How governance impacts non-timber forest product value chains in Cameroon

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1. Introduction and context

Over the last two decades, studies have highlighted the economic, social and cultural importance of non-timber forest products (NTFPs)[1] in Central Africa[2] (Ingram et al., 2012a, 2012b; Tieguhong and Zwolinski, 2008). Based on data from Cameroon (Ingram, 2014), around a third of NTFPs harvested are estimated as traded. Many of the high value traded NTFPs (Ingram et al., 2012a, Ingram et al., 2012a) form the basis of local, regional and international trade by individual entrepreneurs and small and medium-scale enterprises (SMEs) (Ingram et al., 2012a; Tieguhong et al., 2010; Ndoye and Tieguhong, 2004). Official, systematically collected data about the value of NTFP trade in the region does not exist. Whilst efforts are being made to collect this as part of the Central African Forest Observatory, studies, market data and trade permits indicate that the annual value of the sector is slightly over a billion US$ (Ingram et al., 2012a, 2012b). Many SMEs sell two or more NTFPs often alongside agricultural products, in quantities which provide a significant income (Tieguhong et al., 2009a). Among the highest valued and commercialised NTFPs in six Central African countries are the leaves of two forest vines or vegetables known as okok or eru (*Gnetum africanum* and *Gnetum buchholzianum*) in Cameroon, fumbwa in the DRC, nkumu or mfumbu in Gabon and koko in Congo and the Central African Republic (CAR)

[1] Products of biological origin from natural modified and managed forested landscapes. They include plants and animals, whole or in part.

[2] Equatorial Guinea, Republic of Congo, Democratic Republic of Congo (DRC), Cameroon, Central African Republic (CAR) and Gabon.

(Bikoue et al., 2006; Ingram, 2014; Ingram et al., 2012a, 2012b; Mala, 2008). Eight of the most highly commercialised NTFPs in Cameroon provide on average 40% of annual household income for those involved in their chains (Ingram et al., 2012a). In Cameroon, *Gnetum* spp. traders earn on average 1,469 US$ annually, exporters 6,121 US$, and retailers 1,458 US$ (Ingram 2014). However, both species are threatened in Cameroon by over-exploitation, habitat loss and poor or weak governance (Bikoue et al., 2006; Mala, 2008; Ingram, 2013, 2014), a manifestation of which is corruption (de Wasseige et al., 2012, Transparency International 2009).

1.1 The NTFP sector in Cameroon

Trade in many of these NTFPs has occurred for centuries, and appears to have increased in the last thirty years. For example, okok trade involves around 1,885 people and at least 20 SMEs in Cameroon, and in the DRC at least 1,744 people (Ingram et al., 2012a; Ingram et al., 2012c). In the DRC, in 2007, the annual average revenue of okok harvesters was around at 668$ (Awono et al., 2009). van Dijk (1999)estimated that okok sellers can earn a daily wage of around US$ 1.5. Many NTFP are gathered, processed and marketed both by the main ethnic groups as well as minority groups (Tieguhong *et al*., 2012a; 2009a). Whilst men dominate many of the chains and often have customary ownership over tree-based products, comprising 60% of people involved in general (Ingram 2014), women generally are engaged in specific activities such as harvest, processing and retail of ‘women’s’ products (Ingram *et al*. 2013). Ndoye *et al*. (1997) showed that 94% of the estimated 1,100 NTFP retailers in 18 major markets in the humid forest zone of Cameroon were female. Inter-African and international trade in NTFPs is also important. The okok trade from Cameroon to Nigeria was at least 3.8 million US$ annually in 2010, with a

tenfold increase in the volume of exports estimated since 1991, involving around 1,885 people and at least 20 SMEs (Ingram et al., 2012a; Ingram et al., 2012c).

1.2 Value chain governance

The processes involved as NTFPs are harvested, processed, sold and used create what is known as a value chain. Taking a chain perspective allows the impacts of governance on the trade of these products to be assessed (Kaplinsky and Morris, 2003). Different stakeholders are typically involved at each stage of the chain: small scale harvesters, traders, transporters, exporters and consumers (Ingram et al., 2012c), NTFP chains operate in a context of increasing urbanization, significant poverty, a difficult business environment and significant corruption (de Wasseige et al., 2012). The Central African Forest Commission (COMIFAC) has emphasized the importance of NTFPs as strategic products in realising its three objectives, to fight poverty, enhance economic development and conserve biodiversity through sustainable development of forest resources.

The provision of a favourable business climate by governments has been seen as a prerequisite for economic growth led by the private sector (Commission for Africa, 2005). The regulatory, institutional and policy framework affects the performance of SMEs (Bonannée et al., 2007). However, despite being regulated in many countries in the region, the political and regulatory framework has been criticised as being haphazardly applied, inconsistent, illogical and largely ineffective in ensuring sustainable trade (Awono et al., 2010; Laird et al., 2010; Molnar et al., 2010; Ndoye and Awono, 2010). To address such issues, COMIFAC's 'Sub-regional directives on the sustainable management of NTFP of plant origin in Central Africa' aim to improve governance. The directives provide member countries with guidelines for including NTFPs in

68 their national legal frameworks and to stimulate their participatory management, strengthen value
69 chains and regional trade, thus increasing their economic contribution and visibility (FAO, 2010;
70 Ingram et al., 2012a, 2012b;COMIFAC, 2008).
71
72 Regulations are however not the only mode of governance for NTFP chains. If and when
73 statutory regulations operate, they are often superimposed by other governance arrangements:
74 customary, voluntary and market-based schemes, rules introduced by projects and programmes
75 and international standards (Ingram, 2014). The configurations of which vary widely per product,
76 chain and country. Plural arrangements can result in conflicting governance regimes, negatively
77 affecting the sustainability of species upon which the chains are based in the long term (Ingram,
78 2014). A product's growing economic value is often manifested by increasing corruption, illegal
79 activities and conflicts over ownership and access rights to NTFPs (Foundjem, 2013; Ingram,
80 2012). In timber chains, illegality (the non-respect of prevailing legal rules) has resulted in
81 unsustainable forest management (Tacconi et al., 2003), increasing poverty by reducing forest
82 resources available to the poor (Cerutti and Tacconi, 2006), and significantly reductions in
83 government revenues (Cerutti et al., 2010). Given the widespread view that improving forest
84 governance is essential to sustainably, equitably and effectively manage competing demands on
85 forest products (Djeukam, 2007; Kozak, 2009; WRI, 2009), knowing the economic and
86 environmental impacts of governance arrangements is essential to provide recommendations for
87 policymakers and practice (Laird et al., 2010; Ndoye et al., 2010) to sustainably govern NTFPs.
88 Given this context, this paper seeks to answer three questions:
89 1. What formal, regulatory arrangements govern the okok chain in Cameroon and who are
90 the main stakeholders involved?
91 2. What are the impacts of these arrangements?

3. What changes should be made to provide a favourable governance framework for sustainable NTFP trade in Cameroon?

2. Conceptual framework

Links between governance, sustainable development and poverty alleviation were made at the 1997 International Conference on Governance for Sustainable Growth and Equity and subsequently to forests (Kaimowitz, 2003; Ros-Tonen and Kusters, 2011). Practical challenges in realising forest conservation and development goals, have increasingly highlighted that governance plays a critical role in the sustainable management of forests and their products (Tacconi et al., 2003). How forests and their products are governed can have far reaching resource related outcomes, depending on who governs, why, the rights and rules, which have implications for the sustainability of livelihoods (Laird et al., 2009; Mayers and Vermeulen, 2002). Sachs *et al.* (2004) see governance as one of the problems creating and maintaining poverty. They contend that tropical Africa's poverty trap means it is too poor to achieve robust, high levels of economic growth and, in many places, simply too poor to grow at all. Policy and governance reform alone are deemed insufficient to overcome this trap.

Over the past five decades, many of the difficulties faced in managing natural resources in Africa have been linked to weaknesses of governance and the absence of an effective state (Commission for Africa, 2005). Governance refers to public, civil society and private interactions initiated to solve societal problems and create opportunities (Kooiman et al., 2008). It is the way a society organises itself to make and implement decisions – achieving mutual understanding, agreement and action and comprises the mechanisms and processes for citizens and groups to articulate their interests mediate their differences and exercise their legal rights and obligations (UNDP 2007).

These definitions emphasise that governance embraces the decisions and processes that define expectations, grant and exercise power[3], and/or verify performance. Good governance as purported by the Commission for Africa (2005) is the ability of government and public services to create an economic, social and legal framework that will encourage economic growth and allow poor people to participate in it. Institutionalised corruption, euphemistically called 'informal taxes' in Cameroon, it is a manifestation of a lack of respect of both the corrupter and corrupted for (formal and informal) rules governing their interactions. It has been seen as a failure of 'good' governance (Kaufmann et al., 2010) and a cause of poverty (Harford, 2006). Defined as the exercise of power for private gain, corruption ranges from additional payments 'to get things done' in business to elites engaging in state and power capture. In Cameroon corruption persists despite anti-corruption campaigns in forestry and state affairs, at the behest of international institutions (Topa et al., 2009), or elites wishing to reorient systems to ensure continued personal gain (Cerutti et al., 2013). When nested within formal institutional statutory structures and customary institutions, run in parallel by the same governors, it forms a pluralist layer in the governance of forest resources. Where formal regulations are unknown, unclear or unenforced, corruption can occur. Corruption is often expected, although unpredictably applied, impacting how, when and where transactions occur in value chains and their costs. Most corruption in Cameroonian forest product chains occurs when in accessing markets (transport to markets and ports, and obtaining market places) and accessing resources (obtaining land titles, permits and waybills) (Ingram et al., 2015). The costs of bribery can therefore been taken as a proxy for corruption (Philips, 2006).

[3] Power is defined as the possession of control, authority or influence over others and the ability to enforce wishes when opposed, including when livelihoods are threatened.

Institutions are the formal and informal norms, rules, procedures and processes defining how individuals interrelate, act and make decisions within and outside of organisations. Institutions may not be clearly defined or static in terms of time or space, can be formal or informal and are interlinked with issues of knowledge, power and control. Leach et al. (1999) emphasise that informal institutions are upheld by socially shared usually unwritten rules, created and enforced among the stakeholders involved (Arnold and Ruis Pérez, 2001). The relationships and interactions between the system that is governed and the governance arrangements affects the natural system and setting limits to resource users' potential (Kooiman and Bavinck, 2005). Variables affecting the impacts of governance are summarised in Figure 1. These principles provide a framework for analysing governance arrangements in NTFP value chains.

Figure 1 Institutional design principles

3. Methodology

Literature was reviewed to identify the NTFPs most affected by the practices of state agents enforcing regulations on their transportation and trade and to understand the regulatory framework concerning NTFP exploitation, use and trade in Cameroon and in the COMIFAC region. The okok chain was selected as a case due to its high economic, social and environmental value – both in Cameroon and in other Central African countries (Ingram et al., 2012a). A policy analysis was conducted to assess the influence of regulations on trade and in the light of the COMIFAC guidelines on the sustainable management of NTFPs of plant origin (COMIFAC, 2008). Interviews were conducted with government staff, NGOs, international development organisations, and enterprises in the period 2009 to 2013 as part of four consultation sessions concerning the revision of the forestry law on NTFPs. Both the literature (Ingram et al., 2012c;

Ndoye and Awono, 2007; Foundjem-Tita et al., 2013; Ndoye and Awono, 2010) and the sessions indicated that the regulatory framework and legality was an issue at the trader and transporter stages of the chain, justifying the selection of these areas for study.

Interviews were held with 45 traders in Cameroon in 2010 to establish the 10 most important commercialised NTFPs. Okok was stated as the most important, confirming the literature review and justifying its selection for this study. Of these traders, 12 small and medium enterprises trading in okok agreed to participate in the survey, upon the understanding that recommendations to improve the sector would be passed onto decision-makers. Data was collected at road-side check-points and barriers along the two main roads used to transport okok from one of the major production zones around Sa'a, north of Yaoundé in the Centre region, to the main export port of Ideneau in Southwest region, near the Nigerian border, a distance of over 500 km. Semi-structured questionnaires guided interviews with traders, asking about the value chain, stakeholders, and how the chain is governed: the regulations, routes used, the agents stopping vehicles for controls. Corruption was measured by ascertaining costs incurred at every check-point or barrier and to which type of agent payments were made, the location of the transaction, whether receipts were issued, the volume of okok transported on each trip, the purchase and selling prices and product spoilage en route and the perceived impacts on their trade. Traders were accompanied every two days for a period of 26 weeks. Of the 12 traders, six were active throughout the year, three for 26 weeks and three for 20 weeks. Traders subsequently recorded this information themselves for the following six months using a data collection form. Data were analysed using Microsoft Excel. Recommendations based on this data were discussed with traders and also developed further with direct stakeholders (harvesters, traders, exporters),

government and civil society organisations in the sector, as part of the consultative process to revise the 1994 Forestry and Wildlife Law.

4. Results

The first section summarises the results of the literature review, policy analysis and interviews – providing details of the regulatory framework and the reality of the formal arrangements governing okok trade, answering the first research question. The second section details the results of interviews and data collected on the economic and environmental impacts of the governance arrangements, responding to the second question. Based on the literature and interviews, the third section details recommendations on changes required to create a governance framework that supports sustainable NTFP trade in Cameroon.

4.1 Regulatory framework and stakeholders in NTFP trade

Legislation regarding forests in Central Africa is based upon a forest management model that is centred on timber exploitation. Although national forest codes make reference to NTFPs, they are often considered as secondary or accessory products (COMIFAC, 2008). National strategies defining the political priorities for effective valorisation of NTFP have been non-existent until recently. For example, in 2012 the Cameroonian government and stakeholders finalised a plan to manage and develop NTFP (Ministere des Forets et de la Faune, 2012). In all Central African countries, the state is the main owner of forests and natural resources, setting the rules governing access to NTFP and trade at local and national levels. However customary management of forests and resources continues in many countries and remains particularly prevalent in rural, remote and forested areas (Laird et al., 2010; Sunderland et al., 1998). The Cameroonian 1994 Forestry and

Wildlife Law 94/01 (Art. 20) distinguishes between the permanent forest domain — land permanently allocated to forests and/or wildlife habitats (i.e. protected areas and timber concessions), and the non-permanent forest domain — forested lands that can potentially be allocated to other land uses and can be privately owned. Legislation in most countries has enshrined access to resources in the non-permanent domain through traditional use rights, entitling the local population to consume products collected from the forest. The commercialisation of these products is prohibited by law in several countries, regardless of the vulnerability of the resource. Exceptions are small-scale commercialisation in the DRC and potentially in Cameroon with the proposed revisions to the forestry law. Rights and legal access to commercialise specific NTFP are granted in the form of harvest and exploitation permits, and management conventions for specified areas such as for community and communal forests in Cameroon, Gabon, the Republic of Congo and the DRC.

In Central Africa generally and in Cameroon, the institutional framework is characterized by a multitude of ministries and organisations involved in the NTFP sector. In Cameroon, multiple government agencies govern NTFP trade, including the ministries of forestry and wildlife, livestock, agricultural, enterprises and customs. This lack of institutional leadership, human and financial constraints and effective collaboration between the concerned institutions does not facilitate the development of the sector, despite it being stated as a political priority according to Cameroonian Forest Environment Sector Programme and the COMIFAC Convergence Plan and the Congo Basin Forest Partnership action plan. NTFPs are only briefly mentioned in the elaboration and implementation of poverty reduction policies such as the Poverty Reduction Strategy Document. In 2012 a national action plan for NTFPs was developed with private sector, research, development and civil society organisations (Ministere des Forets et de la Faune, 2012).

As a result, whilst NTFPs are the subject of numerous conservation projects, they have only recently been targeted by programs and projects promoting sustainable enterprise development.

As in most COMIFAC countries, trade in specific NTFPs is regulated in Cameroon. The main texts are the 1994 Law on Forestry and Wildlife n^{o} 94/01 and a 1995 decree N° 95/53 fixing the modalities of the application of the forestry regime. Every person or organisation intending to commercialise 'special forestry products' and other NTFPs first needs to be approved (*gré à gré*)[4] by the Ministry of Forestry and Wildlife (MINFOF) in Yaoundé. This approval allows access to the sector and renders the trader legal. To obtain approval, a file of information is required, the fee of which costs 150,000 CFA (333 US$). Traders also reported that additional bribes are commonly needed to obtain progress a dossier through the bureaucratic process and obtain the agreement. The procedures are cumbersome. They involve twelve separate steps and documents[5], and are highly hierarchical, as approval is required by the Prime Minister. They are costly at around 2.5 to 3 million CFAF (5,555 to 6,666 US$) and time-consuming taking between six to ten months. The system is difficult, particularly for individuals or SMEs located far from the capital, with few political connections, or access to sufficient capital to invest in the approval dossier (Nguenang et al., 2013) or for bribes to obtain the approval. Due to these reasons, the number of approvals has remained low, with on average four granted annually since 2008. As a consequence, NTFPs generate comparatively lower revenues for the state compared to timber or wildlife, damning the image of the sector as unimportant and of low value. The average annual

[4] Loi 94, Articles 56(3), 148, 149.

[5] Individuals need to provide a stamped letter indicating the quantity requested, a curriculum vitae indicating their experience and qualifications, proof of any criminal record, statistics and their registration with the Chamber of Commerce. For 'moral' persons or organisations, a stamped letter indicating the quantity and type of NTFP requested, type of business and address of the organisation, a copy of their legal status, statistics and registration with the chamber of commerce, copy of police record, a curriculum vitae of the manager, current and former activities of the organisation, certificate showing social security (CNPS) contributions, evidence of tax payments, documents indicating the area of interest, technical knowledge, attestation of financial capacity, and receipts indicating payment of the 10 CFA per kg regeneration tax for the entire quota has been paid.

253 value of tax revenues reported by MinFoF in the period 2008 to 2012 was 15,225,292 CFAF
254 (33,834 US$).
255
256 **Table 1** Special forestry product permits and approvals
257
258 In Cameroon there are administrative hurdles to obtain an exploitation permit. After the approval,
259 an exploitation permit is required to access to markets for certain special forestry products
260 (*produits forestier spéciaux*). A flat-rate regeneration tax of 10 CFA per kg is payable for all
261 special forestry products in Cameroon. A waybill (*lettre de voiture*) is required for the permit
262 holder to transport NTFPs (Decret 95 article 127(2)), without which they may be subject to fines
263 and imprisonment. To export forest products, article 66 (2) of the 1994 Law additionally requires
264 that traders possess an export authorization, a certificate of origin, a specification sheet, a
265 phytosanitary certificate and proof of payment of a graduated surtax depending on the volume to
266 be exported and the level of processing (MINFOF, 2006). The steps in obtaining legal access to
267 NTFP resources and markets are summarised in Figure 2.
268
269 **Figure 2** Administrative procedures for trading NTFPs in Cameroon
270
271 Whilst not explicit or seemingly intended, a result of the regulatory framework is that it creates
272 differential access to legal trade. The administrative requirements for trade in NTFP are similar to
273 those for exploiting timber sector, even though NTFP exploitation rarely occurs on a similar scale
274 or is of a similar value for individual permit holders. For example, the annual value of fiscal
275 receipts from timber from 2000 to 2005 was 84 million US$ (de Wasseige et al., 2009), and in

2012, tax revenues from timber were 14.4 billion CFA (32 million US$)[6]. The permitting system is accessible for larger companies and elites with political links, which can be seen in their domination of permits and agreements in the last decade (Ingram, 2014). In contrast, smaller enterprises and community-based organisations, including community forests, have faced major problems and generally not been able to obtain agreements or permits, even when supported by local and international support organisations and NGOs (Nguenang et al., 2013; Ingram, 2014). This difficult, centralised and relatively costly administrative system has resulted in widespread and persistent corruption and illegal transactions in the transportation and trade of high value NTFPs. The statutory system is avoided as the benefits of obtaining permits are not perceived as outweighing time and financial costs, so the majority of traders sell nationally and export without the necessary permits. Some traders are not aware of the statutory permits (Ingram et al., 2012c; Laird et al., 2010; Ndoye and Awono, 2010). Others prefer to operate illegally, as legality does not result in less corruption from forestry or other officials (Foundjem et al., 2013; Ingram et al., 2012c).

4.2 Impacts of governance arrangements on the *Gnetum* spp. value chain

The impacts of the governance arrangements are examined from two angles, economic and environmental.

4.2.1 High administrative and transaction costs

The administrative procedures were seen as cumbersome, leading to high transaction costs in terms of time, financial resources and energy. The number of permits is inversely related to the

[6] Annual forestry fee (*redevance forestière annuelle, RFA)* 6.5 billion, cutting tax (*taxe d'abattage*), 6 billion and factory tax (*taxe d'entrée à l'usine*) 1.9 billion (pers. com. Abouen, Ministry of Finance, July 2013)

number of SMEs involved in the sector, which forces many to operate illegally. For instance, the number of exploitation permits for special forestry products and approvals delivered by MINFOF have decreased over time, shown in Table 1, despite strong evidence of growing volumes of trade (Betti, 2007; Ingram, 2014; Ndoye and Ruiz Perez, 1997; Ruiz-Pérez et al., 1999). The difficulties of the quota allocation system, obtaining waybills, the short timescales covered by permits and the social ties and power of rent seekers restricts access to permits for all but the most powerful (Tieguhong et al., 2010). Thus most traders operate illegally, and often informality. Social ties to members of the quota allocation committee and to MINFOF officials were reported as critical roles in obtaining quotas. A consequence is that quotas and waybills are allocated to individuals or enterprises not actively participating in the chains, who sell them to SMEs trading in the regulated NTFPs, at prices of up to 500% higher than officially paid for waybills. This represents lost revenue for the government and additional costs for enterprises, with profit gained by a few rent seekers. The practice makes control of harvesting practices un-transparent when the permit holder has no control or knowledge of practices on the ground. Figure 3 shows that the price of waybills increased between 2000 and 2002. This influenced many enterprises to operate illegally. Given that quotas and permits are for a one-year period with taxes payable regardless of the actual quantity exploited and traded, most buyers seek to maximise quantities to lower this fixed cost. The government collects around 60% of the value of the regeneration tax (Betti, 2007).

Figure 3 Yearly variation in waybill and tax costs in Cameroon

4.2.2 The economic costs of corruption

Over the year which okok traders were tracked from the production zone to the port of export, on average, vehicles were held up for five minutes at each of the average 60 check-points from the Sa'a (area of production) to Ideneau (port of export). Of these check points, only 10.6% were legal (indicated by payment to a government agent being accompanied by a receipt), 65.6% were illegal (payment to a government agent without a receipt) and 23.8% had both legal and illegal operations. At each checkpoint several financial transactions took place. A total of 18,368 financial transactions took place within the study period, 83.6% of which were illegal and 18.4% legal. The 12 traders spent a total of 341,250,960 CFA, equivalent to US$ 758,336 on all transactions during this period, 33.5% of the value of which was on illegal transactions (Table 2). Thirteen different types of state agents conducted controls and requested bribes, with MINFOF agents, police, gendarmes and customs officers being the most predominant (Figure 4).

Table 2 Number of transactions and amount spent per route taken and legality status

Figure 4 Proportion of costs of corruption from okok traders per type

4.2.3 Encouraging unsustainable resource management

A 2006 Ministerial decision[7] specified 13 NTFP as 'Special Forestry Products' and which are regulated by MINFOF through quotas determined annually by an inter-ministerial committee. The listing and quotas are arbitrary and the logic is unclear. Quotas are allocated for all Special

[7] Décision No 0336/D/MINFoF du 6 Juillet 2006, fixant la liste des produits forestiers spéciaux présentant un intérêt particulier au Cameroun

Forestry Products (except recently *Prunus africana*) without any knowledge of the resource base or inventory, as required by the 1994 Law. Although specified in the 1995 Decree (Article 35) and Article 2 of the 2006 decision, resource inventories have not been implemented for *Gnetum* spp., with only one NTFP, *Prunus africana*, recently inventoried. This is a special case given its Convention on International Trade in Endangered Species of Wild Fauna and Flora listing.

The one year validity of the permit from the date of delivery forces permit holders to exploit resources in any way possible to meet their quotas, even if harvesting is not sustainable (Ndoye *et al*., 2010; Tieguhong *et al*., 2010). This is illustrated by 46% of *Gnetum* harvested from the Southwest and Littoral regions being harvested unsustainably: the entire vine is uprooted or the tree supporting the vine felled (Ingram et al., 2012c). This practice inhibits regeneration and increases scarcity. Illegal exploitation was seen as the cause of environmentally unsustainable harvesting practices.

4.2.4 *Environmental impacts of corruption*

Okok leaves are perishable but if kept in suitable conditions remain saleable for around 10 days. Extreme humidity or dryness results in losses. During transport, on average 428 packets (about 0.4 tons) (standard deviation 278 packets) of leaves deteriorated to an unsaleable condition per trip (on average 5.3% of the quantity transported on a trip). Over the six-month period of study, 36,783 packets (about 37 tons) out of the total of 692,024 packets (around 692 tons) became unsaleable. The traders perceived these losses as an impact of corruption, due to opening and closing of vehicles at each control and due to the additional journey time. Traders reported that to counter such practices the amount purchased and therefore harvested, is routinely higher.

4.3 Recommendations for a enabling regulatory and policy environment for sustainable NTFP trade

Major changes were recommended to create a favourable business environment for sustainable NTFP trade in Cameroon, including:

- Enacting recommendations from the stakeholder consultation process to revise the forestry laws, to reflect the realities and importance of the NTFP sector to those directly involved as harvesters, traders and consumers;
- Creating affordable access to resources and markets through a graduated system of permits and associated fiscal regime, which is based on the nature of the species, its vulnerability to harvesting, the exploitation method, which promotes legality, sustainability and employment;
- Continue campaigns against corruption in the sector, by forestry and other officials, particularly in the permitting process and during transport, and eliminate illicit check points with clear signals made public by monitoring, enforcement and punishment of corrupt agents;
- Introduce procedures to reduce administrative bottlenecks and corruption and stimulate lower cost
- The validity of the exploitation permits needs to be changed, moving towards area based allocation units where specified NTFP are collected in a given area under a management plan – allowing long term, sustainable exploitation and viable businesses.
- The exploitation permit should not be transferred or sold in the form of a waybill and should be accompanied by technical prescriptions related to the exploitation, conservation

and processing of the NTFP with financial obligations that encourage processing and employment within the country.

- More transparent models could either be where MINFOF conducts inventories financed by taxes, or where the trader conducts inventories and develops a management and exploitation plan, according to regulatory guidelines approved by the public forest administration, as occurs in the timber sector.

5. Discussion

The formal arrangements and stakeholders involved in the okok value chain in Cameroon reflect Kooiman et al. (2008)'s work: a multi-stakeholder, plural interplay of governance arrangements with institutions representing divergent perceptions and interests. While regulations, governing institutions and boundaries were known and accepted by traders and transporters, with moral ground as long lived national laws, few of the other institutional design principles were met. This strongly suggests, that the arrangements are ineffective. The lack of monitoring and compliance, of sanctions and enforcement – creates space for the illegal practices (seen as morally unjust) which were found to be common in okok transport and trade. Such normality of illegality is mirrored by other studies of NTFP sector in Cameroon (Foundjem-Tita et al., 2013) and in the region (Djeukam, 2007). Most forest policy reforms in COMIFAC countries have targeted timber sector, focussing on sustainability, legality and informality (Cerutti and Tacconi, 2006; University of Copenhagen, 2012) and the fiscal regime (Betti, 2007; Bigombe, 2004). In contrast, the non-timber sector has been invisible for policy makers, both in terms of its social and economic importance. The legal and institutional framework for NTFP trade in Cameroon,

414 combined with the pervasiveness of corruption, hinders sustainable development of this
415 important and apparently growing sector.
416
417 The study shows the discrepancy between regulations on paper and common practices on the
418 ground, indicating that implementation is a critical variable in the sustainability of NTFP chains.
419 This finding reflects the institutional design principles concerning the need for congruence
420 between rules being adapted to local conditions and having benefits proportional to inputs; that
421 affected parties participate in developing and modifying rules; compliance monitoring with rules
422 by monitors who are accountable to users; that there are sanctions for rule violations; that
423 stakeholders can devise their own (effective) institutions; that such activities are nested into
424 different layers of governance arrangements; and for strong institutional enforcement (Agrawal
425 and Chhatre, 2006; Cox et al., 2010; Ostrom, 1990; Scott, 2001). The lack of participation of in
426 creating the rules, in conflict resolution, and accountability of the state to stakeholders in the
427 chain were all issues raised in the consultative process to revise the law (Awono et al., 2010;
428 FAO, 2010).
429
430 The impacts of regulation and corruption in increasing trading costs, supports Kaplinsky and
431 Morris' (2003) view that governance does indeed "matter" – affecting not just competitiveness
432 but also allowing indirect stakeholders (state officials) to gain strongly at the expense of direct
433 stakeholders (traders and transporters). Moreover, given this ineffective, poor governance setting,
434 the aims of national and regional forestry regulations to ensure poverty reduction, sustainable
435 forest management and trade, are largely impaired. The okok case appears typical in the sector:
436 corruption has been shown to comprise up to 20% of okok traders gross costs (Ndoye *et al*.,
437 2010), and 37% of exporters' costs (Ingram et al., 2012c). This study had similar findings, with

corruption accounting for around 32% of all costs. These costs are also born by harvesters, as traders purchase at lower prices to maintain profit margins. High trader costs lead to higher prices passed onto retailers and consumers. Reduced profits were reported to lead to closure or stagnation of some enterprises (Tieguhong et al., 2010). The high costs of regulation and corruption stimulate a vicious circle of illegal trade, which further exacerbates trader's difficulties in obtaining permits. At the national level another impact is low revenue capture, due to tax evasion and non-collection of fees. This in turn contributes to the perception that the NTFPs sector is of low economic and social importance.

The environmental impacts of regulations are counter to the intention of the 1994 law, which seeks "to achieve the general objectives of forest policy, wildlife and fisheries, in a framework for integrated management ensuring, in a sustained and sustainable way, the conversation and the use of those resources and of different ecosystems" (Art. 1). The ecological sensitivity of NTFPs is highly geographic, species and part specific (Cunningham, 2001; Ticktin, 2004). It is known that the vulnerability of okok, and its regeneration potential, depend on the combination of natural variables and levels of abundance and density related to its preferred ecosystem type and the disturbance thereof; the parts harvested (leaves and stems), the quantity harvested and the harvesting techniques (Ingram, 2014). However, permits are based on actual levels of supply, rather than the current demand based system. A knowledge of the status of the resource is essential to ensure and regulate sustainable exploitation (FAO, 2010). Resource inventories based on scientific and local knowledge and management plans have long been recommended for vulnerable and high value NTFPs prior to exploitation and permitting (ETFRN, 2000; FAO et al., 2001). Although specified in the laws, they have not been implemented for *Gnetum* spp. Further environmental impacts of inappropriate regulations and corruption include the larger volumes

462 harvested and possible over-exploitation of the resource in order to cover losses incurred during
463 transport, to meet market demand.
464
465 These impacts are important for several reasons. First because poverty in Central Africa has
466 remained prevalent in rural areas, where on average 56% of the population, about 65 million
467 people, live. These people living adjacent to or in forests and are highly dependent on natural
468 resources such as okok, for food and income (Tieguhong and Nkamgnia, 2012; FAO, 2007;
469 Ingram et al., 2011; Tieguhong et al., 2009a). Whilst NTFPs can contribute to poverty alleviation,
470 better access to markets is essential (Tieguhong et al., 2012a; Pfund and Robinson, 2005;
471 Tieguhong and Ndoye, 2006; Tabuna, 2007). A governance regime that supports sustainable
472 chains is critical if NTFPs are to constitute part of a lasting path out of poverty, rather than a
473 short term gain that ultimately, exacerbates the difficulties faced by the poor and rural dwellers in
474 the region (Ingram, 2014).
475
476 Secondly, as the importance of the timber sector in the region has decreased due to the economic
477 crisis, fiscal revenues have diminished (Tieguhong et al., 2009b), along with employment and job
478 creation opportunities. Although most COMIFAC member countries have planned or are
479 implementing growth and employment strategies, the NTFP sector is hardly integrated into them
480 (Tieguhong et al., 2012).
481
482 Thirdly, the interviews show how many stakeholders have limited options to change regulatory
483 arrangements, except to work illegally, as they until recently they have had little voice in
484 governance arrangements or policymaking. The changes to the regulatory and fiscal regime
485 proposed by the COMIFAC directives (COMIFAC, 2008) and now reiterated in the long

proposed revision to the forestry laws in Cameroon, represent innovations that could create a more enabling environment. These include the clarification of terminologies on NTFP of plant origin and elaborating the potential for differential taxation regimes (FAO, 2010), and the promotion of extending traditional use rights of local communities to commercial rights, justified by the poverty context and to achieve the MGDs (Chomitz et al., 2007). A careful balance between specifying non-threatened NTFPs, taking into account the parts harvested, the sustainability of harvesting practices, the potential of natural stands, the existing and development potential of domestication, and the capacity of the government to support and enforce such changes has been seen as essential (COMIFAC, 2008; FAO, 2010). The okok case illustrates that unsustainable harvesting practices of wild or cultivated NTFPs are real and pertinent issues. However, until both the revised law and its implementing decrees and decisions are enacted, practical application of the consultations, COMIFAC directives and regional harmonisation will remain out of reach.

The recommendations for changes to create a more effective, less corrupt governance arrangements mirror other commentators viewpoints and point towards growing consensus on how the regulatory framework should be not just revised, but also enforced. This includes that permits should to reflect the nature of the species and the exploitation methods while reflecting the impact on sustainability and its vulnerabilities (Tchatat and Ndoye, 2006; Laird et al., 2010). Enacting only the recommendations from consultations and COMIFAC directives may be insufficient: investments in transport infrastructure are also needed, mirroring Sachs and colleagues (2004) recommendations.

6. Conclusions

Approaches to reduce poverty through economic growth have focused on the private sector, particularly small and medium sized enterprises, such as those involved in NTFP chains. The growth and development of such businesses has been seen as an opportunity in reducing rural poverty given a favourable enabling institutional, policy, legal and financial environment (Albu and Griffith, 2005; Kozak, 2009; Macqueen et al., 2008; Tieguhong and Ndoye, 2006). This case study of okok demonstrates that businesses based on NTFPs appear viable despite being burdened by high costs and a disabling legal and institutional context. Their long term environmental sustainability is questionable, with corruption leading to waste and possibly unsustainable access to wild resources.

Improved governance, particularly reducing corruption, could stimulate growth and development for traders and transporters of NTFPs and the ability of the government to enable sustainable trade. The okok value chain highlights that improvements in governance are imperative if the economic impact upon the livelihoods of thousands of people is to be maintained or enhanced to ensure sustainable trade. This study shows the negative economic and environmental impacts of arrangements governing the sector. It illuminates that the negative impacts arise due to the differential power and ability of traders and transporters in the chain to access regulatory systems, and the common practice of corruption, which promotes a vicious circle of illegality and informality. The review of the law and the case shows the lack of transparency and the complexity of regulatory procedures, their arbitrary application and costliness, create further opportunities for corruption. The current illogical and inadequate legal framework hinders legal access to these forests resources and their markets, their sustainable stewardship, and creates a disenabling business environment and diminishes incomes. Corruption also leads to product

spoilage and losses, wasting resources and possibly negatively impacting rural and urban food security.

By reducing the transaction costs related to NTFP trade by increasing transparency of the permitting system, by decreasing the number of check points, issuing receipts for payments made to government agents and instituting deterrent punishments, profits to traders and revenue to government could increase, stimulating the sector. Hope is offered in this direction by the COMIFAC directives for the sustainable management of NTFP in Central Africa. Implementing such a framework implies changes to the political, legislative, fiscal and institutional arrangements governing the access to the production and commercialisation of NTFPs.

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References

557 Agrawal, A., Chhatre, A., 2006. Explaining success on the commons: Community forest
558 governance in the Indian Himalaya. World Development 34, 149-166.
559 Albu, M., Griffith, A., 2005. Mapping the Market: A framework for rural enterprise development
560 policy and practice, Markets and Livelihoods Programme. Practical Action, Warwickshire,
561 UK, p. 36.
562 Arnold, J.E.M., Ruis Pérez, M., 2001. Can non-timber forest products match tropical forest
563 conservation and development objectives? Ecological Economics 39, 437-447.
564 Awono, A., Ingram, V., Schure, J., 2010. Sustainable non-timber forest trade for small and
565 medium enterprises in Central Africa Project GCP/RAF/408/EC « Mobilisation et
566 Renforcement des Capacités des Petites et Moyennes Entreprises impliquées dans les Filières
567 des Produits Forestiers Non Ligneux en Afrique Centrale ». FAO-CIFOR-SNV-World
568 Agroforestry Center-COMIFAC-GTZ, Yaoundé, Cameroun, p. 10.
569 Awono, A., Manirakiza, D., Ingram, V., 2009. Etude de base de la filiere *Gnetum spp* (Fumbwa)
570 dans les Provinces de L'Equatuer et de Kinshasa, RDC, in: CIFOR (Ed.), Project
571 GCP/RAF/408/EC « Mobilisation et Renforcement des Capacités des Petites et Moyennes
572 Entreprises impliquées dans les Filières des Produits Forestiers Non Ligneux en Afrique
573 Centrale ». FAO-CIFOR-SNV-World Agroforestry Center-COMIFAC, Yaoundé p. 82.
574 Betti, J.L., 2007. Perspectives d'une Fiscalite Appropriee Promouvant le Commerce et la Gestion
575 Durable Des Produits Forestiers Non Ligneux en Afrique Centrale, GCP/RAF/398/GER
576 Renforcement de la sécurité alimentaire en Afrique Centrale à travers la gestion et l'utilisation
577 durable des produits forestiers non ligneux. Ministère des Forêts et de la Faune/Cabinet/CT1,
578 p. 58.
579 Bigombe, L.P., 2004. Le retournement de l'État forestier. L'endroit et l'envers des processus de
580 gestion forestière au Cameroun. Presses de l'UCAC, Yaoundé, Cameroon.

581 Bikoue, M.A.C., Essomba, H., Tabuna, H., Degrande, A., Tchoundjeu, Z., Walter, S., 2006.
582 Gestion des ressources naturelles fournissant les produits forestiers non ligneux alimentaires
583 en Afrique Centrale, Produits forestiers non ligneux Document de travail No.5 Organisation
584 des Nations Unies pour l'alimentation et l'agriculture, Yaounde, p. 104.
585 Bonannée, M., Asseng Zé, A., Walter, S., 2007. Le cadre legislatif et reglementaire regissant
586 l'utilisation des Produits Forestiers Non Ligneux (PFNL) en Afrique Centrale, Programme des
587 Produits Forestiers Non Ligneux Projet GCP/RAF/398/GER Renforcement de la Securite
588 Alimentaire en Afrique Centrale a travers la gestion ret l'utilisation durable des Produits
589 Forestiers Non Ligneux. Programme de partenariat Norvege-FAO, Yaounde, Cameroon, p. 5.
590 Cerutti, P.O., Lescuyer, G., Assembe-Mvondo, S., Tacconi, L., 2010. The challenges of
591 redistributing forest-related monetary benefits to local governments: a decade of logging area
592 fees in Cameroon. International Forestry Review 12, 130-139.
593 Cerutti, P.O., Tacconi, L., 2006. Forests, Illegality, and Livelihoods in Cameroon, Working Paper
594 No. 35. CIFOR, Bogor, p. 28.
595 Cerutti, P.O., Tacconi, L., Lescuyer, G., Nasi, R., 2013. Cameroon's hidden harvest: Commercial
596 chainsaw logging, corruption, and livelihoods. Society & Natural Resources 26, 539-553.
597 Chomitz, K.C., Buys, P., de Luca, G., Thomas, T.S., S.Wertz-Kanounnikoff, 2007. At
598 loggerheads? Agricultural expansion, poverty reduction and environment in the tropical
599 forests World Bank., Wasginton DC, p. 308.
600 COMIFAC, 2008. Sub-regional guidelines on the sustainable management of NWFPs of plant
601 origin in Central Africa, Yaounde, p. 26.
602 Cox, M., Arnold, G., Tomás, S.V., 2010. A review of design principles for community-based
603 natural resource management. Ecology and Society 15, 38.
604 Cunningham, A.B., 2001. Applied ethnobotany: people, wild plant use and conservation, London.

de Wasseige, C., de Marcken, P., Bayol, N., Hiol Hiol, F., Mayaux, P., Desclée, B., Nasi, R., Billand, A., Defourny, P., Eba'a, R., 2012. Les Forêts du Bassin du Congo – Etat des Forêts 2010. Office des Publications de l'Union Européenne, Luxembourg, p. 276.

de Wasseige, C., Devers, D., Marcken, P., Eba'a, R.A., Nasi, R., Mayaux, P., 2009. The Forests of the Congo Basin. State of the Forest 2008. Office des publications de l'Union Européenne, Yaoundé, Cameroon, p. 426.

Djeukam, R., 2007. Le cadre legislatif et reglementaire de l'utilisation des produits forestiers non ligneux au Cameroon, GCP/RAF/398/GER Renforcement de la sécurité alimentaire en Afrique Centrale à travers la gestion et l'utilisation durable des produits forestiers non ligneux. Food and Agriculture Organisation of the United Nations (FAO), Yaounde, p. 47.

ETFRN, 2000. Developing needs-based inventory methods for non timber forest products, Developing Needs-Based Inventory Methods For Non-Timber Forest Products Application And Development Of Current Research To Identify Practical Solutions For Developing Countries. European Tropical Forest Research Network, FAO, Rome, Italy.

FAO, 2010. Rapport Consolidé des Ateliers Préliminaires Techniques de Consultation Régionale sur les Produits Forestiers Non-Ligneux (PFNL) FAO, Yaoundé, Cameroon.

FAO, Wong, J.L.G., Thornber, K., Baker, N., 2001. Resource Assessment of Non-Wood Forest Products: Experience and biometric principles FAO, Rome.

Foundjem-Tita, D., Speelman, S., D'Haese, M., Degrande, A., Van Huylenbroeck, G., Van Damme, P., Tchoundjeu, Z., 2013. A tale of transaction costs and forest law compliance: Trade permits for Non Timber Forests Products in Cameroon. Forest Policy and Economics.

Foundjem, D.T., 2013. A new institutional economic analysis of policies governing non-timber forest products and agroforestry development in Cameroon. Ghent University.

Harford, T., 2006. The Undercover Economist. Abacus, London.

629 Ingram, V., 2012. Governance of non-timber forest products in the Congo Basin. ETFRN news
630 53, 36-46.
631 Ingram, V., 2014. Win-wins in forest product value chains? How governance impacts the
632 sustainability of livelihoods based on non-timber forest products from Cameroon, Amsterdam
633 Institute for Social Science Research, Governance and Inclusive Development Group.
634 University of Amsterdam, Amsterdam, p. 361.
635 Ingram, V., Ndoye, O., Iponga, D.M., Tieguhong, J.C., Nasi, R., 2012a. Non timber forest
636 products: Contribution to national economy and strategies for sustainable management, in: de
637 Wasseige, C., de Marcken, P., Bayol, N., Hiol Hiol, F., Mayaux, P., Desclée, B., Nasi, R.,
638 Billand, A., Defourny, P., Eba'a, R. (Eds.), The Forests of the Congo Basin. State of the Forest
639 2010. Office des publications de l'Union Européenne, Luxembourg, p. 276.
640 Ingram, V., Ndoye, O., Iponga, D.M., Tieguhong, J.C., Nasi, R., 2012b. Produit forestierer non-
641 ligneux : contribution aux economies nationales et strategies pour developpement durable, in:
642 de Wasseige, C., de Marcken, P., Bayol, N., Hiol Hiol, F., Mayaux, P., Desclée, B., Nasi, R.,
643 Billand, A., Defourny, P., Eba'a, R. (Eds.), Les Forêts du Bassin du Congo – Etat des Forêts
644 2010. Office des Publications de l'Union Européenne, Luxembourg, p. 276.
645 Ingram, V., Tonen, M.R., Dietz, T., 2015. A fine mess: Bricolaged forest governance in
646 Cameroon. International Journal of the Commons Special edition 'Challenges of critical
647 institutionalism – bricolage and the dynamics of natural resource governance".
648 Ingram, V.J., Ndumbe, L.N., Ewane, M.E., 2012c. Small scale, high value: *Gnetum africanum*
649 and *Gnetum buchholzianum* value chains in Cameroon, Small Scale Forestry, 13-02-2012 ed.
650 Kaimowitz, D., 2003. Forest law enforcement and rural livelihoods. The International Forestry
651 Review 5, 199-210.

652 Kaplinsky, R., Morris, M., 2003. Governance Matters in Value Chains. Journal of Development
653 Alternatives, Inc. 9, 11-18.
654 Kaufmann, D., Kraay, A., Mastruzzi, M., 2010. Governance Matters IV Updated Governance
655 Indicators 1996-2009, in: World-Bank (Ed.), Worldwide Governance Indicators (WGI)
656 project, Washington.
657 Kooiman, J., Bavinck, M., 2005. The governance perspective. Fish for life: Interactive
658 governance for fisheries, 11-14.
659 Kozak, R.A., 2009. Alternative business models for forest - dependent communities in Africa: A
660 pragmatic consideration of small - scale enterprises and a path forward Madagascar
661 Conservation and Development 4, 76-83.
662 Laird, S., Ingram, V., Awono, A., Ndoye, O., Sunderland, T., Lisinge, E., Nkuinkeu, R., 2010.
663 Integrating customary and statutory systems: The struggle to develop a legal and policy
664 framework for NTFPs in Cameroon, in: Laird, S.A., McLain, R., Wynberg, R.P. (Eds.), Wild
665 Product Governance: Finding Policies that Work for Non-Timber Forest Products. Earthscan,
666 London, pp. 53-70.
667 Laird, S.A., McLain, R., Wynberg, R.P., 2009. Wild Product Governance: Finding Policies that
668 Work for Non-Timber Forest Products, Policy Brief. People and Plants International London,
669 p. 16.
670 Leach, M., Mearns, R., Scoones, I., 1999. Environmental Entitlements: Dynamics and Institutions
671 in Community-Based Natural Resource Management. World Development 27, 225-247.
672 Macqueen, D., Dufey, A., Gomes, A.P.C., Hidalgo, N.S., Nouer, M.R., Pasos, R., Suárez, L.A.A.,
673 Subendranathan, V., Trujillo, Z.H.G., Vermeulen, S., Voivodic, M.d.A., Wilson, E., 2008.
674 Distinguishing community forest products in the market. Industrial demand for a mechanism

675 that brings together forest certification and fair trade, Small and Medium Forestry Enterprise
676 Series. International Institute for Environment and Development Edinburgh, UK, p. 123.
677 Mala, W., 2008. Statut De Mise A Jour Des Informations Disponibles Sur L'exploitation Des
678 PFNL Dans Le Basin Du Congo, in: CIFOR (Ed.), Rapport. CIFOR, Yaounde, p. 54.
679 Mayers, J., Vermeulen, S., 2002. Power from the Trees: How Good Forest Governance can Help
680 Reduce Poverty. IIED, London, p. 8.
681 MINFOF, 2006. Circular letter no. 0253/LC/MINFOF/SG/DF/SDAFF of 31 May 2006, related to
682 documents required at check points and fix or mobile control posts, in: Ministry of Forests and
683 Wildlife, D.o.F., SDAFF (Ed.), Yaoundé, Cameroon.
684 Ministere des Forets et de la Faune, 2012. Plan National de Développement des Produits
685 Forestieres Non Ligneux in: MINFOF, D. (Ed.), Direction de la promotion et de la
686 transformation des produits forestiers, ed, Yaounde, p. 35.
687 Molnar, A., Mbile, P., Bandiaky, S., Kozak, R., Canby, K., France, M., 2010. Small Scale, large
688 impacts. Transforming Central and West African Forest industry and trade to improve
689 sustainable development, growth and governance. Rights and Resources Initiative,
690 Washington DC, p. 48.
691 Ndoye, O., Awono, A., 2007. Regulatory policies and Gnetum spp. trade in Cameroon, Forest
692 Livelihood Briefs No 6. Center for International Forestry Research, Yaounde, p. 2.
693 Ndoye, O., Awono, A., 2010. Regulatory policies and *Gnetum* spp. trade in Cameroon:
694 Overcoming Constraints that Reduce Benefits and Discourage Sustainability, in: Laird, S.A.,
695 McLain, R., Wynberg, R.P. (Eds.), Wild Product Governance: Finding Policies that Work for
696 Non-Timber Forest Products. EarthScan, London, pp. 71-76.
697 Ndoye, O., J.C., T., Asseng Ze, A., Grouwels, S., Masuch, J., Fokou, S.I., 2010. Regulatory
698 policies and development of non-wood forest product enterprises in Central Africa, XXIII

699 IUFRO World Congress “Forests for the Future: Sustaining Society and the Environment".
700 IUFRO, Seoul, Korea.
701 Ndoye, O., Ruiz Perez, M., 1997. The markets on non-timber forest products in the humid forest
702 zone of Cameroon, in: Doolan, S. (Ed.), African rainforest and the conservation of
703 biodiversity: proceedings of the Limbe Conference, Limbe Botanic Garden, Cameroon, pp.
704 128-132.
705 Ndoye, O., Tieguhong, J.C., 2004. Forest Resources and Rural Livelihoods: The Conflict
706 Between Timber and Non-timber Forest Products in the Congo Basin. Scandinavian Journal of
707 Forest Research 19, 36-44.
708 Nguenang, G.M., FAPA, C., Schindler, J., Mbolo, J., Ntamekene, M.L., 2013. Le coût de la
709 légalisation des organisations paysannes pour la collecte et la commercialisation des produits
710 forestiers non ligneux au Cameroun. Note de présentation. Leçons apprises accompagnement
711 pilote. GIZ, Programme d’Appui au Programme Sectoriel Forêt et Environnement (ProPSFE),
712 Yaounde.
713 Ostrom, E., 1990. Governing the commons: The Evolution of Institutions for Collective Action.
714 Cambridge University Press, Cambridge.
715 Philp, M. (2006). Corruption definition and measurement. Measuring corruption. C. Sampford,
716 A. Shacklock, C. Connors and F. Galtung. Hampshire/Burlington, Ashgate Publishing
717 Company: 45-56.
718 Pfund, J.-L., Robinson, P., 2005. Non-timber forest products between poverty alleviation and
719 market forces. Working Group 'Trees and Forests in Development Cooperation'. p. 53.
720 Ros-Tonen, M.A.F., Kusters, K., 2011. Pro-poor Governance of Non-timber Forest Products: The
721 Need for Secure Tenure, the Rule of Law, Market Access and Partnerships, in: Shackleton, S.,

722 Mitchell, D., Shackleton, C., Campbell, B., Shanley, P. (Eds.), Non-timber Forest Products in
723 the Global Context. Springer pp. 189-207.
724 Ruiz-Pérez, M., Ndoye, O., Eyebe, A., 1999. Marketing of non-wood forest products in the
725 humid forest zone of Cameroon. Unasylva 198, 12-19.
726 Sachs, J.D., McArthur, J.W., Schmidt-Traub, G., Kruk, M., Bahadur, C., Faye, M., McCord, G.,
727 Kremer, M., O'Connell, S.A., 2004. Ending Africa's Poverty Trap. Brookings Papers on
728 Economic Activity 1.
729 Scott, W.R., 2001. Institutions and Organizations. Sage Publications, Thousand Oaks.
730 Sunderland, T.C., Clark, L.E., Vantomme, P., 1998. Non-Wood Forest Products in Central
731 Africa; Current research issues and prospects for conservation development, in: Sunderland,
732 T.C., Clark, L.E., Vantomme, P. (Eds.), International Expert Meeting on Non-Wood Forest
733 Products in Central Africa. FAO, Limbe, Cameroon, p. 288.
734 Tabuna, J., 2007. Commerce régional et international des produits forestiers non ligneux
735 alimentaires et des produits agricoles traditionnels en Afrique Centrale. FAO., Rome, Italy.
736 Tacconi, L., Boscolo, M., Brack, D., 2003. National and international policies to control illegal
737 forest activities. Report for the Ministry of Foreign Affairs, Government of Japan. CIFOR,
738 Bogor, Indonesia.
739 Tchatat, M., Ndoye, O., 2006. Étude des produits forestiers non ligneux de Afrique centrale :
740 réalités et perspectives. Bois Et Forêts Des Tropiques 288, 27-39.
741 Ticktin, T., 2004. The ecological implications of harvesting non-timber forest products. Journal
742 of Applied Ecology 41, 11-21.
743 Tieguhong, J.C., Mala, W.A., Ndoye, O., Grouwels, S., Useni, K.M., Betti, J.L., 2012. Financial
744 status of small and medium scale enterprises based on non-wood forest products (NWFP) in
745 Central Africa. Forest Policy and Economics 20, 112-119

746 Tieguhong, J.C., Ndoye, O., 2006. Transforming subsistence products to propellers of sustainable
747 rural development: Non-timber forest products (NTFPs) production and trade in Cameroon. ,
748 Africa-Escaping the Primary Commodities Dilemma. African Development Perspective
749 Yearbook Verlag, Berlin, pp. 107-137.
750 Tieguhong, J.C., Ndoye, O., Grouwels, S., Mala, W.A., Useni, M.K., Betti, J.-L., 2010. Rural
751 enterprise dvelopment for poverty alleviation based on non-wood forest products in Central
752 Africa. International Forestry Review, 13.
753 Tieguhong, J.C., Ndoye, O., Tchatat, M., Chikamai, B., 2009a. Processing and Marketing of
754 Non-wood Forest Products: Potential Impacts and Challenges in Africa. Discovery and
755 Innovations 21, 60-65.
756 Tieguhong, J.C., Ndoye, O., Vantomme, P., Grouwels, S., Zwolinski, J., Masuch, J., 2009b.
757 Coping with crisis in Central Africa: enhanced role for non-wood forest products. . Unasylva
758 233, 49-54.
759 Tieguhong, J.C., Zwolinski, J., 2008. Unrevealed economic benefits from forests in Cameroon,
760 in: Stirn, L.Z. (Ed.), IUFRO International Symposium on emerging needs of society from
761 forest ecosystems: Towards the opportunities and dilemmas in forest managerial economics
762 and accounting. IUFRO & University of Ljubljana,, Ljubljana, Slovenia, pp. 9-16.
763 Transparency International (2009). Global Corruption Report 2009. Corruption and the Private
764 Sector. Transparency International, Ernst & Young. Cambridge, Cambridge University Press
765 493.
766 Topa, G., Karsenty, A., Megavand, C., Debroux, L., 2009. The Rainforests of Cameroon:
767 Experience and Evidence from a Decade of Reform. World Bank,, Washington.
768 University of Copenhagen, 2012. International Conference: Illegal logging and legality
769 verification – the FLEGT/VPA as new modes of governance, Copenhagen, p. 16.

van Dijk, J.F.W., 1999. Non-timber forest products in the Bipindi-Akom II Region, Cameroon : A socio-economic and ecological assessment Tropenbos-Cameroon Series 1. Tropenbos-Cameron Programme, Kribi, p. 197.

WRI, 2009. The governance of forests toolkit (Version 1): A draft framework of indicators for assessing governance of the forest sector, The Governance of Forests Initiative. WRI, IMAZON, ICV, p. 69.

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

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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 16th 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 16th 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, 16th 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 10th 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 13th and 14th 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 17th 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 19th century, the fishery expanded in the wake of the industrial revolution, steam-powered vessels replacing sailing vessels (Engelhard, 2008; Smith, 1994). In the 20th century, fishing pressure further increased as a result of a large array of technological innovations that increased fishing power of individual vessels (Fock, 2014; Lescrauwaet 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 16th 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 16th 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 (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 20th 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**
Scyliorhinus canicula	Small-spotted catshark	well known	often caught	c.	0	1
Scyliorhinus stellaris	Nursehound				0	0
Galeorhinus galeus	Tope shark	well known	very seldom, sometimes one in 5, 6 or 8 years	vr.	0	+
Sphyrna zygaena	Smooth hammerhead		seems to be caught with tope shark	vr.	0	0
Mustelus sp.	Smooth hounds	well known	often caught in nets and on hook	c.	+	+
Squalus acanthias	Spiny dogfish		not close to the coast but in deeper water	c.	3	+
Squatina squatina	Angelshark	well known	5-6 in a year	r.	0	0
Torpedo marmorata	Marbled electric ray		unknown	a.	0	0
Torpedo nobiliana	Electric ray	not well known	only 1 caught during my lifetime	vr.	0	0
Dipturus batis	Skate	well known	often caught along the coast	c.	0	0
Raja clavata	Thornback ray	very well known	brought to market now that everything is expensive	c.	2	1
Raja brachyura	Blonde ray	very well known	One or two among common rays	c.	0	0
Raja montagui	Spotted ray				0	+
Leucoraja naevus?	Cuckoo ray				0	0

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

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

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

Barbus barbus	Common barbel		
Albumus albumus	Common bleak		
Blicca bjoerkna	Silver bream		
Abramis brama	Common bream	in all waters of Holland	c. in fresh w.
Cyprinus carpio	Common carp	most important fish of fresh water	
Siluris glanis	Wels catfish	seldom caught	vr. in fresh w.
Anguila anguila	European eel	plentiful	p. in fresh w.
Perca fluviatilis	European perch		
Gymnocephalus cernuus	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 erythropthalmus*), 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*) where unkown 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
Drift net	buys, boat	herring	North Sea, specially North Scotland, also Norway
? net	pink (slabbeschip), schuitje	herring	coastal waters off Holland (during Coenen's youth)
Plaice net	pink*	plaice	coastal waters off Holland
Flounder net	flounder ship		coastal waters of Zeeland
Sole or narrow net	pink*	sole	coastal waters off Holland
Salmon net (new & strong)	pink*	salmon	coastal waters off Holland
Cod net	pink*	cod, haddock, whiting	coastal waters of Holland
Porpoise net		harbour porpoise	coastal wars of Holland
Hook and line,	dogger	cod, haddock	northern North Sea
Hook and line, pole and line	pink*	cod, haddock, whiting	coastal waters of Holland
Beach seine (5-6 men)	-	pilchard	coastal waters of Holland
Drag net (2 men)		garfish (bait fish)	Marsdiep
	-	sole, flounder, twaithe shad, salmon, thick lipped grey mullet, mackerel	coastal waters of Holland (by laymen)
Baskets	-	lampern (baitfish)	upriver
Drift net & hoop net & weir & seine	-	salmon	mouths of major rivers
Grass shrimp net & drag net	-	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 plaice, 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).

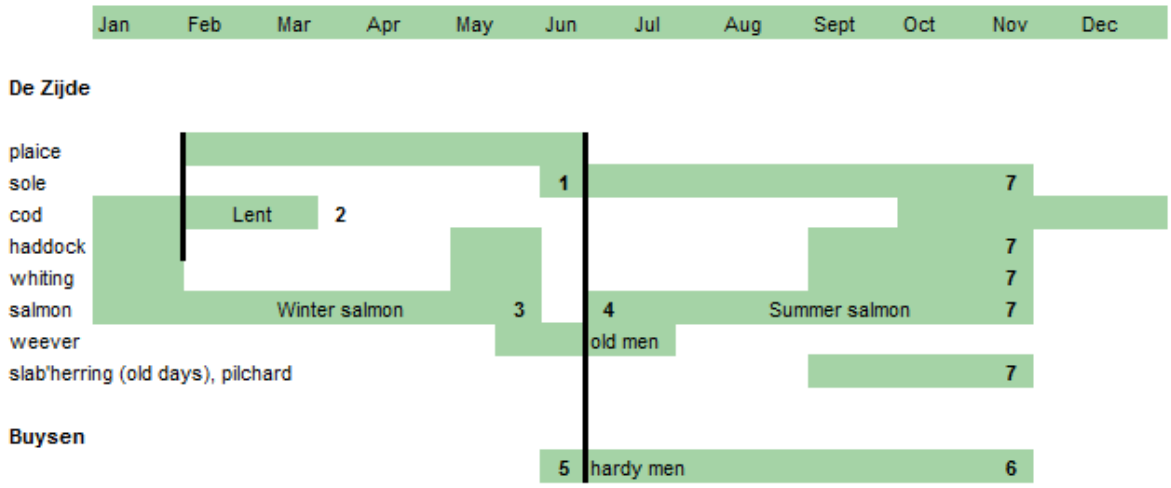
Doggers from Zeeland also went to Helgoland to catch cod, but were apparently less specialized, because they also came back with lobster (*Homarus gammarus*) as part of their catch. The lobsters were sold alive in The Hague and Delft.

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).



1) Start of summer
2) Until Easter
3) Until May (occasional later)
4) Before St Johns day (24 June)
5) Pentecoast, some before St Johns day (24 June)
6) All Saints'Day (1 Nov) or St Cathrenes Day (25 Nov)
7) Until autumn

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’.

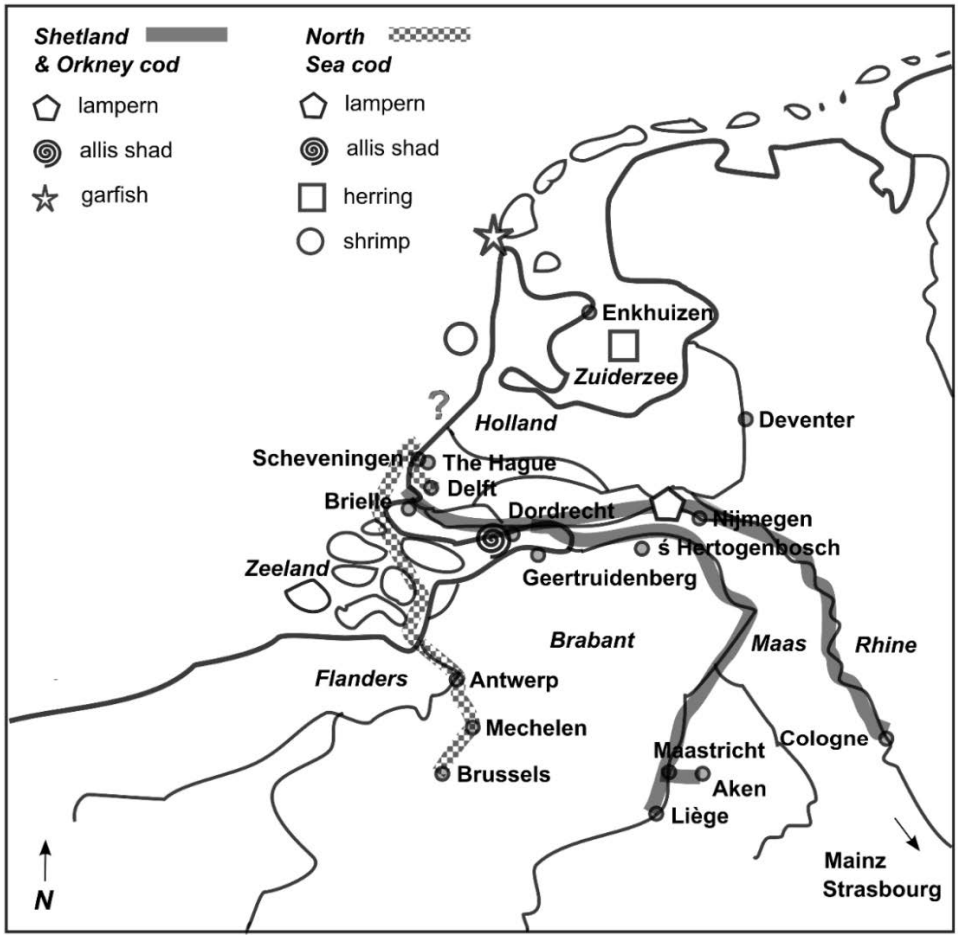


Figure 6. Cod economy around 1570 according to Coenen. Trade routes of salted cod from Scotland and fresh cod from the southern North Sea and catch areas of bait species. Whether fishing villages further north on the coast exported fresh cods is unknown.

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 16th-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 15th 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 20th 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 benthivororous species occurring in shallow waters are represented. In contrast, the 20th 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.

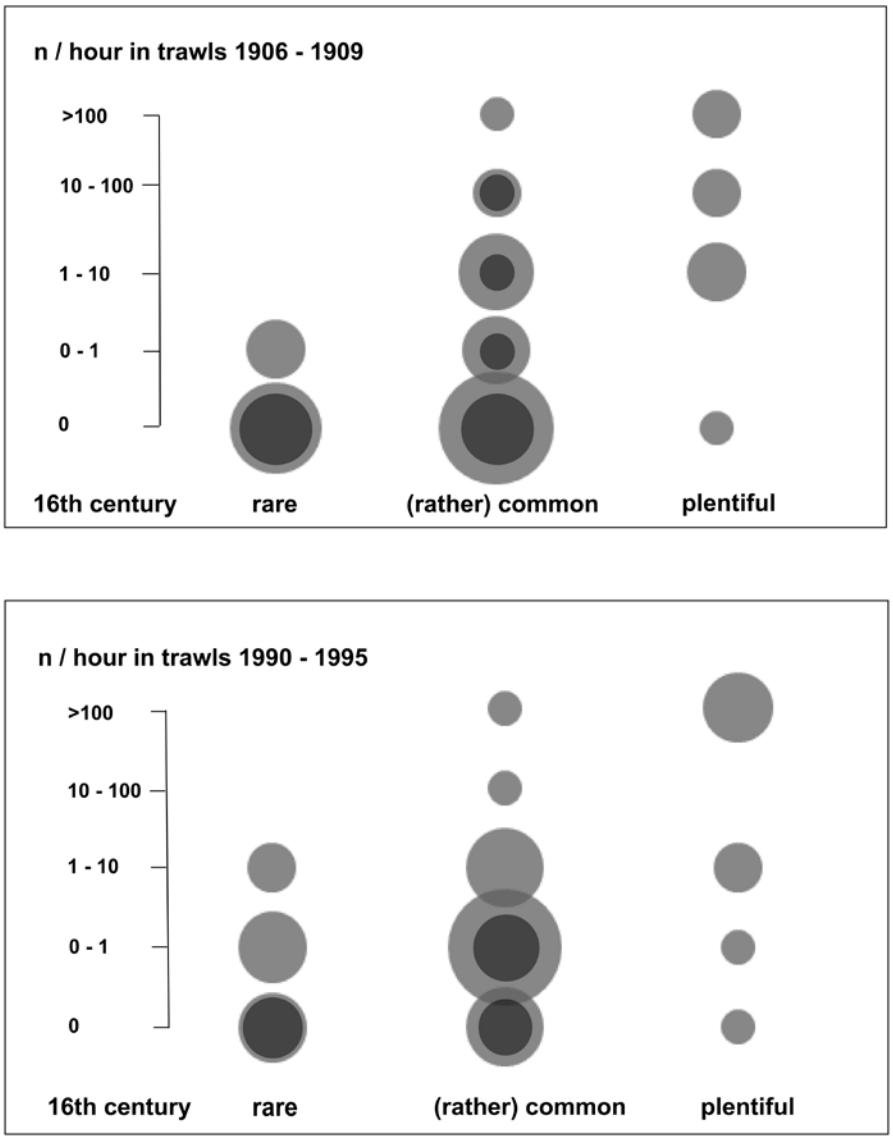


Figure 7. 20th century **t**rawl data of table 1 (a: 1906-1909; b. 1990-1995) compared to three 16th century abundance classes by Coenen (horizontal axis). Sizes of circles represent number of species. Dark area's represent elasmobranches. Number of species is 41.

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).

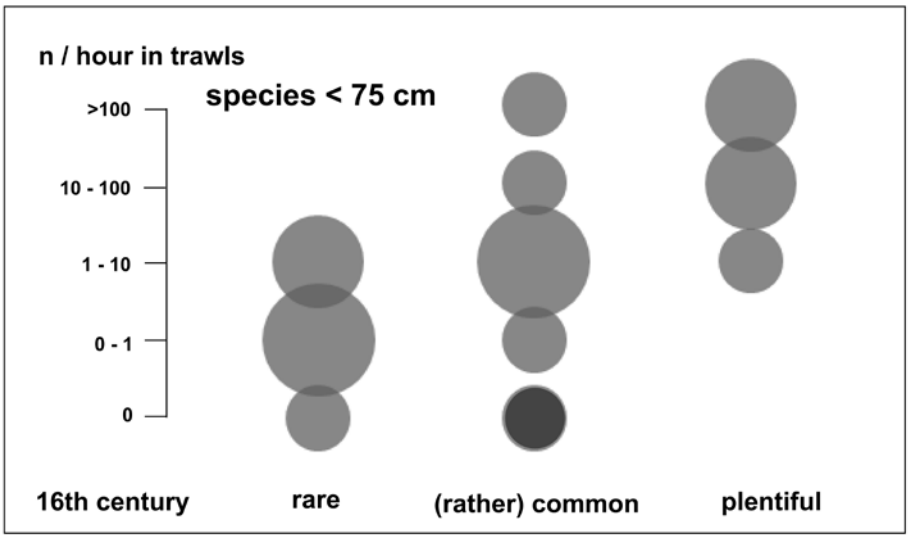
Eight species that were plentiful in the 16th century were mostly also abundant (herring, sprat, cod, whiting, plaice) in the 20th century, although the relative abundance may have changed. Greater weever and haddock were recorded in fair numbers in the early 1900's but declined strongly afterwards.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

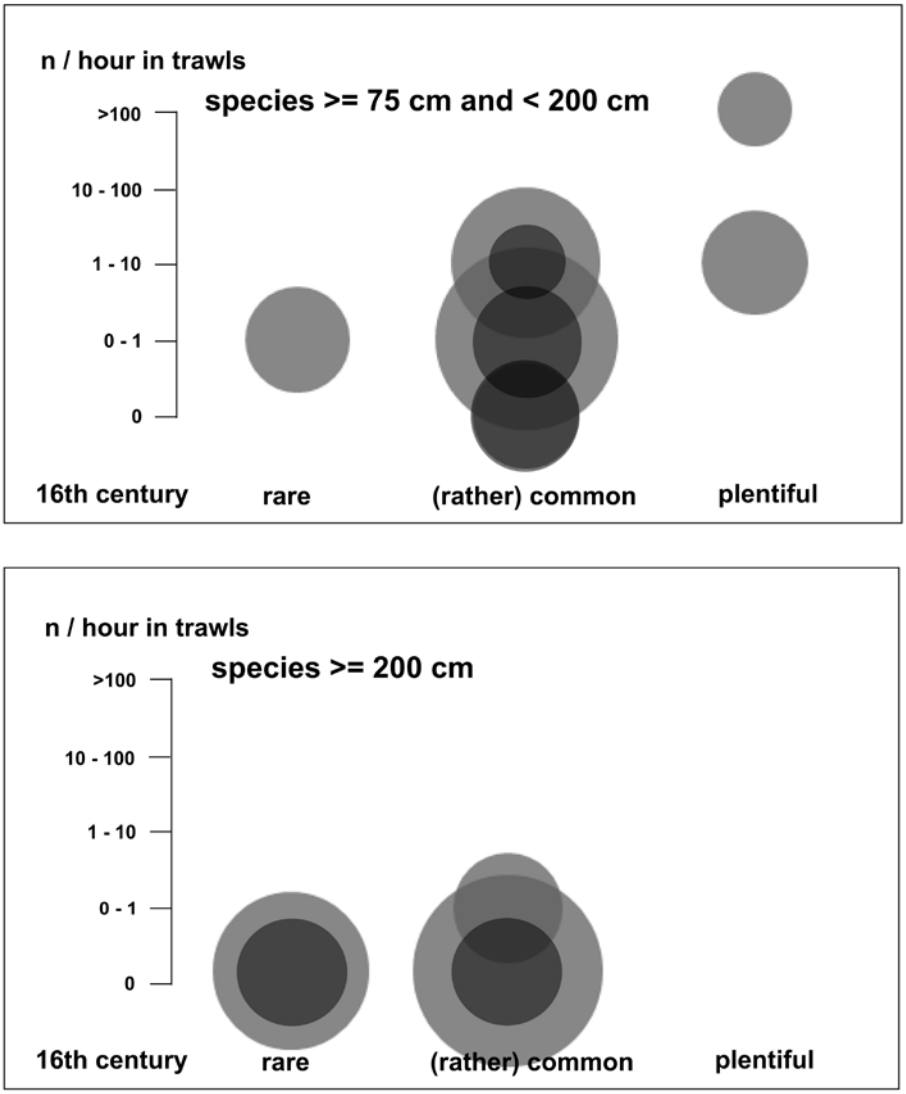
and the first half of the 20th century, but disappeared almost completely from the southern North Sea since the strong winter of 1963 (Daan, 1989).

Of the 23 species that were classified as common for the 16th century 14 species were caught in low numbers (<= 0,05 $n.h^{-1}$) in the early 20th 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 $n.h^{-1}$) at the start of the 20th century but declined in the 20th century to low numbers (<= 0.05 $n.h^{-1}$) at the end. Eight species occurred in relatively high numbers or very high numbers (dab) in the 20th 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 16th 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 16th 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 Vooys & 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 16th century is remarkable in the light of 20th-century bluefin tuna fishing in the North Sea and the association of this tuna with herring (MacKenzie and Myers, 2007).





Figures 8. Average of 20th century trawler data of table 1 compared to three 16th 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 elasmobranches. Number of species is 18, 17 and 6.

It is noteworthy that many of the species that were seldom caught in the 20th 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 16th century, all 4 species larger than 2 meter were caught at low numbers (<=0.05) in the 20th 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 20th 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 particularity 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 16th century were flounder and sole, whereas turbot and brill were mentioned as important by catch. These species remained commercially important during the 20th 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 20th 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 20th 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 20th 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 Coenen's account, has declined substantially in de period between 1840 and 1914 (Poulsen et al., 2007) and has maintained itself at a low abundance during the 20th 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 20th 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). Asa 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 19th 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 en 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'stime. Their decline set in the beginning of the 20th century leadingto 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 where 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 16th century. From the paid amounts it can be derived that rather large populations lived in the Waddenzee and the Rhine-Maas-Scheldt estuary (Vooys et al. 2012). In the 20th 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 20th 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 15th 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 17th and 18th 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 where traditionally caught along the coast but Dutch cod fishers reached the Dogger Bank soon and went to Iceland in the middle of the 17th 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 15th and early 16th century (Ervynck et al. 2004) but this massive Dutch 16th-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 send 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 fromanother piece of information provided by Coenen. The assumptionthat salted or dried cods were always decapitated (Barrett et al.,2011) is not universally true. According to Coenen Cologne obligedsalted cod to be decapitated but the same product was sent to otherplaces with their head on. It would be worthwhile to search thearchives 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 16th 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 17th till the 19th 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 al 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 send 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 moths. 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 16th-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)

References

Anonymous. 1540. Ordonantie. Versl. en Med. Ver. Uitgave Bronn. Oude Vad. Recht. Deel V. 1909. Blz. 388 e.v.; Haags Gemeente Archief P 1399. Original source: Koninklijke Bibliotheek III^{2} f° 54 v^{so}, Den Haag.

Anonymous, 1494. Enqueste ende informatie upt stuck van der reductie ende reformatie van den schiltaelen, voertijts getaxeert ende gestelt geweest over de landen van Hollant ende Vrieslant. Reissued by R. Fruin (Ed), 1876. E.J. Brill, Leiden.

Anonymous, 1514. Informacie up den staet faculteyt ende gelegenheyt van de steden ende dorpen van Hollant ende Vrieslant om daernae te reguleren de nyeuwe schiltaele. Reissued by Fruin, R. (Ed), 1866. A.W. Sijthoff, Leiden.

Barrett, J.H., Locker, A.M., and Roberts, C.M. 2004. The origins of intensive marine fishing in medieval Europe: the English evidence. Proceedings of the Royal Society B, 271: 2417–2421.

Barrett, J. H., Nicholson, R. A., and Cerón-Carrasco, R. 1999. Archaeo-ichthyological evidence for long-term socioeconomic trends in northern Scotland: 3500 BC to AD 1500. Journal of Archaeological Science, 26: 353-388.

Barrett, J. H., Orton, D., Johnstone, C., Harland, J., Van Neer, W., Ervynck, A., Roberts, C. M. *et al*. 2011. Interpreting the expansion of sea fishing in medieval Europe using stable isotope analysis of archaeological cod bones. Journal of Archaeological Science, 38: 1516-1524.

Beaujon, A., 1884. The history of Dutch sea fisheries; their progress, decline and revival. International Fisheries Exhibition, London 1883. Clowes, London.

Beaujon, A., 1885. Overzicht der geschiedenis van de nederlansche zeevisscherijen. Leiden. Brill.

Bellon, P. 1555. La nature & diversité des poissons, Paris.

Bennema, F. 2010. De Haringkoning. Het Zeepaard, 70 (1): 15-18.

Berghahn, R., and Bennema, F.P. 2013. Ancient history of flatfish research. Journal of Sea Research, 75:3-7.

Boelmans Kranenburg, H. A. H. 1946. De zeevisscherij van Holland in den tijd der Republiek, Paris, Amsterdam.

Boelmans Kranenburg HAH, 1979a. Visserij in de Zuidelijke Nederlanden 1490-1580, in: Van Houtte, J. A. (Ed.), Algemene Geschiedenis der Nederlanden 6. Fibula – van Dishoek, Haarlem, pp. 129-137.

Boelmans Kranenburg. H. A. H. 1979b. Visserij in de Zuiderlijke Nederlanden 1650-1795, in: Van Houtte, J. A. (Ed.), Algemene geschiedenis der Nederlanden 8, Fibula – van Dishoek, Haarlem, pp. 261-264.

Boelmans Kranenburg, H. A. H. 1983. The Netherland fisheries and the Shetland Islands, in: Withrington, D. J. (Ed.) Shetland and the outside world 1469-1969. Oxford University Press, Oxford, p.p. 96-106.

Bolle L.J., Rijnsdorp, A. D., van Neer, W., Millner, R. S., van Leeuwen, P. I., Ervynck, A., Ayers, R., Ongenae, R. E. 2004. Growth changes in plaice, cod, haddock and saithe in the North Sea: a comparison of (post-)medieval and present-day growth rates based on otolith measurements Journal of Sea Research 51: 313– 328.

Brander, K., 1981. Disappearence of the common skate, *Raia batis*, from the Irish Sea. Nature 290, 48-49.

Brasseur, S.M.J.M. & P.J.H. Reijnders 1997. The Harbour Seal in the Netherlands. Rijksinstituut voor Kust en Zee, Den Haag.

Burd, A.C. 1978. Long-term changes in North Sea herring stocks. Rapports et Procès-Verbaux des Réunions Conseil International pour l'Exploration de la Mer 178, 137-153Camphuysen, C.J. and Peet, G. H. 2006. Whales and dolphins of the North Sea. Fontaine Uitgevers, 's-Graveland.

Camphuysen, C.J., Peet, G.H., 2006. Whales and Dolphins of the North Sea. FontaineUitgevers, 's-Graveland.

Cau, C., van Leeuwen, S., Scheltus, J., Scheltus, P., Scheltus, I. 1658-1796. Groot placaet-boeck, vervattende de placaten, ordonnantien ende edicten van de doorluchtige, hoogh mog. heeren Staten Generael der Vereenighde Nederlanden ende vande ed. groot-mog. heeren Staten van Hollandt en West-Vrieslandt, mitsgaders vande ed. mog. heeren Staten van Zeelandt. 9 Volumes. Van der Wouw, H.J. and successors, The Hague.

Coenensz. van Schilperoort, A. ,1577-1581. Visboeck. Scheveningen.

Coenensz. van Schilperoort, A. ,1584-1585. Walvisboeck. Scheveningen.

Daan, N., 1989. The ecological setting of North Sea fisheries. Dana 8:17-31.

Daan, N., Bromley, P. J., Hislop, J. R. G., and Nielsen, N. A. 1990. Ecology of North Sea fish. Netherlands Journal of Sea Research, 26 (2-4): 343-386.

De Smet, W.M.A., 1981. Evidence of whaling in the North Sea and English Channelduring the Middle Ages. FAO Fisheries Series, 5. FAO Advisory Committee onMarine Resources Research Working Party on Marine Mammals, pp. 301–309,3.

Engelhard, G. H., Ellis, J. R., Payne, M. R., Ter Hofstede, R., Pinnegar, J. K., 2011. Ecotypes as a concept for exploring responses to climate change in fish assemblages. ICES Journal of Marine Sciene 68 (3): 580-591.

De Groot, S.J., 1984. The impact of bottom trawling on benthic fauna of the North Sea. Ocean Management 9, 177-190.

De Groot, S.J., 1990a. Decline of the catches of coregonids and migratory smelt in the lower Rhine, The Netherlands. Journal of Applied Ichthyology 6, 247-251.

De Groot, S.J., 1990b. The former allis and twaite shad fisheries of the lower Rhine, The Netherlands. Journal of Applied Ichthyology 6, 252-256.

De Groot, S.J., 1992. Decline and fall of the salmon fisheries in the Netherlands: is restocking the Rhine a reality? Aquaculture Research 23, 253-264.

De Vooys, C.G.N., van der Meer, J. 1998. Changes between 1931 and 1990 in by-catches of 27 animal species from the southern North Sea. Journal of Sea Research 39: 291-298.

De Vries, J., and van der Woude, A. M. 1995. Nederland 1500-1815. De eerste ronde van moderne economsche groei. Balans, Amsterdam.

Dulvy, N.K., Metcalfe, J.D., Glanville, J., Pawson, M.G., Reynolds, J.D., 2000. Fishery stability, local extinctions, and shifts in community structure in skates. Conservation Biology 14, 283-293.

Eero, M., 2012. Reconstructing the population dynamics of sprat (*Sprattus sprattus balticus*) in the Baltic Sea in the 20th century. ICES Journal of Marine Science 69, 1010-1018.

Egmond, F. P. 2005. Het Visboek – De wereld volgens Adriaen Coenen 1514-1587. Walburg Pers, Zutphen.

Egmond, F., Mason, P., and Lankester, K. 2003. The whale book - Whales and other marine animals as described by Adriaen Coenen in 1585. Reaktion Books, London.

Engelhard, G.H., 2008. One hundred and twenty years of change in fishing power of English North Sea trawlers, in: Payne, A., Cotter, J. and Potter, T (Eds.), Advances in Fisheries Science 50 years on from Beverton and Holt, Blackwell Publishing, London, pp. 1-25.

Enghoff, I.B., MacKenzie, B.R., Nielsen, E.E., 2007. The Danish fish fauna during the warm Atlantic period (ca. 7000–3900bc): Forerunner of future changes? Fisheries Research 87, 167-180.

Ervynck, A., Van Neer, W., Pieters, M., 2004. How the north was won (and lost again): historical and archaeological data on the exploitation of the North Atlantic by the Flemish fishery, in: Housely, R.A., Coles, G.M. (Eds.), Atlantic Connections and Adaptations: Economies, Environments and Subsistence in Lands Bordering the North Atlantic. Oxbow Books, Oxford, pp. 230-239

FAO, 2011. Review of the state of world marine fishery resources. FAO Fisheries and Aquaculture Technical Paper No. 569. FAO, Rome.

Fenton, A. 1978. The Northern Isles: Orkney and Shetland. John Donald, Edingburgh.

Fock, H.O., 2014. Estimating historical trawling effort in the German Bight from 1924to 1938. Fish. Res. 154, 26–37.

Fromentin, J.M., Powers, J.E., 2005. Atlantic bluefin tuna: population dynamics, ecology, fisheries and management. Fish and Fisheries 6, 281-306.

Gessner, C. 1563. Thierbuch: das ist, ein kurtze beschreybung aller vierfuessigen thieren, so auff der Erden und in Wassern wonend, sampt irer waren, Conterfactur, Zurich.

Godø, O.R., 2003. Fluctuation in stock properties of north-east Arctic cod related to long-term environmental changes. Fish and Fisheries 4, 121-137

Goodland, A. 1983. Five centuries of Shetland Fisheries, in: Withrington, D. J. (Ed.) Shetland and the outside world 1469-1969. Oxford University Press, Oxford, p.p. 107-118.

Haalmeijer, H., Vuik, D. 2007. Buizen, Bommen, Bonzen en Botters. Zeilschepen van de Lage Landen, de Visserij. De Alk, Alkmaar. 184 pp.

Harding, D., Nichols, J.H., Tungate, D.S., 1978. The spawning of the plaice (*Pleuronectes platessa* L.) in the southern North Sea and English Channel. Rapports et Procès-Verbaux des Réunions Conseil International pour l'Exploration de la Mer 172, 102-113.

Hoffman, R.C., 2005. A brief history of aquatic resource use in medieval Europe. Helgoland Mar. Res. 59, 22–30.

Holm, P., 2002. History of marine animal populations: a global research program of the Census of marine life. Oceanol. Acta 25, 207–211.

Holm, P., 2005. Human impacts on fisheries resources and abundance in the Danish Wadden Sea, c1520 to the present. Helgoland Marine Research 59, 39-44.

ICES, 2012. Report of the ICES Advisory Committee 2012. ICES Advice, 2012. Book 1-11.

Jackson, J.B.C., Kirby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.W., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A., Hughes, T.P., Kidwell, S., Lange, C.B., Lenihan, H.S., Pandolfi, J.M., Peterson, C.H., Steneck, R.S., Tegner, M.J., Warner, R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293, 629-638.

Jennings, S., Reynolds, J.D., Mills, S.C., 1998. Life history correlates of responses to fisheries exploitation. Proc. R. Soc. London, Ser. B: Biol. Sci. 265, 333–339.

Kerby, K., Cheung, W.L., Engelhard, G.H., 2012. The United Kingdom's role in North Sea demersal fisheries: a hundred year perspective. Reviews in Fish Biology and Fisheries 22, 621-634.

Kerby, T.K., Cheung, W.W.L., van Oosterhout, C., Engelhard, G.H., 2013. Entering uncharted waters: Long-term dynamics of two data limited fish species, turbot and brill, in the North Sea. Journal of Sea Research 84.

Lescrauwaet, A. K., Debergh, H., Vincx, M., Mees, J., 2010. Fishing in the past: Historical data on sea fisheries landings in Belgium. Marine Policy 34, 1279-1289.

Lotze, H.K., 2005. Radical changes in the Wadden Sea fauna and flora over the last2000 years. Helgoland Mar. Res. 59, 71–83.

Lotze, H.K., 2007. Rise and fall of fishing and marine resource use in the WaddenSea, southern North Sea. Fish. Res. 87 (2–3), 208–218.

Lotze, H.K., Worm, B., 2009. Historical baselines for large marine animals. TrendsEcol. Evol. 24 (5), 254–262.

MacKenzie, B. R. and Myers, R. A. 2007. The development of the northern European fishery for north Atlantic bluefin tuna Thunnus thynnus during 1900–1950. Fisheries Research, 87 (2–3): 229-239.

Magnus, O. 1555. Historia de gentibus septentrionalibus, Rome. 1567, in German translation, Basel.

McClenachan, L. 2009. Documenting loss of large trophy fish from the Florida Keys with historical photographs. Conservation Biology 23, 636-643.

McMillan, B. and Parry, M. H., 2001. Aak to Zimbra: A Dictionary of the World's Watercraft. The Mariners Museum, Newport News.

Molhuijsen, P. C., 1844. De visscherij in de Zuiderzee. Bijdrage voor de vaderlandse geschiedenis en oudheidkunde 1 (4): 307-319. Nijhoff. Arnhem.

Moss, M.L and Cannon, A., Editors. 2011. The archaeology of North Pacific Fisheries. University of Alaska Press, Fairbanks.

Nijssen, H., De Groot, S. J., 1980. Zeevissen van de Nederlandse kust. Wetenschappelijke Mededelingen K. N. N. V. 143. K. N. N. V., Hoogwoud.

De Oliveira, J.A.A., Ellis, J.R., Dobby, H., 2013. Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias*. ICES Journal of Marine Science 70, 1341-1353

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R., Torres, F., 1998. Fishing down marine food webs. Science 279, 860-863.

Pieters, M., Baeteman, C., Bastiaens, J., Bollen, A., Clogg, P., Cooremans, B., De Bie, M., De Buyser, F., Decorte, G., Deforce, K., De Groote, A., Demerre, I., Demiddele, H., Ervynck, A., Gevaert, G., Goddeeris, T., Lentacker, A., Schietecatte, L., Vandenbruaene, M., Van Neer, W., Van Strydonck, M., Verhaeghe, F., Vince (†), A., Watzeels, S., Zeebroek, I., 2013. Het archeologisch onderzoek in Raversijde (Oostende) in de periode 1992-2005. Vuurstenen artefacten, een Romeinse dijk, een 14de-eeuws muntdepot, een 15de-eeuwse sector van een vissers nederzetting en sporen van een vroeg-17de-eeuwse en een vroeg-18de-eeuwse belegering van Oostende, Relicta Monografieën, Brussel.

Pope, J.G., Macer, C.T., 1996. An evaluation of the stock structure of North Sea cod, haddock, and whiting since 1920, together with a consideration of the impacts of fisheries and predation effects on their biomass and recruitment. ICES Journal of Marine Science 53, 1157-1169.

Poulsen, R.T., Cooper, A.B., Holm, P., MacKenzie, B.R., 2007. An abundance estimate of ling (Molva molva) and cod (Gadus morhua) in the Skagerrak and the northeastern North Sea, 1872. Fisheries Research 87, 196-207.

Poulsen, B. 2008. Dutch herring an environmental history c. 1600-1860. Aksant Academic Publishers, Amsterdam.

Redeke, H. C., 1941. Pisces (Cyclostomi – Euichthyes)., in: H. C. Boschma (Ed.), Fauna van Nederland 10. Sijthoff, Leiden.

Reijnders, P.J.H., van Dijk, J., Kuiper, D. 1995. Recolonization of the Dutch Wadden Sea by the grey seal *Halichoerus grypus*. Biological Conservation 71: 231-235.

Reijnders, P.J.H. 1994. Historical population size of the harbour seal, Phoca vitulina, in the Delta area, SW Netherlands. Hydrobiologia (282/283): 557-560.

Richter, C. 2006. Hollandse visboeken, de onweerstaanbare kracht van de afbeelding. Historisch tijdschrift Holland, 38 (3): 161-176.

Roberts, C.M., 2007. The unnatural history of the sea. Island Press / Shearwater Books, Washington, USA.

Rose, G.A., 2004. Reconciling overfishing and climate change with stock dynamics of Atlantic cod (*Gadus morhua*) over 500 years. Canadian Journal of Fisheries and Aquatic Sciences 61, 1553-1557.

Rose, G.A., 2007. Cod: The Ecological History of the North Atlantic Fisheries. Breakwater Books, St. John's.

Rijnsdorp, A.D., 1989. Maturation of male and female North Sea plaice (*Pleuronectes platessa* L.). Journal du Conseil international pour l'Exploration de la Mer 46, 35-51.

Rijnsdorp, A.D., van Leeuwen, P.I., Daan, N., Heessen, H.J.L. 1996. Changes in abundance of demersal fish species in the North Sea between 1906-1909 and 1990-1995 ICES J. Mar. Sci, 53: 1054-1062,

Rijnsdorp, A.D., Millner, R.S., 1996. Trends in population dynamics and exploitation of North Sea plaice (*Pleuronectes platessa* L) since the late 1800s. ICES Journal of Marine Science 53, 1170-1184.

Rijnsdorp, A.D., Poos, J.J., Quirijns, F.J., HilleRisLambers, R., de Wilde, J.W., Den Heijer, W.M., 2008. The arms race between fishers. Journal of Sea Research 60, 126–138.

Sibbald, R., 1711. The description of the isles of Orknay and Zetland. Edinburgh.

Smith, J., 1661. The Trade of Fishing of Great-Britain Displayed with a Descriptionof the Islands of Orkney and Shotland, by Captain John Smith. Nathaniel Webb,London.

Smith, T.D., 1994. Scaling fisheries: the science of measuring the effects of fishing, 1885-1955. Cambridge University Press, Cambridge.

Tesch, J.J., de Veen, J., 1933. Die Niederländische Seefischerei. Handbuch der Seefischerei Nordeuropas. Band VII. Die Seefischerei der westeuropäischer Länder, Heft 2. 104 pp.

Thurstan, R.H., Hawkins, J.P., Roberts, C.M., 2013. Origins of the bottom trawling controversy in the British Isles: 19th century witness testimonies reveal evidence of early fishery declines. Fish and Fisheries, doi: 10.1111/faf.12034.

Tittizer, T., Krebs, F. Krebs 1996. Öekosystemforschung: Der Rhein und seine Auen Springer Berlin Heidelberg.

Tys, D., Pieters, M. 2009. Understanding a medieval fishing settlement along the southern North Sea: Walraversijde, C. 1200-1630, in: Sicking, L., Abreu-Fereira, D., Beyond the Catch. Fisheries of the North Atlantic, the North Sea and the Baltic, 900-1850. Brill, Leiden, pp. 91-122.

Van Bochove, C. 2004. De Hollandse haringvisserij tijdens de vroegmoderne tijd. Tijdschrift voor Sociale en Economische Geschiedenis 1 (1): 3-27.

Van Bochove, C. 2009. The 'Golden Mountain': An Economic Analysis Of Holland's Early Modern Herring Fisheries, in: Sicking, L., Abreu-Fereira, D., Beyond the Catch. Fisheries of the North Atlantic, the North Sea and the Baltic, 900-1850. Brill, Leiden, pp. 209-244.

Van Dam, P. E. J. 2009. Fish for feast and fast fish consumption Fish For Feast And Fast Fish Consumption In The Netherlands In The Late Middle Ages, in: Sicking, L., Abreu-Fereira, D., Beyond the Catch. Fisheries of the North Atlantic, the North Sea and the Baltic, 900-1850. Brill, Leiden, pp. 309-336.

Van Deinse, A. B.,1918. Over de potvissen in Nederland gestrand tusschen de jaren 1531-1788. Zoologische Mededeelingen 4: 22-50.

Van Neer, W., Ervynck, A., Bolle, L.J., Millner, R. S., Rijnsdorp, A. D. 2002. Fish otoliths and their Relevance to Archaeology: An Analysis of Medieval, Post-Medieval, and Recent Material of Plaice, Cod and Haddock from the North Sea. Environmental Archaeology, 7: 61-76

Van Neer, W., Ervynck, A., Bolle, L. J., Millner, R. S. 2004. Seasonality only works in certain parts of the year: The reconstruction of fishing seasons through otolith analysis. International Journal of Osteoarchaeology*, 14* (6): 457-474.

Van Vliet, A. P., 1994. Vissers en kapers: de zeevisserij vanuit het Maasmondgebied en de Duinkerker kapers (ca. 1580-1648). Hollandse Historische Reeks 20, 's-Gravenhage.

Vooys, C. G.N., Brasseur, S.M.J.M., van der Meer, J., Reijners, P.J.H., 2012. Analyses of four centuries of bounty hunting on seals in Zeeland, SW-Netherlands. Lutra 55 (1): 55-65.

Walker, P.A., Heessen, H.J.L., 1996. Long-term changes in ray populations in the North Sea. ICES Journal of Marine Science 53, 1085-1093.

Walker, P.A., Hislop, J.R.G., 1998. Sensitive skates or resilient rays? Spatial and temporal shifts in ray species composition in the central and north-western North Sea between 1930 and the present day. ICES Journal of Marine Science 55, 392-402

Witsen, N. C., 1671. Aeloude en hedendaegsche scheeps-bouw en bestier. Commelijn, Boer and Appelaer, Amsterdam.

Wolff, W.J., 2000. The south-eastern North Sea: losses of vertebrate fauna during thepast 2000 years. Biol. Conserv. 95 (2), 205–217.