen along the sandy coast used flat-bottom boats to fish for flatfish and gadids. Larger boats left from deeper water in the Maas and Scheldt estuary either to fish for herring or for gadids in fishing areas further north, especially near Shetland. Other large fisheries described were those of salmon in the rivers and of herrings in the Zuiderzee, a large inland sea that has been closed off in the 1930s. More specialised fisheries were the catch of bait species to be used in gadid fisheries, and the catch of salmon and shrimps at sea. All these fisheries implemented specialised fishing gear, for example various kinds of hemp nets, hook and line or baskets (Table 2).

**Table 2.** Fishing gear, vessel type and their main target species and fishing grounds of Dutch fisheries in the late 16th century as described by Coenen. (\* = Coenen does not mention the name pink but other contemporary sources do, e.g. Anonymous, 1514).

Fishing gear	Vessel	Target species	Fishing area
<b>Drift net</b>	buys, boat	herring	North Sea, specially North Scotland, also Norway
<b>? net</b>	pink (slabbeschip), schuitje	herring	coastal waters off Holland (during Coenen's youth)
<b>Plaice net</b>	pink*	plaice	coastal waters off Holland
<b>Flounder net</b>	flounder ship		coastal waters of Zeeland
<b>Sole or narrow net</b>	pink*	sole	coastal waters off Holland
<b>Salmon net (new &amp; strong)</b>	pink*	salmon	coastal waters off Holland
<b>Cod net</b>	pink*	cod, haddock, whiting	coastal waters of Holland
<b>Porpoise net</b>		harbour porpoise	coastal wars of Holland
<b>Hook and line,</b>	dogger	cod, haddock	northern North Sea
<b>Hook and line, pole and line</b>	pink*	cod, haddock, whiting	coastal waters of Holland
<b>Beach seine (5-6 men)</b>	-	pilchard	coastal waters of Holland
<b>Drag net (2 men)</b>		garfish (bait fish)	Marsdiep
	-	sole, flounder, twaithe shad, salmon, thick lipped grey mullet, mackerel	coastal waters of Holland (by laymen)
<b>Baskets</b>	-	lampern (baitfish)	upriver
<b>Drift net &amp; hoop net &amp; weir &amp; seine</b>	-	salmon	mouths of major rivers
<b>Grass shrimp net &amp; drag net</b>	-	Common shrimp	coastal waters of Holland

The Dutch herring fishery using 1.4 km long driftnets has been well studied and quantified (Poulson, 2008). Although Coenen does not provide much new data, his account is nonetheless valuable because he describes the less-known period before 1600. He recalled that in his youth fisherman from the coast of Holland fished for *slabharing* in autumn. They used small boats that could be drawn onto the beach (*pinken*) and brought their 6 to 9 lasts (9 to 12 t.) of herring directly to the local market. *Panharing* (that was smoked) was caught in the Zuyderzee from the start of the winter (especially before Christmas) till the second half of March. Slabharing and panharing were hard to conserve and sold fresh or dried, the name of the latter is thought to refer to a frying pan.



**Figure 2.** Herring fishery in the northern North Sea between the Orkney – Shetland islands and Norway.

Large amounts of herring were caught by French, Flemish, English and Dutch fishermen in the Channel and along the coasts of England, Scotland and Norway. Dutch fishermen fished off Scotland (Orkney, Fairhill and Shetland) using two types of boats, the smaller *boeten* that could contain 12 to 16 lasts (20 to 27 t fresh weight, Poulson, 2008) and *buysen* that could contain 20 to 36 lasts (34 to 61 t fresh weight). The season started at Pentecost, some left just before 24 June (St John's Day) and lasted till All Saints' Day on 1 November or St Catherine's Day on 25 November. In this period, they would make 3 to 4 trips in some years and 2 to 3 in others.

Coenen describes that 'before the great French war' (in the 1540's), 200 *buysen* left from ports along the Maas river (Rotterdam, Delfshaven and Schiedam) not only engaging traditional fishermen but also farmers from the northeast of Holland were engaged on these ships. However, when Coenen wrote his book, most farmers sailed on boats that landed their herrings in Enkhuizen on the Zuiderzee. At the same time an 'innumerable' amount of boats left from the fishing villages in the southern province of Zeeland.

Plaice and flounder were caught close to the coast, fishing depth being down to at least two fathoms (3.65m). Although Coenen does not specify the boats used, other sources mention that flatfish were fished by the flat-bottomed *pinken* and the smaller *schuitjes*, that could carry only for 2 or 3 men (Anonymous, 1514). Common nets for these fisheries were presumably drag nets.



**Figure 3.** Plaice fishery by trawl nets off the coast of Holland and hook-and-line fishery further offshore.



**Figure 4.** Flounder fishery off the coast of Zeeland.

Fishermen from villages at the sandy coast north of the Maas estuary were referred to as *plaiice*, those to the south as flounder fishermen. Dab, turbot, brill, sole and an occasional lemon sole were essentially a by-catch. When the highly praised sole (*Solea solea*) were abundant, special 'sole' or 'narrow' nets (with smaller meshes) were used. Plaice arrived in shallow waters in April, when they sometimes aggregated in big masses (*leks*) close to the coast. Fishermen hoped that these 'leks' would form in the vicinity of their village. They told Coenen that, although also attracted many boats from other places, it could take 2 to 3 months to deplete them.

Gadids (cod, haddock and whiting) were targeted along the shore by hook and line and by nets employed from the same boats used in the flatfish fishery, but slightly further offshore (Figure 3), while *doggers* used their hook and line as far away as Shetland. The catches taken along the Dutch coast were sold fresh at Dutch and Flemish markets. The offshore (*dogger*) fishery was conducted by an 'amazing amount of big boats' that departed from Holland and Zeeland to fish near Shetland, Fairhill and Orkney, where these species could be found in excess. The men as well as the boats who undertook these four to five-week voyages were called *doggers* or *korvers*. The lines were baited with lampern, allis shad and garfish (*Belone belone*). They came back with casks filled with salted gadids, although the main goal was *aberdaen* (other sources speak of *labberdaan*): salted true cod.

In Scotland, they met with little competition from the local fishermen who, the Dutch fishermen told, fished for *koel* (saithe, *Pollachius virens*) in small boats 'that were constructed by joining two planks'. This observation matches the local line fishery targeting gadids in the Middle Ages as described by Barret et al. (1999). The description of the boats is probably a misinterpretation of the construction of the Ness yoles, which were built from the broad timbers from Norwegian forests, which permitted the use of a small number of planks (Fenton, 1978).

*Doggers* from Zeeland also went to Helgoland to catch cod, but were apparently less specialized, because they also came back with lobster (*Homarus gammarus*) as part of their catch. The lobsters were sold alive in The Hague and Delft.

### 3.4 Annual cycle in fishing habits along the coast of Holland (de Zijde)

Coenen's home-village Scheveningen is exemplary for the fishing villages along the sandy coast of Holland (*de Zijde*), where fishers managed to secure a year-round income by fishing with hook and line or nets for either cods and for flatfish (Table 3). In early winter, they fished for cod, haddock and whiting (cod: October – Easter), while in February (at Candlemas) many skippers took their *plaice nets* aboard to fish for plaice till June. From June (Pentecost till St John's Day) till November (All Saints' Day), the 'hardy men' enrolled on boats to fish for herring in Scotland, although the 'old and easy going' stayed and fished for sole and weever.

A small group of fishermen fished for salmon along the coast all year round. This required new and strong hemp nets, because the regular hemp nets used for plaice could not withstand the resistance offered by salmon. Only well-to-do fishermen could afford these special nets.

**Table 3.** Annual cycle in the fisheries employed along the sandy coast of Holland (de Zijde).

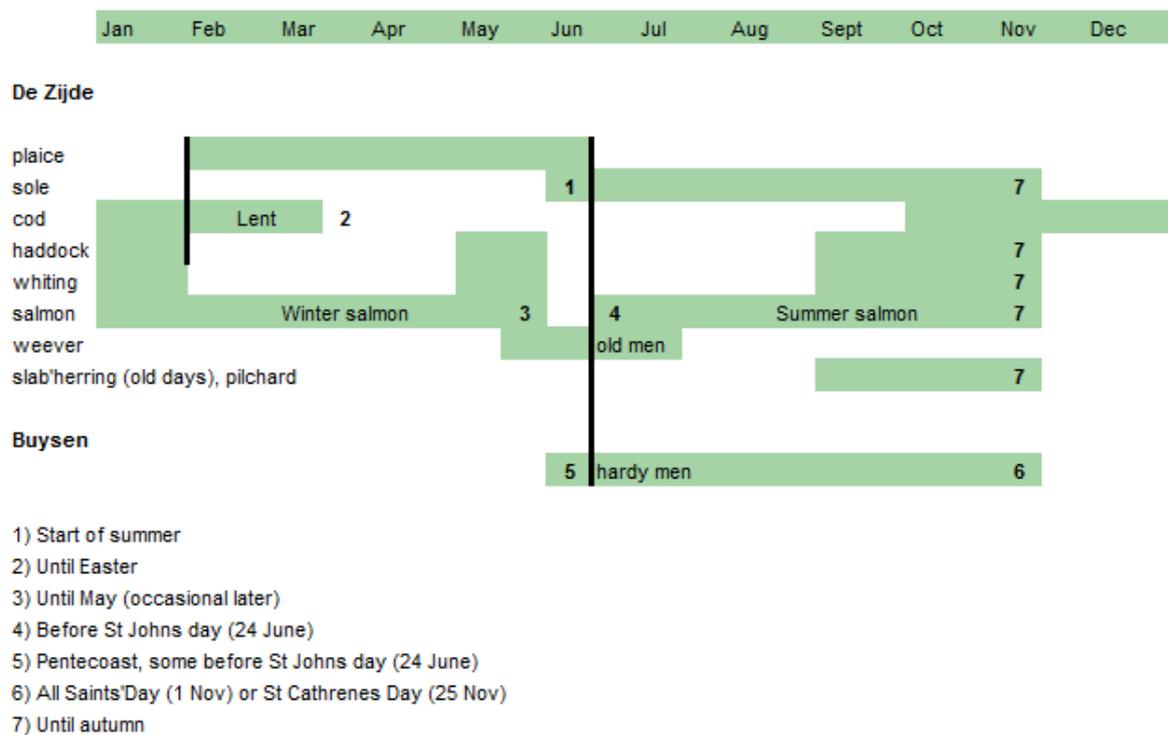
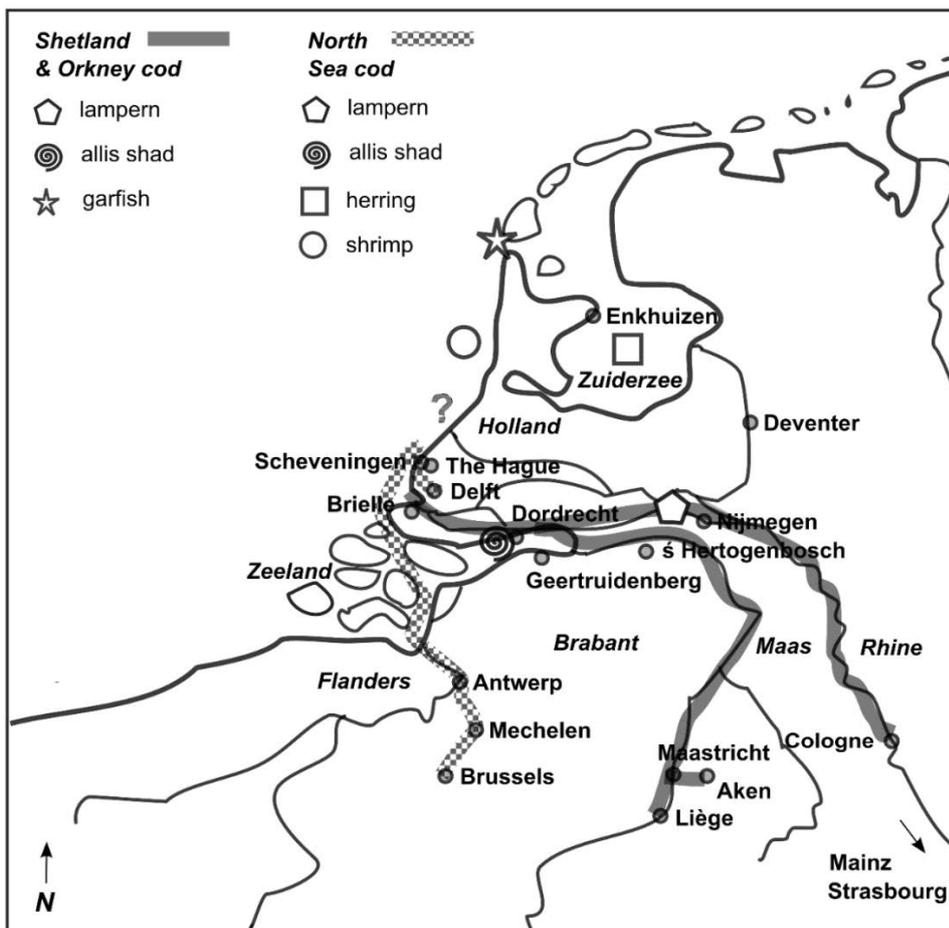




Figure 5. Fishing common shrimps using a drag net (beach seine) and grass shrimp nets (push nets).

### 3.5 Gadid bait trade

The intensive fishery for cod and haddock by Dutch fishermen demanded a large amount of bait. A reordering of the information in the Fish Book reveals a true 'bait economy'.



**Figure 6.** Cod economy around 1570 according to Coenen. Trade routes of salted cod from Scotland and fresh cod from the southern North Sea and catch areas of bait species. Whether fishing villages further north on the coast exported fresh cods is unknown.

*Doggers* leaving for Scotland to catch cod took along three species of fish as bait. The order in which these were employed was first lampern, then salted allis shad, and lastly salted garfish. No information is given whether the lampern were alive, but during later periods they surely were transported alive in special containers (Kranenburg, 1946). Traders from Brielle bought lamperns upriver in the province of Gelre (Gelderland) to sell them as bait. Allis shad were caught in the estuary of the Maas river near Dordrecht and Geertruidenberg. Garfish were caught in seine nets in the Marsdiep (the channel between Holland and the isle of Texel). They were salted and put in casks to be sold specially as bait for cod fishing.

Allis shad and lampern were also used to fish for cod along the coast, but three more bait species were used in this fishery: herring, *voorn* (roch/rudd) and shrimp (*Crangon crangon*). The herring (*panharing*) caught in the Zuiderzee during winter was used by coastal fishers during Lent. Shrimps were caught nearby, along the shore. Cod caught using shrimps as bait was believed to be tastier and paid for by the 'rich and wealthy', while cod caught with allis shad was considered second best.

Like cod, haddock were caught off the coast using lampern and shrimp. However, Coenen also mentions *pekelharing*, European sprat and livers of cows and sheep (both fresh and salted). *Pekelharing* refers to salted herring caught in Scotland. Sprat was taken as a by-catch in the salmon fishery in the Maas river.

### 3.6 Fish trade

While the herring trade is well documented in the scientific literature, the trade of other species has received much less attention. As a trader, Coenen was in a good position to provide inside information on this less regulated trade. As fish played an important role in the 16<sup>th</sup>-century economy (De Vries and van der Woude, 1995), it is interesting to look at trade routes and the development of the market.

In Scheveningen, fish was sold to traders through an auctioneer or writer, professions actually practiced by Coenen at some time in his life. His role as a trader can be described as an opportunity seeker. He used to send fish to markets in Belgium, yet at other times he also acted as a middleman for German wholesalers. He explored the market actively, looking out for merchandise as well as buyers. Sometimes, he visited places inland to procure bait for the fishermen of his hometown. At another occasion, he and his colleagues visited the inland town 's-Hertogenbosch to explore whether there were enough rich people to buy their merchandise.

The role of wholesalers in the trade of plaice changed during his lifetime. In his youth, German wholesalers went to Antwerp to buy dried plaice. Later on, wholesalers from 's-Hertogenbosch and Nijmegen started to buy plaice for the German market in the fishing villages directly. As an example to

give an impression of the volumes involved, the trader Jacob Cornelisen ordered Adriaen Maetz, a dryer in Katwijk, to deliver 2400 caskets of plaice within one year.

Control of supply chains is illustrated by the lampern trade by Schimmelpenninck, a rich wholesaler specialized in this product. Schimmelpenninck sold them to fishermen from Zeeland to be used as bait. He used to take his position in the market by buying large amounts, leading on one occasion to his bankruptcy. Because of the French war in the 1540's, fishermen from Zeeland were forbidden to sail and this left him with his supplies and large claims from his suppliers. After the war his trade recovered again.

Two other merchants from Brielle actively developed their markets by travelling to Scheveningen to find new customers. They offered their lampern as bait in exchange for half of the catch. Because the catch of cod and haddock was higher than ever before, the relatively expensive lampern became the preferred bait among local fishermen.

### 3.7 Markets

The 'rich and wealthy' were considered to live in cities in Flanders (Antwerp, Mechelen and Brussels) and Holland (The Hague and Delft). Therefore, these towns were important places for traders to sell fresh fish such as cod, flounder, halibut (*Hippoglossus hippoglossus*), turbot and sturgeon. Fresh and salted salmon caught in Dutch rivers were transported to these markets as well.

During Lent, there was a high demand in Flemish cities for 'fish'-like harbour seals and harbour porpoise. Remarkably, it was forbidden to sell female harbour porpoise in Antwerp, according to the rumours because the mayor's wife had eaten its meat and had become too lustful afterwards. Harbour porpoise was sent up the river Maas (to Maastricht, Liège and Aachen) and to London as well.

The less fortunate people in Holland visited markets to buy the cheaper fresh sea products like plaice, flounder and weever as well as blue mussels (*Mytilus edulis*). Also freshwater fish like eel, bream, smelt and ruffe (*Gymnocephalus cernuus*) were for sale. Some species were also sold on the street by youngsters: shrimps in The Hague, periwinkles (*Littorina littorea*) in Dordrecht and bleak (*Alburnus alburnus*) in Zwolle.

Preserved fish was ready for export to surrounding countries. Coenen realized that export of salted fish was extremely important for the Dutch economy. On two occasions, when writing about the herring trade and when dealing with the transport of plaice to Germany, he described the export as "the golden mountain of Holland".

Dried plaice was transported in casks and baskets over the Rhine to Germany and sold all over the country. Although Cologne served as the central market, wholesalers from Mainz, Strasbourg and beyond also came to Holland to buy plaice. During Lent, the demand increased beyond capacity, but salted plaice and flounder were also acceptable. Although Cologne forbade the import of flounder,

there was an alternative destination: flounder could be sent to the Land of Kleve and Jülich, for the inhabitants of that region 'did not know flounder from plaice'.

Salted cod (*aberdaen*) was sent whole (no heads or bones removed) along the Maas to Maastricht, Liège and Aachen, and with the *nasen* (noses) removed along the Rhine to Cologne because of local rules. Salted mackerel (*Scomber scombrus*), a by-catch in the herring fishery, were especially favoured in France. The Frenchmen also preferred salted pilchard above salted herring. The harbour of Rouen was the place to transport salted pilchard to.

Dordrecht and Geertruidenberg were important centres for the export of caught in the river Maas (sturgeon, salmon and allis shad) to Flemish cities and, in case of the latter two species, also to Maastricht, Liège and Aachen.

### 3.8 Consumers

Throughout the Fish Book, Coenen provides information about the taste of different species and about the preferences of those who buy them. Reordering the information leads to a detailed classification of fish consumers:

1. *Inedible, mostly thrown back after catch.* Most sharks fall in this category, although small-spotted catshark (*Scyliorhinus canicula*) were appreciated, especially in Zeeland and by fishermen, and also cuttlefish (*Sepia officinalis*), angler (*Lophius piscatorus*), common stingray (*Dasyatis pastinaca*) and European sprat.
2. *Poor fishermen:* Juvenile smelt, common stingray and smooth hounds (*Mustelus sp.*). Common stingray was mostly thrown away but eaten by these fishermen when other fish were expensive. In bad weather, they ate skate (*Dipturus batis*). Smooth hounds was also eaten by trainees on herring boats.
3. *Poor people:* Salted saithe, thornback ray, angelshark (*Squatina squatina*), viviparous blenny (*Zoarces viviparus*) and shore crab. Angelshark was only brought to market when other fish was expensive.
4. *Farmers and labourers:* Herring, thornback ray (*Raja clavata*), salted saithe and dried skate. Dried skate was exported to German farmers and 'workers in mountains and on wine yards'. Coenen was amazed that they would eat 'this stinking dried skate with their carrots'.
5. *Common people:* Flounder and plaice (fresh), weever, cod, viviparous blenny, bream and smelt.
6. *Everyone.* European eel and blue mussels were eaten by both rich and poor.
7. *Rich and wealthy:* Fresh skate and juvenile rays, dab, sole, cod (especially when caught with common shrimp), the liver of the ling, sturgeon, salmon, harbour porpoise (monks in Belgium), bream, wels catfish (*Silurus glanis*), gobies, smelt, trout (*Salmo trutta*), and - at the court in Brussels - lampern. Also, harbour seals, lobster, edible crab (*Cancer pagurus*) and common

shrimp. Weever came in vogue after Mary of Hungary, the sister of Charles V, ate weever in Scheveningen and expressed that she was delighted.

8. *Skippers and their family and friends*. Wolffish (*Anarhichas lupus*) and tusk (*Brosme brosme*) caught in Scottish waters were considered to be delicate fish, too good for the 'rich and wealthy'. The skipper preserved them in private casks for own consumption or to give away to family or friends.

## 4. Discussion

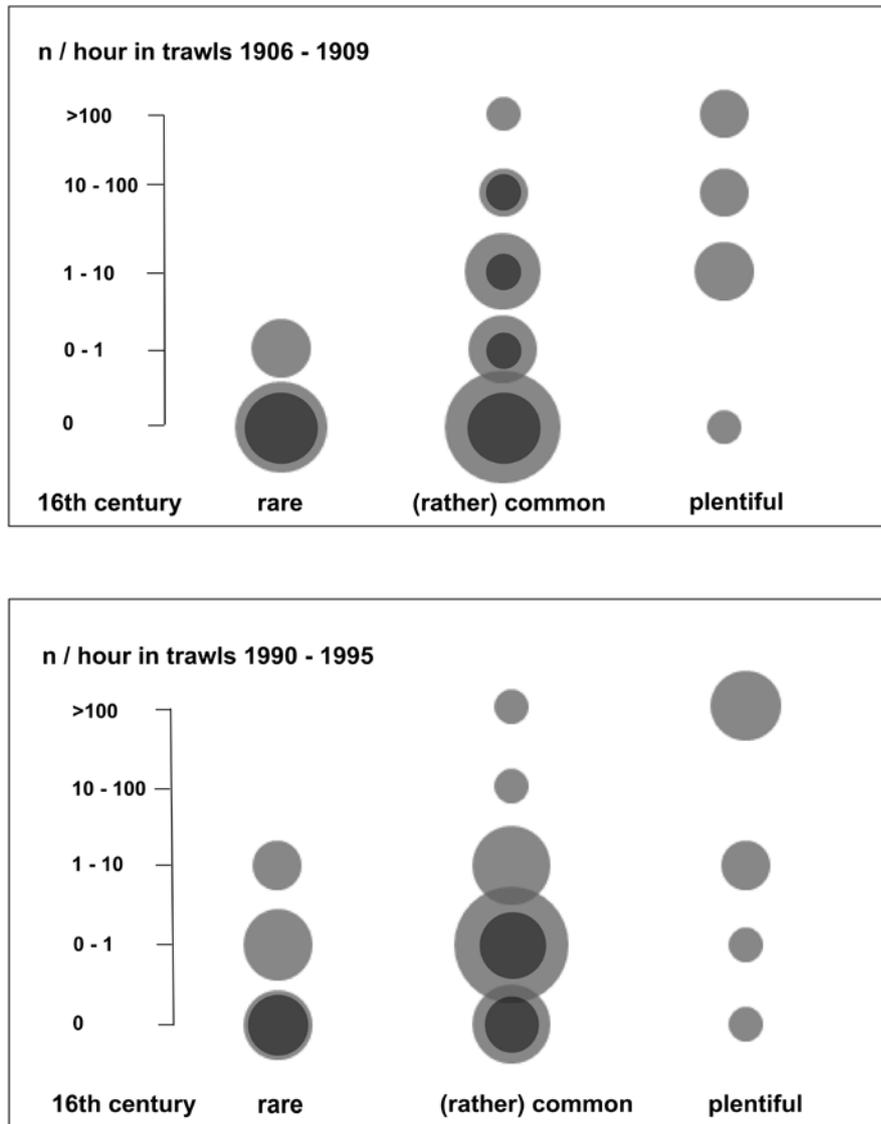
### 4.1 Marine fish

The relative abundance of fish species reported by Coenen along the Dutch coast is largely in agreement with the relative abundance of fish bones in the mittens of the 15<sup>th</sup> century fishing village Raversijde (Pieters et al, 2013) about 100 km southwest of Scheveningen. This collection of more than 50.000 fish bones was dominated by flatfish (41%), gadoids (35%) and clupeids (17%), whereas eels (3%) and rays (2%) were less abundant. Flatfish remains were dominated by plaice 65%, flounder 28%, dab 6% and sole 1%, with brill, turbot and halibut represented 0.2% or less. Within the gadoids, cod predominated, followed by haddock and whiting, and a few pouting (*Trisopterus luscus*) and ling. Clupeids were heavily dominated by herring. European sprat, European pilchard and shads (*Alosa* sp.) occurred far less frequently. Among the rays, the thornback ray was the dominant species followed by spotted ray (*Raja montagui*), sandy ray (*Leucoraja circularis*), undulate ray (*Raja undulata*) and skate, Shark remains were extremely rare (<0.1%) and comprised of smooth hounds, spiny dogfish (*Squalus acanthias*), tope shark (*Galeorhinus galeus*), small-spotted catshark and porbeagle (*Lamna nasus*) (Pieters et al., 2013).

The first quantitative data that are available for comparison originate from the trawl surveys conducted in roughly the same area at the beginning of the 20<sup>th</sup> century. These data have been analysed and compared to trawl survey data collected between 1990 and 1995 by Rijnsdorp et al. (1996) and the relevant results are included in Table 1. Of course, the relative abundance inferred from Coenen's account for the Dutch coast is affected by the fishing gear used at that time and by the fishing grounds visited. The main gears used were bottom trawls close to coast and hook and line a bit further offshore (see below). Hence, piscivorous fish were sampled well, but only benthivorous species occurring in shallow waters are represented. In contrast, the 20<sup>th</sup> century research vessel data refer to beam-trawl (8m – BT8) and bottom-trawl (OT20 or GOV) only. The data should be used with caution due to the use of different gear. To avoid the suggestion of exactness we aggregated the catch rates in powers of ten (Table 1 and Figures 7 and 8).

Moreover, species that have reported only a few times during Coenen's lifetime refer essentially to strayers from other areas and cannot be considered to form a regular part of the North Sea fish community. These nine species, classified as very rare, have been omitted from the comparison,

because a research vessel survey cannot really be expected to provide reliable data on their occurrence.



**Figure 7.** 20<sup>th</sup> century trawl data of table 1 (a: 1906-1909; b. 1990-1995) compared to three 16<sup>th</sup> century abundance classes by Coenen (horizontal axis). Sizes of circles represent number of species. Dark area's represent elasmobranchs. Number of species is 41.

The comparison with the two sets of research vessel data shows that there is an overall consistency in the abundance classification of the North Sea fish community among the three sources (Figure 7).

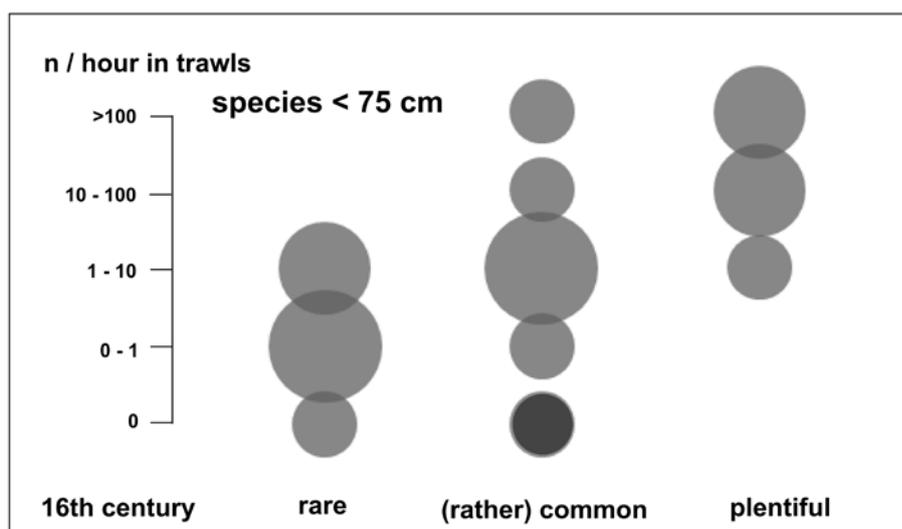
Eight species that were plentiful in the 16<sup>th</sup> century were mostly also abundant (herring, sprat, cod, whiting, plaice) in the 20<sup>th</sup> century, although the relative abundance may have changed. Greater weever and haddock were recorded in fair numbers in the early 1900's but declined strongly afterwards. Greater weever was abundant enough to have commercial value both in Coenen's time

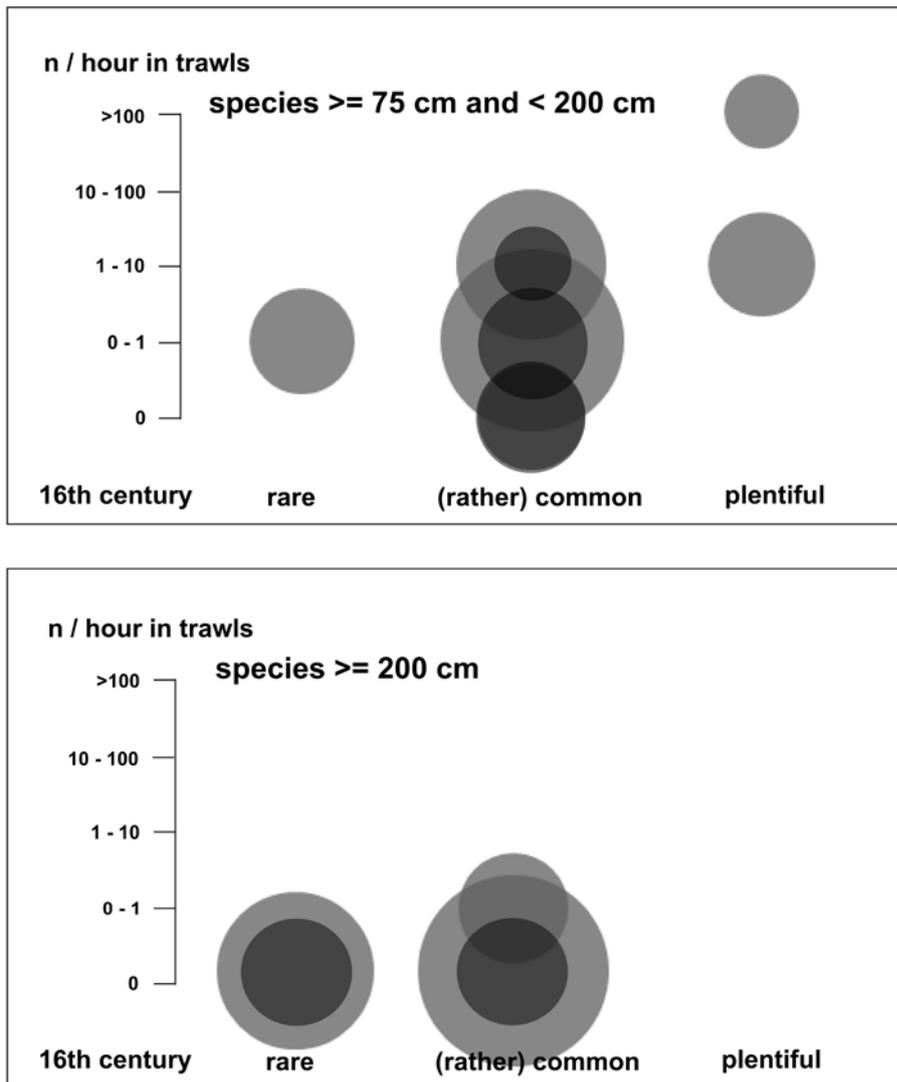
and the first half of the 20<sup>th</sup> century, but disappeared almost completely from the southern North Sea since the strong winter of 1963 (Daan, 1989).

Of the 23 species that were classified as common for the 16<sup>th</sup> century 14 species were caught in low numbers ( $\leq 0,05 \text{ n.h}^{-1}$ ) in the early 20<sup>th</sup> century catches: small-spotted catshark, smooth hounds, skate, common stingray, blonde ray, sturgeon, pilchard, saithe, pollack (*Pollachius pollachius*), ling, sea bass (*Dicentrarchus labrax*), brill, halibut and salmon. One species, spiny dogfish, was caught in relative high numbers ( $10 \text{ n.h}^{-1}$ ) at the start of the 20<sup>th</sup> century but declined in the 20<sup>th</sup> century to low numbers ( $\leq 0.05 \text{ n.h}^{-1}$ ) at the end. Eight species occurred in relatively high numbers or very high numbers (dab) in the 20<sup>th</sup> century trawls. The species that occurred in relatively high numbers were: thornback ray, pouting, turbot, sole, bull rout (*Myoxocephalus scorpius*), tub gurnard and greater sandeel (*Hyperoplus lanceolatus*).

The rare fish along the coast in the 16<sup>th</sup> century have largely remained rare (e.g. wolffish, conger (*Conger conger*), halibut, mackerel and angelshark). But for two species this observation needs some refinement, thick lipped mullet (*Chelon labrosus*) and lumpfish (*Cyclopterus lumpus*), are rare along sandy coasts, but not in the estuaries.

Most of the very rare fish in the 16<sup>th</sup> century (e.g. tope shark, electric ray (*Torpedo nobiliana*), bluefin tuna, opah (*Lampris guttatus*) are still seldom seen along the coast of Holland (Redeke, 1941; Nijssen & de Groot, 1980) called in surveys (Daan et al 1990) or reported by commercial fishermen (De Vooyo & van der Meer, 1998). Notable is that also garfish and angler fall in this category. Garfish was not common along the coast but appeared in larger numbers in the Marsdiep, this situation still exists. Angler was probably hard to catch with the fish gear that was used at that time. The fact that bluefin tuna (*Thunnus thynnus*) was virtually unknown in the 16<sup>th</sup> century is remarkable in the light of 20<sup>th</sup>-century bluefin tuna fishing in the North Sea and the association of this tuna with herring (MacKenzie and Myers, 2007).





**Figures 8.** Average of 20<sup>th</sup> century trawler data of table 1 compared to three 16<sup>th</sup> century abundance classes by Coenen (horizontal axis). Graphs for three species size categories (maximum size of species according to Engelhard et al., 2011). Sizes of circles represent the number of species. Dark area's represent elasmobranchs. Number of species is 18, 17 and 6.

It is noteworthy that many of the species that were seldom caught in the 20<sup>th</sup> century are characterised by a large body size (Fig 8). If we take into account the species that were classified as plentiful or common for the 16<sup>th</sup> century, all 4 species larger than 2 meter were caught at low numbers ( $\leq 0.05$ ) in the 20<sup>th</sup> century trawl surveys. Of the 15 species between 0,75 and 2 meter 6 (40%) were caught at such low numbers and of the species less than 0,75 m. none were rare in the 20<sup>th</sup> century surveys. Many of the species that declined strongly were elasmobranchs (smooth hounds, common skate, common stingray, blonde ray (*Raja bracyura*)) but sturgeon, pollack, saithe and ling may be mentioned as well.

This confers with historical data that reveal that large, valuable fish species were commercialised first, which often led to their depletion (Lotze, 2007; Lotze and Worm, 2009). These large sized species are

characterised by life history traits (late maturation, slow growth rate) that makes them particularly sensitive for increases in fishing mortality rate (Brander, 1981; Jennings et al., 1998).

Within the flatfish fisheries, plaice has remained a dominant target species since medieval times (van Neer et al., 2002, 2004; Rijnsdorp and Millner, 1996). Other flatfish targeted in the 16<sup>th</sup> century were flounder and sole, whereas turbot and brill were mentioned as important by catch. These species remained commercially important during the 20<sup>th</sup> century (Kerby et al., 2013), with the exception of flounder, which has decreased in importance owing to the expansion of the trawl fisheries into offshore areas (Smith, 1994; Engelhard, 2008; Kerby et al., 2012) and because of a marked reduction in estuarine habitat (closure of the Zuiderzee and part of the Maas delta). The suggested decline in flounder in Table 1 is likely due to the fact that the 20<sup>th</sup> century trawl surveys did not cover the estuaries.

Coenen noted that cod and haddock were plentiful and that there were large amounts of whiting. Early in the 20<sup>th</sup> century, whiting was more abundant than the other two gadid species and has increased its dominance since then (Pope and Macer, 1996). Haddock disappeared from the southern North Sea during the 20<sup>th</sup> century (Table 1; Bolle et al., 2004; Holm, 2005), but remained a major component of the demersal fish community in the northern North Sea. The abundance of cod has decreased substantially since the 1980s and the stock is considered to be in danger (Pope and Macer, 1996; ICES 2012). The relative abundance of ling, the largest North Sea gadoid species, which was common according to Coenen's account, has declined substantially in the period between 1840 and 1914 (Poulsen et al., 2007) and has maintained itself at a low abundance during the 20<sup>th</sup> century (Daan et al., 1990).

The only elasmobranchs that were recorded in fairly high numbers in the early 1900's were spiny dogfish and thornback ray. This corroborates the changes in abundance of elasmobranchs during the 20<sup>th</sup> century (Walker and Heessen, 1996; Walker and Hislop, 1998; Dulvy et al., 2000; De Oliveira et al., 2013).

Coenen's observations also document the decline in diadromous species (salmon, sturgeon, smelt, houting, allis shad, twaite shad and European eel ) in or along the North Sea which can be related to the deterioration in their freshwater spawning habitat or the hydraulic engineering works that have created barriers in the upstream migration (De Groot, 1990, 1992).

Already in the Middle Ages a decline of salmon and sturgeon was noticed in the rivers throughout Europe as a result of habitat alteration and fishery pressure (Hoffman, 2005; Lotze, 2005). As a result salmon fisheries moved from upriver to the river mouths and estuaries (Hoffman, 2005). Salmon catches in the lower Rhine remained high until the end of the 19<sup>th</sup> century. It was not uncommon for Dutch and German fishermen to land 100,000 salmon a year. Since then, catches started to decline and by 1983 the Dutch salmon fishing industry had virtually ceased to exist. Factors that led to this decline were the increased use of locks and weirs along the Rhine, increase in chemical and thermal

pollution, and the loss of accessible spawning and nursery areas of the required quality (De Groot, 1992).

Fishery for sturgeon in the Rhine river continued after Coenen's time. Their decline set in the beginning of the 20th century leading to extinction as a breeding species in 1942 (De Groot, 1992).

It is clear that Coenen's 'superfluous' sea has nowadays lost part of its richness. In his time common species have diminished in numbers (cod, haddock: Pope and Macer 1996), have become rare (sharks and rays: Walker and Heessen 1996) or have even totally disappeared from Dutch coastal waters (common skate, salmon, sturgeon, houting: De Groot 1990, 1992). Although the above comparison will only give a rough indication, most of the suggested changes in the fish community since the 16th century are in line with the expectations based on life history theory. Some of the larger fish species, which due to their low reproductive rate will be most vulnerable for fishing, had already decreased by the start of the 20th century. The increase in fishing pressure during the 20th century (Engelhard, 2008), which peaked in the period between 1970 and 1990 (ICES, 2012), resulted in a further decline of large, long-lived species relative to small, short-lived species. For species for which the changes in exploitation rate have been estimated since the early 20th century, results show that the stocks were already exploited at a rate well above the rate of natural mortality rate at the start of the time series (Pope and Macer, 1996; Rijnsdorp and Millner, 1996; Burd, 1978; Eero et al., 2007; Godø, 2003).

#### 4.2 Freshwater fish

Coenen emphasized that a great wealth of fish lived in rivers and ponds and that fresh water fishery was a valuable source of living. Thereby, his account supports the conclusion that limited inland fish resources were not the main factor behind the expansion of fishing at sea (Barret et al. 2011). The fresh water fisheries in Holland declined only later as a consequence of salination and the loss of open waters caused by extensive land reclamation projects in the middle of the 17th century (De Vries and van der Woude, 1995). But there were exceptions, such as the catch of vast amounts of salmon along the rivers Rhine and IJssel, which continued till the start of the 20th century (De Groot, 1992).

#### 4.3 Marine mammals

Coenen's report on seasonal sightings of large groups of migrating whales along the Dutch coast is in sharp contrast to the current situation, where only an odd specimen may be seen in the North Sea. His claim that these groups were formed by sperm whales is not congruent with modern literature. Sperm whales visit the North Sea only occasionally as individual males or in small groups (Camphuysen and Peet, 2006; De Smet, 1981). In the Atlantic only large bulls regularly occur north of about 40°N and these males are not known to form large groups. Probably Coenen misidentified the migrating whales, yet it is not clear which species he observed. In earlier times the North Sea is thought to be inhabited by great numbers of North Atlantic right whales (*Eubalaena glacialis*) and grey whales (*Eschrichtius robustus*) (De Smet, 1981; Wolff, 2000). Both species are known to swim close to the coast thus

enhancing the chance that they were spotted from land. But after the Middle Ages their numbers were low in the North Sea, in the case of the right whale partly because of whaling (De Smet, 1981). Another candidate is the humpback whale (*Megaptera novaeangliae*) which nowadays occur in northern Norway and west of the British Isles (Camphuysen and Peet, 2006). This species is often sighted in different parts of the world as it migrates close to the coast and has a conspicuous breaching behaviour. While the Fish Book only report strandings of sperm whales his Whale Book is more elaborate about cetaceans, also reporting strandings of a fin whale (*Balaenoptera physalus*), a North Atlantic bottlenose whale (*Hyperoodon ampullatus*) and a long-finned pilotwhale (*Globicephala melas*) (Egmond et al., 2003; Camphuysen and Peet, 2006)

Coenen's report on seasonal sightings of migrating sperm whales along the Dutch coast is in sharp contrast to the current situation, where only the odd specimen may be seen in the North Sea. His description is in agreement with the relatively high number of strandings of large bulls reported in the period from 1566 to 1788 (Smeenk, 1997; van Deinse, 1918), no longer occur. Coenen's Whale Book is more elaborate about cetaceans, reporting strandings of a fin whale (*Balaenoptera physalus*), a North Atlantic bottlenose whale (*Hyperoodon ampullatus*) and a long-finned pilot whale (*Globicephala melas*) (Egmond et al., 2003; Camphuysen and Peet, 2006).

All we know about the harbour porpoises is that their number declined in southern North Sea from 1939 till 1960 and recovered afterwards. The reasons for this fluctuation are unknown (Camphuysen and Peet, 2006).

Because harbour seals were considered to compete with fishermen, a bounty has been paid for hunted individuals since the 16<sup>th</sup> century. From the paid amounts it can be derived that rather large populations lived in the Waddenzee and the Rhine-Maas-Scheldt estuary (Vooy's et al. 2012). In the 20<sup>th</sup> century both populations strongly declined (Reijnders, 1994, Brasseur and Reijnders, 1997).

The grey seal (*Halichoerus grypus*) was not present in the area in Coenen's time. This species disappeared in the Middle Ages as the result of overexploitation and disturbance and only returned in the middle of the 20<sup>th</sup> century (Reijnders et al, 1995).

#### 4.4 Fisheries

Fisheries along the Dutch and Flemish coast in the early modern period (1500-1800) have been studied by various Dutch historians (Beaujon 1884; (Boelmans) Kranenburg, 1946, 1979a, 1979b; Tesch and de Veen, 1933; Van Vliet 1994; De Vries and van der Woude 1995; Van Bochove 2009). Poulsen (2008) studied the Dutch herring fisheries in the period from 1600-1860 landing up to 60.000 t per year. Most of these studies concentrated on the catch of herring and to a much lesser extent on a few commercial species like cod and some flatfish or fresh water species. The value of Coenen's multispecies fisheries account lies in providing an overall picture.

The seasonal pattern (Table 3) is in agreement with the seasonal pattern inferred from the species composition of fish bones from 15<sup>th</sup> century mittens of a fishing village at the Flemish coast (Pieters et al., 2013): “fishermen may have had an annual ‘round’ starting in winter with cod, then haddock, then flatfish, and then, in summer and autumn, herring”. A study on annual growth rings in otoliths showed a comparable seasonality, plaice fishing in spring preceded by a haddock fishing season, probably in late winter/early spring (Van Neer et al, 2004). Once again the value of Coenen’s data lay in its completeness, all efforts by different fishermen from the *Zijde* being included.

During Coenen’s life, the catch of herring started to increase in response to the discovery of a large stock between Scotland and Norway (De Vries and van der Woude, 1995), which would lead to the Dutch domination of these fisheries in the 17<sup>th</sup> and 18<sup>th</sup> century (Poulsen, 2008). Already in the 1600s, the herring trade became strongly regulated by the ‘College van de Grote Visserij’ (Boelmans Kranenburg, 1979a; Poulsen 2008). The small fishing villages were not allowed to land or trade gibbed herring any more. It is probably for this reason that Coenen does not provide much new information, but his account is still valuable because he describes the less-known period before 1600. New is his information about the sizes of the boats that sailed to Shetland and Orkney. Sizes still varied strongly, the ideal size of these herring boats had not yet established. (De Vries and van der Woude, 1995). Extensive information and quantified data on the catch of Dutch herring in the North Sea is provided by Poulson (2008).

As an inhabitant of Scheveningen, Coenen paid much attention to the flatfish fishery (Berghahn and Bennema, 2013). Considering the poverty of the coastal fishing villages in recent centuries (Tesch and de Veen, 1933), it is striking to read about the great amount of money earned by selling salted plaice to Germany. Plaice is a dominant flatfish occurring throughout the North Sea down to a depth of about 100m. In the autumn, the adult population migrates to the spawning grounds that are located in the offshore waters of the eastern English Channel and Southern Bight (Harding et al., 1978). After spawning, part of the adults move to coastal waters to resume feeding (Rijnsdorp, 1989), matching Coenen’s report that “in many years the plaice that came from the deep in April, aggregated in big masses close to the coast” (Berghahn and Bennema, 2013).

The Fish Book also pays much attention to the ‘cod economy’, fishery and trade of cods and their bait. Gadids were traditionally caught along the coast but Dutch cod fishers reached the Dogger Bank soon and went to Iceland in the middle of the 17<sup>th</sup> century (Beaujon, 1884; Tesch and de Veen, 1933; De Vries and van der Woude, 1995; Boelmans Kranenburg 1997b). Coenen fills the gap with his description of cod fishery near Shetland and Orkney. There are indications that Flemish fishermen caught cod in Scotland in the 15<sup>th</sup> and early 16<sup>th</sup> century (Ervynck et al. 2004) but this massive Dutch 16<sup>th</sup>-century cod fishery in Northern Scotland appears to have escaped attention (Boelmans Kranenburg, 1983, Fenton, 1978, Goodland, 1983). Yet there are other records of this fishery. In 1633 captain Smith was sent to the Shetland islands to report on fisheries (Smith, 1661). He noted not only about 1500 Dutch busses of 80 t but also about 400 Dutch ‘dogger-boats which were of the burden of 60 t, which fished only with hook and line for cod and ling’. Within eight to ten days after the dogger-

boats went to sea they came into the sound again 'so full laden as they could swim.' Unfortunately, the number of ships in this report does not seem very accurate, the total number of busses that left the Netherlands did not exceed 1000 (Van Bochove, 2004; Poulsen, 2008). This cod fishery was quite persistent, at the start of the 17th century hundreds of doggers still accompanied the fleet of Dutch herring busses in Shetland and, later in the season, further south along the British North Sea coast (Sibbald, 1711).

Archaeological studies on fish bones may also benefit from another piece of information provided by Coenen. The assumption that salted or dried cods were always decapitated (Barrett et al., 2011) is not universally true. According to Coenen Cologne obliged salted cod to be decapitated but the same product was sent to other places with their head on. It would be worthwhile to search the archives of Cologne in order to find confirmation for Coenen's claim.

#### 4.5 Fishing boats and gear

The number of boats in the fishing villages along the 117 km long coast of Holland at the start of the 16<sup>th</sup> century can be derived from inventories by the States of Holland and Vrieslant (Anonymous, 1494, 1514). The villages owned about 140 *pinken*, 40 small herring boats and an unspecified amount of smaller boats. Some *buysen* were counted as well, most lying in the Oude Rijn in Katwijk aan Zee. The flat-bottomed pink remained very popular to fish for flatfish and gadids along the coast until the 19th century. A detailed building plan is provided by Witsen (1671).

Fishermen along the Dutch coast used various types of fishing gear made of hemp. Plaice, sole, salmon and cod nets operated from *pinken* were specialised simple trawls. It is not clear if the flounder nets that were used in the southern estuary were different from plaice nets. Cod nets were used to catch porpoises as well.

Fixed gill nets were not named in the Fish Book but there is an indication of their use. An ordinance by the municipality of The Hague regulating fishery activities in Scheveningen (Anonymous, 1540), mentioned 'nets standing in the sea'.

In the Zuiderzee, fishermen from Holland used *waterschepen*, boats with a water compartment to hold fish. They fished for flatfish using *cuylen*, dragnets hung on beams at both sides of the ship. There were many disputes with other Zuiderzee fishermen about the mesh widths of their nets. In a petition these competitors claimed the number of waterschepen from Holland in the Zuiderzee had increased to 600 (Beaujon, 1884, 1885; Molhuijsen, 1844).

While there is much information about herring nets used in the North Sea (e.g. Poulson, 2008) the composition of driftnets (Ervynck et al., 2004) used to catch herring along the coast is not clear. Finally, we may add hook and line to catch gadids, and dragnets and seines that were operated from the beach, to the gear used by fishermen along the sandy coast.

Information about the mesh widths of the popular plaice- and sole nets used along the North Sea coast is available from other sources. Two ordinances by the States of Holland (1676 and 1677) tell that plaice nets had a mesh width of 'twenty-eight' and the sole nets of thirty-two'. According to Beaujon in the Dutch version of his book (1885) these measures could mean 1/28 Dutch ell or 24,8 mm for the plaice nets and 1/32 ell or 21,7mm for the sole nets.

Disputes about mesh widths of dragnets used to catch flatfish (plaice, flounder and turbot) in the Zuiderzee were older. In 1547 Emperor Charles V forbade mesh widths less than '5 fishermen thumbs' (about 12,5 cm). After protest from fishermen from Holland, in 1555 the minimum width changed to 2 thumbs (about 5 cm) (Beaujon 1884, 1885).

The use of beam trawl gear seems to have commenced relatively late in this area. In the United Kingdom acts were passed in Parliament to ban the use of trawls in 1350 and 1371 already (De Groot, 1984), in Flanders trawls were banned in 1499 and in France in 1584 (Roberts, 2007). In 1583 the States of Holland forbade trawling with *coorden* in the Maas estuary and determined a minimum mesh width. The *coorden* was described as a net held open by beams of about 3 fathoms width and loaded with up to 16-17 pounds of lead to which stones were added. The first decrees for the coast of Holland, forbidding the use of *schrobnetten* and declaring the mesh width of sole nets as a minimum were issued in 1676 and 1677, almost a century after Coenen wrote his Fish Book (Cau et al., 1796).

The relatively large *buysen*, used to catch herring in the North Sea laid in deeper water in the Maas and Scheldt estuary. Coenen mentions that before the French war (1540's) 200 buysen left from the Maas and numerous others from Zeeland. Recent estimates about the situation in 1600 suggest that about 400 buysen departed from the Maas and about the same amount from the Zuiderzee. Detailed information on their numbers from the 17<sup>th</sup> till the 19<sup>th</sup> century are provided by Van Bockhove (2004) and Poulson (2008).

Coenen accurately depicted the nets used in passive herring fishery on the North Sea (Fig. 2). Herein caskets also held up a vertical line to which in this case the hemp nets were attached. The whole construction could be 1350 to 1500 m long (Van Vliet, 1994; Poulson 2008). As Coenen also depicted, flags on the surface showed the position of the nets.

The *dogger*, used to catch gadids in open sea is a less well known boat type. Coenen described doggers as large ships that left the Maas river to catch gadids in North Scotland. After 1655 these boats were used to catch gadids near Iceland and later they were replaced by *hoekers* (Kranenburg, 1946). The construction of doggers or dog-boats, which were used in England, French, Belgium and Denmark as well, is unknown. The term dogger does not seem to specify a fixed vessel type (McMillan and Parry, 2001).

Coenen's drawing suggest that gadids along the coast were caught with lines which had sidelines with one hook at the end (Fig. 3). Coenen provides no pictures of gadid fishing in Scotland. Elaborate constructions were used in the *beug* fishery, but it is not clear from literature when this type of fishery

started. A beug was kept afloat by caskets that held up an underline which in turn held up about 200 fishing lines with 20 hooks (van Vliet, 1994).

#### *4.6 Trade*

The availability of Dutch fresh water fish may explain why so many marine and fresh water fish were exported to Belgium and Germany. Export to the populated cities in Flanders fits the demographic imperative, increasing demand for fish in towns stimulated fishing at sea (Barret et al., 2011). The ultimate factor that caused the demand for salted or dried fish in Germany is less clear. Coenen refers to an increased consumption during Lent, witnessing the role of Christianity, but the export was also high during the rest of the year. Population growth in cities will have contributed to the demand but also the decline of local fish populations, caused by the erosive effects of deforestation (Tittizer and Krebs, 1996) has to be taken into account. Coenen mentioned that dried skate was exported to German 'labourers in vineyards and mountains', suggesting a demand for fish from ecological disrupted areas.

Except for herring, the fish trade took place in a free market in which small opportunity seekers like Coenen as well as wholesalers operated. The only restrictions seem to have been made by the market places; they could refuse certain species or enforce preferred conservation methods. Fresh fish was popular and could be sold on markets in cities that lay at an acceptable distance from the sea by waterways and roads. The distance between the coast of Holland and the Flemish markets was about 140 km by boat. Assuming a two days voyage, it will have demanded for cold weather conditions to keep the fish fresh. This matches the fact that three of the four species that were sent to Flanders (cod, halibut and turbot) were caught by cod fishers during the coldest months of the year, The fourth species, the anadromous sturgeon, could also be caught at sea during the coldest months. Dried and salted fish could be exported to staple markets along the rivers. Detailed information on trade routes may be obtained from the supplemental online table on fish.

During Coenen's life, fisheries and fish trade were little affected by the start of the Dutch uproar against the Spanish Empire (1568-1648). But even so Coenen noticed the decline of the market in Antwerp already, as wholesales started to circumvent it by trading plaice directly with the fishing villages. Some years after the Fish Book was completed in 1584, Antwerp became isolated as result of the occupation by the Spanish empire. Up until the Twelve Years' Truce (1609-1621) the Flemish cities could hardly be reached by Dutch traders (De Vries and van der Woude, 1995). It is believed that in the long run, these political troubles caused the decline of fisheries in the southern provinces of the Netherlands and Flanders (Ervynck et al., 2004; Kranenburg, 1946; Tys and Pieters, 2009).

One might expect that fishing villages along the coast would benefit from the fact that the cities in Holland became the new wealthy urban centres. But the geographical location of these fishing villages also had a disadvantage, as the fishing horizon for herring and gadids moved on they could not participate with their own boats. The lack of deep water harbours confined them to use relatively small

flat bottom boats. In the case of herring, six harbour towns monopolised the catch and trade while fishermen became mere employees.

The classification of 16<sup>th</sup>-century consumers of marine food may contribute to the interpretation of archaeological sites. Archaeologists use food scraps like fish bones to derive the social class of the inhabitants at a site. Better knowledge of consumer preferences increases the distinguishing power of this method. The conclusion from historic sources and ancient paintings that the rich preferred fresh, rare and large fish (Hoffman, 2005; Van Dam, 2009) is confirmed by Coenen. The distinction between fish for the rich and for the poor is usual in archaeology. Coenen, however, shows us that in his day the division of consumers was much more refined.

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### **Appendix A. Supplementary data**

Supplementary material related to this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.fishres.2014.09.001>.

(Bennema\_Rijnsdorp\_2015\_Supplementary\_data.html)

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