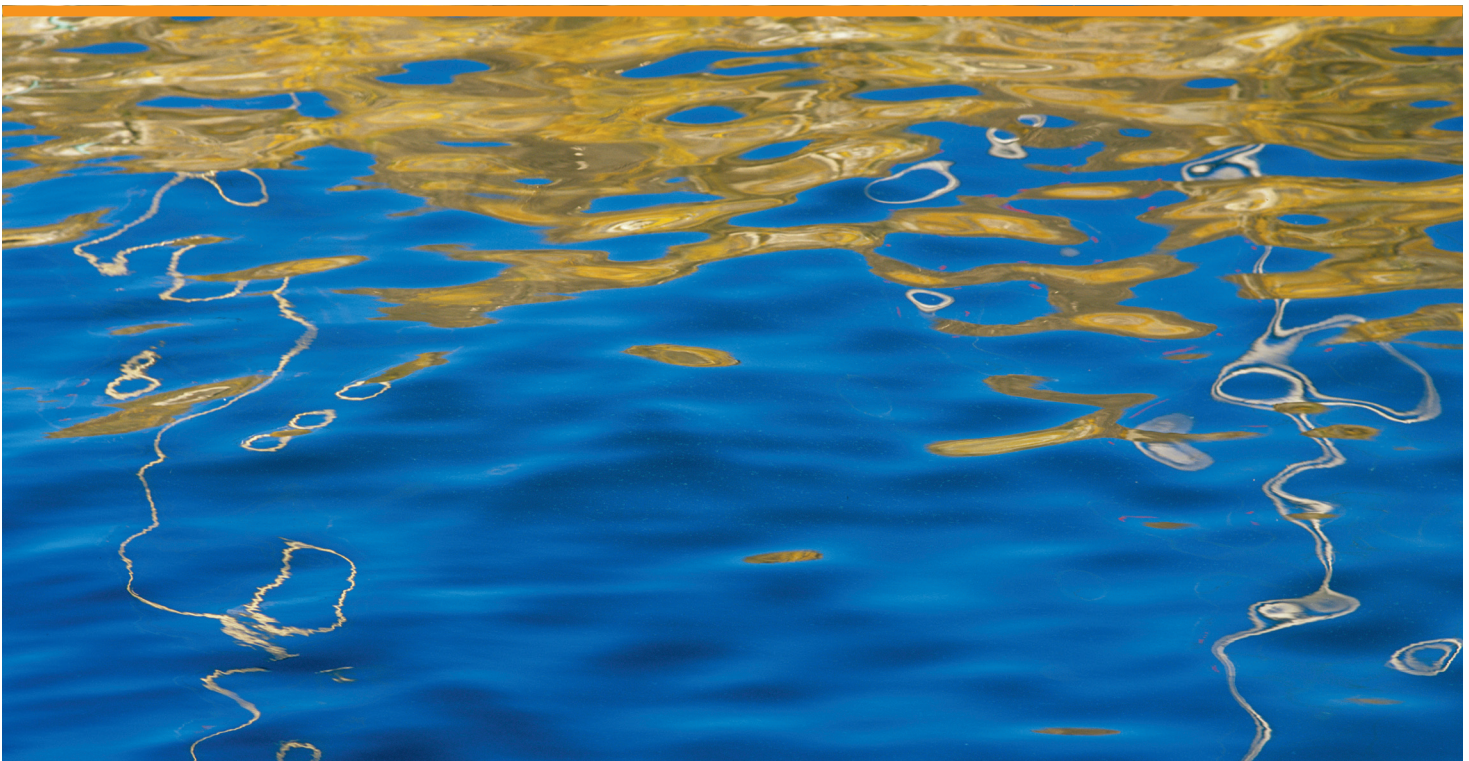


Eel and cod catches in Danish recreational fishing

Survey design and 2009 catches



DTU Aqua report no. 217-2010

By Claus R. Sparrevohn
and Marie Storr-Paulsen

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Colophon

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Abstract

In order to estimate cod and eel catches in the Danish recreational fishery an interview survey was in 2009 planned by DTU Aqua in cooperation with Statistic Denmark. Recreational fishing was separated into anglers (with rod and reel) and passive gear fishing (fyke – and gillnets). In 2009 a total of 196,000 anglers and 34,000 passive gear fishermen had issued the compulsory license. Based on the interviews it was estimated that 23% and 28% of all anglers and passive gear fishermen fished without license, although with a lower effort than fishermen with an annual license. In total, it was estimated that close to a 100 t eel and 20 t cod were caught in fykenets, with the main catches lying in the period August-October. Eel caught by anglers was assumed to be insignificant. The estimated cod catches in the gillnet fishery amounted to 212 t with the main catches in February-April. In this investigation, anglers were estimated to fish close to 900 t cod with the Sound being the area with highest reported catches. Here, recreational fishing accounted for 12% of the total landings. Present interview survey indicates that approximately 4.5% of the total Danish cod catches and approximately 18 % of the total eel catches are taken by recreational fishing.

1 Introduction

1.1 Monitoring of recreational fishing

Denmark is obliged to design and implement monitoring of the recreational fishery. This is a consequence of the EU Council regulation No. 199/2008, concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy. Denmark has to monitor the catches (in weight) of the following species: eel (*Anguilla anguilla*); cod (*Gadus morhua*) and Baltic salmon (*Salmo salar*) on a quarterly basis. This task was introduced in 2009 in all member states of the EU. However, as most member states have their own regulation on recreational fishing, the design of the monitoring differs between member states. For many countries, sampling catches in recreational fishing is a new activity. In a number of cases, pilot studies have been carried out in the past, but in many institutes there is no expertise in sampling these fishing types. For these reasons, derogations have been requested for sampling recreational fisheries in a number of National Programs, waiting for guidelines on the methodology available or to be developed from the ICES Workshop on Sampling Methods for Recreational Fisheries (WKSMRF). This report from the workshop held at IFREMER, Nantes March 2009, gives a comprehensive summary of the national recreational fisheries in the various countries.

1.2 Method approach

In September 2009 Statistic Denmark and DTU Aqua developed a concept for a combined telephone and internet survey for the Danish recreational fishery. To estimate the seasonal and annual fluctuations in the catches the survey are intended to be conducted on a quarterly basis during the next years. This rapport provides results from the analyses of data from the first survey conducted in the period October to December 2009. The survey did not include the catches of Baltic salmon, since it was judged to be a fishery not suited for the sampling approach used in present survey.

The interview survey presented in this report was separated into two different phases with their own questionnaires and group of respondents: 1) The Omnibus and 2) License holders.

1.3 Recreational fishing in Denmark

Approximately 5.5 million people reside in Denmark; 2.5 million on the mainland and the rest on islands (source: Statistic Denmark, www.dst.dk). The coastline of Denmark is 7013 km long and no citizen lives more than 50 km from the nearest coast. Therefore, recreational fishing in marine waters is an important national outdoor leisure activity. In 1997, 16.5% of the Danish public considered themselves anglers and 12.5 % claimed to have been fishing within the last year (Bohn and Roth, 1997). Further, it was found that 25% fished in streams, 30 % in lakes, 27% in put & take ponds, but the majority, 73%, answered marine waters. An economic validation of the recreational fishery underlines the importance of recreational fishery in Denmark, as it was found that Danish willingness to pay for fishing is among the highest in Nordic countries (Roth et al., 2001; Toivonen et al., 2004).

Recreational fishing in Danish coastal waters differs from what is observed in many other countries, especially outside of Europe, in the sense that two major and very different categories of fishing can be identified. The first one is referred to as passive gear fishing throughout this rapport. This is carried out using stationary gear such as gillnets and fykenets. The second category of leisure fishing in saltwater is angling.

Table 1. Number of annual angler- and passive gear licenses issued during 1999 to 2009. In 2004 no data are available. In 2009 17,800 week licenses and 22,200 day licenses was issued.

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2009 |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Anglers | 150526 | 151529 | 156769 | 150925 | 152534 | 160942 | 156474 | 160664 | 160186 | 156000 |
| Passive gear | 33575 | 31709 | 33715 | 33888 | 33516 | 33430 | 34277 | 33787 | 35221 | 34000 |

Approximate numbers

Anglers - domestic as well as tourists - between 18 and 65 years of age have to purchase a license costing DKr. 140 for one year, DKr. 100 for one week and DKr. 35 for one day. All passive gear fishers have to pay a license costing DKr. 275 per year and you are not allowed to fish before the age of 12. The license is personal and non-transferable. Legal reasons for angling without a license are: 1) persons younger than 18 years of age, 2) persons older than 65 years, 3) Private landowners fishing in their own waters, 4) exclusively put & take fishers.

1.3.1 Passive gear fishing

This fishery is also referred to as “household”, “non-angling”, “hobby” or “amateur” fishing and is a fishery carried out with passive gear, such as fykenets and gillnets. For the last 10 years there has on average been 33,700 licenses issued per year (Table 1). The average age of fishermen that has issued a license for this particular type of fishery is 54.2 years and males dominate (Fig. 1). This category of fishing resembles commercial fishery in the sense that the gear used are similar, but differs by the fact that it is leisure based and it is illegal to sell the catch. There are restrictions to the effort as it is only allowed to fish with a maximum of either 3 gillnets plus 3 fykenets or a total of 6 fykenets. The maximum length of gillnets are 45 m and they are not allowed to be closer than a 100 m from the coastline; a restriction mainly set up to protect sea trout (*Salmo trutta*). Further there are several closed areas such as the area around river mouths. The gear are typically deployed from a small boat with a very limited activity radius, which in practice makes this type of fishing more or less stationary. The main target species are eel caught in fykenets and flounder (*Pleuronectes flesus*) caught in gillnets (Sparrevohn et al., 2009). It is a traditional fishery that has been practiced for centuries in the coastal areas. Earlier, a recreational fishery using eel-trawl and long-lines was also practiced but eel-trawl is now prohibited and long-line catches are limited. Cod are caught both with gillnets and fykenets in the passive gear recreational fishery. The catches are mainly restricted to certain areas (Sparrevohn et al., 2009).

1.3.2 Angling

Angling in saltwater are carried out in waders along the coastline, from man-made structures such as piers, bridges or with boats as a platform. It is a very popular outdoor leisure activity practiced by 73% of all fishermen that has fished within the last 12 months (Bohn and Roth, 1997). The average age of angling fishermen with a license is 46.1 year, however people younger than 18 and older than 65 years do not need a license (Fig. 1), thus the true average age of angling fishermen is most probably higher. For the last 10 years there has on average been issued 155,600 annually license (Table 1). Estimated weekly license issued for 2009 are 17.800 and 22.200 for daily license. There are no restrictions, e.g. bag-limit, to the angling fishery in saltwater besides those that apply to fishing in general, i.e. closed areas, minimum size etc. The only exception is that trolling closer than 100 m from the coastline is prohibited. The main target species in saltwater is

seatrout, but garfish (*Belone belone*) and cod are also regularly caught as well as salmon and various flatfish species (Rasmussen and Geertz-Hansen, 2001).

In saltwater Baltic salmon are almost exclusively caught by angling from medium sized (15-25 ft) boats around the island of Bornholm, during the spring/early summer and October/November. Down rigging is the dominant fishing strategy.

Cod are by anglers caught in the Sound, the North Sea, Kattegat, inner Danish waters and western/eastern Baltic. Platforms used for the fishery range from beach fishery with rod and reel using casting lures to deepwater jigging from chartered boats many miles offshore. There is also a substantial fishery on wrecks. An angling fishery on board private boats is also very popular and probably accounts for a substantial part of the total cod catches, at least locally.

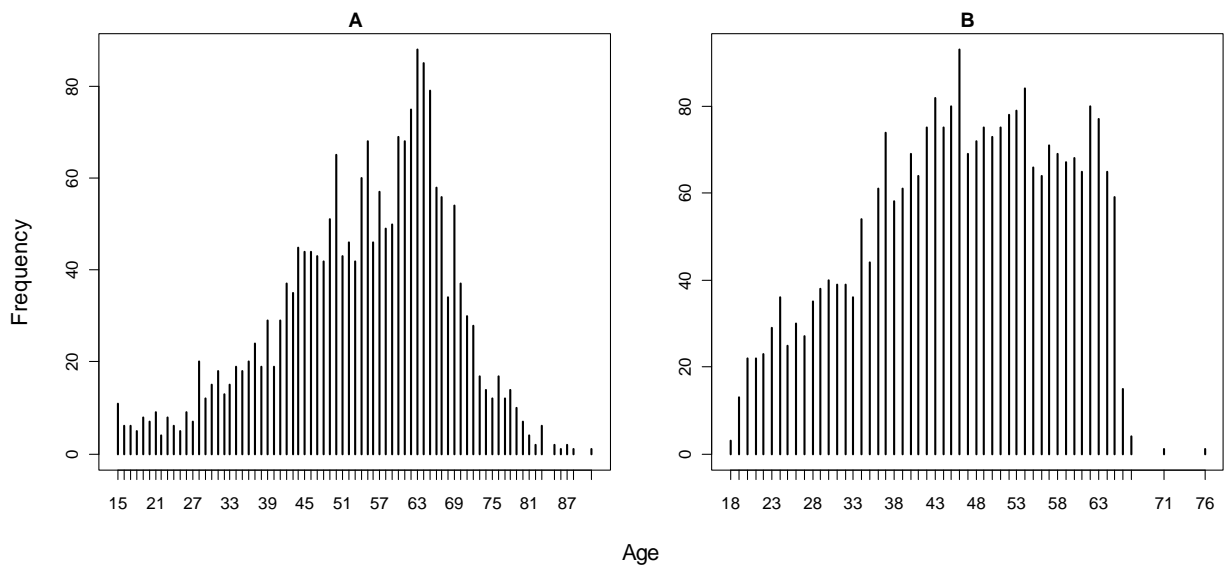


Fig. 1. Age frequency of fishermen holding a license to carry out passive gear (A) fishing or angling (B).

2 Methods

Two questionnaires, the “Omnibus” and the “License”, were developed by Statistic Denmark and DTU Aqua for a combined telephone and internet survey. The interviews were conducted by Statistic Denmark who holds the expertise on this form of investigations. The questionnaire was tested on a subgroup of fishermen with license, to optimize the process and change questions that potentially could lead to bias. DTU Aqua was responsible for the following data processing.

2.1 The Omnibus interview

In 2009 three telephone interview rounds were conducted in October, November and December. The Omnibus is a regular monthly interview conducted by Statistic Denmark to gather a variety of information, such as political views etc. The recreational fishery questions were only a minor part of this interview. Respondents were selected by telephoning a random non-mobile number. The interview was conducted with that person within the household who last had a birthday. Only citizens between 16 and 74 were included. A total of 958, 957 and 968 were interviewed and answered in the three months. The first objective was: 1) to estimate the population size of anglers and passive gear fishermen and 2) to estimate the population size that fished illegally – which in this rapport only covers people fishing without a valid license.

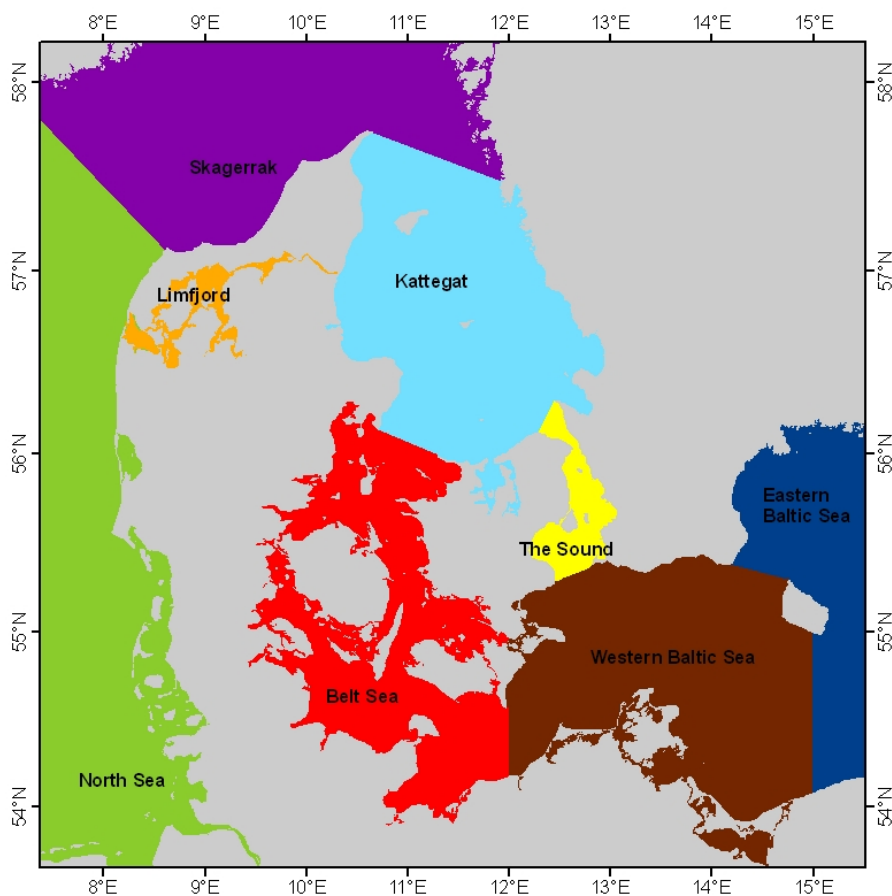


Fig. 2. Area definition used in the interview survey. Green: North Sea, purple: Skagerrak, light blue: Kattegat, orange: Limfjord, yellow: the Sound, red: Belt Sea, brown: western Baltic Sea and blue; eastern Baltic Sea.

Therefore fishermen not holding a license were asked for their reason. There are several legal exemptions from holding the compensatory license for angling fishing (, see section 1.3). Passive gear fishers do not have any legal excuse for not holding a license when fishing in saltwater.

Furthermore respondents were asked for information on effort in fishing days to be able to estimate if people fishing without a license are doing it with same effort as people with a license. These questions would provide the needed information for calculating the fraction of illegal fishermen and the effort they fished with. Respondents were also asked about their fishing pattern outside Denmark, such as countries they had visited for fishing.

2.2 The License interview

The second interview phase was based on people that had a valid annual license at the time of the interview. It was possible to contact persons holding a license directly as names and social security numbers are available. A detailed questionnaire was answered either on web or in a telephone interview. This interview provided detailed information on the fishing carried out and the catches taken. The respondent was explicitly told only to report those catches that were actually taken, which means that the results in the present rapport does not include discards, undersized fish, or fish that for other reasons were released.

To estimate catches by managing areas the respondents were asked which areas and quarters they had been fishing. The operational areas in this investigation were; North Sea, Skagerrak, Kattegat, the Sound, Belt Sea, Limfjord and Eastern and Western Baltic Sea (Fig. 2).

2.3 Estimating catches in Danish recreational fishing

The total catch of cod and eel in the Danish recreational fishery can be calculated from the information gathered in interview phase 2 where the respondents provide information on their catches. These values can then be extrapolated to the entire population of fishermen (license holders and illegal fishers). Illegal fishermen are assumed to show a different effort pattern and therefore it is corrected with the estimated effort fished by illegal fishermen found in interview phase 1. The following equation was used,

$$T_{aq} = \left(\frac{C_{aq}}{r} \cdot p_y + \frac{C_{aq}}{r} \cdot p_w \cdot \frac{E_w}{E_y} + \frac{C_{aq}}{r} \cdot p_d \cdot \frac{E_d}{E_y} \right) + \left(\frac{C_{aq}}{r} \cdot i \cdot (p_y + p_w + p_d) \cdot \frac{E_i}{E_y} \right)$$

where (T_{aq}) is the total catch of either cod or eel per quarter (q) and area (a). T_{aq} is the sum of the catches in the legal fishing (first bracket) and the catches in the illegal fishery (left bracket). C is the total catch reported from the interview, p is the number of license issued (in 2009 around 34.000 were estimated to fish with passive gear and 156.000 as anglers with annual license (y), 17,800 with a weekly license (w) and 22,200 with a daily (d) license, Table 1), r is the number of respondents participated in the license interviews (1585 in the passive gear interview and 1929 in the angling interview). E_i is the average fishing effort of the population that fish illegally, E is the average effort of the population that hold a license and i is the fraction that fish illegally. The estimates can be found in Table 7. For those holding a day license the effort was set to 1 and for those holding a weekly license the effort was set to 3 days.

In the license interview the respondent had the opportunity to report their catches in either kilo or numbers, hence it was necessary to find an average weight in order to change the catches reported in numbers to kilo. The average size of eel and cod above minimum landing size caught in the passive fishery was found from Sparrevohn et al. (2009). Eel larger than the minimum landing size caught in fykenets was set to 47.1 cm corresponding to a weight 188 gram. Cod caught in fykenets above the minimum size was set to 39.0 cm corresponding to 540 gram and cod caught in gillenets was set to 47.6 cm, which corresponds to 975 gram.

In the angling fishery the average weight of cod is more imprecise; however we have used a value of 1.5 kg per fish. This number was derived by dividing the catch of cod reported in kg with the catch of cod reported in numbers, resulting in an average weight of 1.6 kg for those cod caught by anglers with an angler license. For those anglers that fished with a passive gear license the average cod weight was found to be 1.7 kg. Since both estimates are very questionable a rounded value of 1.5 kg was chosen.

3 Results

3.1 Omnibus interview

During three interview rounds in October, November and December a total of 2883 persons were interviewed. When asked whether they had fished within the last twelve months, respectively 13, 16 and 14 % confirmed. Approximately 10 % of these were fishing with passive gear, 90 % were anglers and 0.1% fishing commercially.

3.1.1 Illegal fishing

The margin between respondents that claimed to have a valid license and the actual number of license issued was very small. In 2009 the number of annual license issued was 156,000; weekly license was 17,800 and daily 22,200, summing to a total of 196,000, which is close to the estimated 201,000-239,000 persons that claimed to have had a valid license. For both groups of recreational fishermen approximately half had a license and half did not. Excluding the group that did not hold a license for valid reasons, 23% of all anglers were estimated to fish illegally (Table 2). For the passive gear fishermen, the number of people not holding a license is larger and on average for the three months of our omnibus investigation 28% fished illegally. However, this level fluctuates highly between months and since fewer persons are available in this group, interpretations from this data should be dealt with caution. Further there appeared to be a bias in separating between anglers and passive gear fishery in the first two months since some of the passive gear fishers gave meaningless answers to why they did not hold a license. For example, several respondents answered that they only fished in put & take, an answer that does not make any sense, since a fishery with gillnets or fykenets in put & take lakes does not exist. The problem was recognized and it was emphasized that respondents should have a clear understanding of the difference between anglers and passive gear fishery. In this investigation we have used the average for the three months to up-scale the illegal fishery. However, we have planned to continue the Omnibus survey in 2010 to confirm the level of illegal fishery for both anglers and fishing with passive gear.

Table 2. Table 2A shows the numbers of respondents in the Omnibus in October-December 2009. In table 2B the numbers were scaled up to actual population size of person between 16 and 74.

| A | | | Do you fish? | Do you have a license? | | | | |
|----------------------------|-----------|--------------|--------------|------------------------|---------|-----------|------------|-----------|
| Respondents | | | Yes | Yes | No | No- legal | No-illegal | % illegal |
| Dec | 968 | Angling | 116 | 58 | 58 | 30 | 28 | 24.1 |
| | | Passive gear | 9 | 7 | 2 | 0 | 2 | 22.2 |
| Nov | 957 | Angling | 132 | 69 | 63 | 33 | 30 | 22.7 |
| | | Passive gear | 17 | 8 | 9 | 2 | 7 | 41.2 |
| Oct | 958 | Angling | 119 | 59 | 60 | 34 | 26 | 21.8 |
| | | Passive gear | 14 | 8 | 6 | 3 | 3 | 21.4 |
| B | | | Do you fish? | Do you have a license? | | | | |
| Scaled to total population | | | Yes | Yes | No | No-legal | No-illegal | % illegal |
| Dec | 3,356,206 | Angling | 402,190 | 201,095 | 201,095 | 104,015 | 97,080 | 24.1 |
| | | Passive gear | 31,204 | 24,270 | 6,934 | 0 | 6,934 | 22.2 |
| Nov | 3,318,067 | Angling | 457,664 | 239,234 | 218,431 | 114,416 | 104,015 | 22.7 |
| | | Passive gear | 58,942 | 27,737 | 31,204 | 6,934 | 24,270 | 41.2 |
| Oct | 3,321,534 | Angling | 412,591 | 204,562 | 208,029 | 117,883 | 90,146 | 21.8 |
| | | Passive gear | 48,540 | 27,737 | 20,803 | 10,401 | 10,401 | 21.4 |

3.1.2 Effort

It was expected that that effort between fishermen holding a license and fishermen without was different. This was investigated in the two latest omnibus where the respondents were asked about their fishing pattern and effort. Results indicate that for anglers fishing illegally, the effort was approximately 1/3 compared to anglers fishing with license. For passive gear fishers the effort for people without a license was approximately half compared to fishermen fishing with a license (Table 3).

Table 3. The average days fished for anglers and non-anglers that fished with either a license or illegally.

| | Angling | | Passive gear | |
|----------|--------------|-----------|--------------|-----------|
| | With license | Illegally | With license | Illegally |
| November | 8.5 | 2.2 | 24.0 | 10.7 |
| December | 9.9 | 4.2 | 25.4 | 16.5 |

3.1.3 Fishing in other countries

In the omnibus interview the respondents were asked about fishing habits in other countries. The percentage that fished in other countries was 2.8, 2.1 and 3.3 % of all interviewed. Sweden and Norway were by far the most important countries visited (Table 4). On average approximately 60 % reported one trip to other countries but some reported as many as 12.

Table 4: Respondents that fished in other countries. Total numbers of respondents are: 958, 957 and 968 in the October, November and December omnibus interview round, respectively.

| | October | November | December |
|--|---------|----------|----------|
| Sweden | 11 | 7 | 16 |
| Norway | 9 | 3 | 6 |
| Faroe Island | 3 | 2 | 0 |
| Greenland | 1 | 0 | 2 |
| Rest of Europe | 4 | 3 | 7 |
| Rest of the world | 3 | 6 | 5 |
| Respondents that fished outside of Denmark | 28 | 20 | 32 |

3.2 License interview

For both anglers and passive gear fishing, the fraction of respondents was higher than 70 % and with a higher number that responded via the internet than over telephone (Table 5).

Table 5. The numbers and percentage of respondents that replied via internet and telephone survey.

| | Passive gear | | Anglers | |
|---------------|--------------|-------|---------|-------|
| | Numbers | % | Numbers | % |
| Respondent: | 1,585 | 75.08 | 1,929 | 70.81 |
| via internet | 959 | 45.43 | 1,129 | 41.45 |
| via telephone | 626 | 29.65 | 800 | 29.37 |

3.2.1 Passive gear fishers

A total of 2,111 persons were contacted and 1,585 volunteered to participate in the interview. 959 answered via the internet and 625 via the telephone survey (Table 5). Only 61% of the passive gear fishers answered that they had actually been fishing within the last 12 months. The respondents were asked to give their catches and fishing pattern on a three month interval with the last three months August, September and October first.

The passive gear fishermen participating in the survey were split into 4 groups; 1) catching cod with gillnets 2) catching cod with fykenets or 3) catching eel with fykenets, 4) angling cod on their passive gear license.

A total of 167 fished exclusively with fykenets, 500 fished exclusively with gillnets and 281 fished with both types of gear. Out of the 1585 that had a valid license eels and cod had been caught and kept in fykenets by 23 % and 6 %, respectively. Indicating that fykenet is targeting eels and cod is only caught as a by-catch. Cod was caught and kept by 12% of those fishing with gillnets.

After completing questions about passive gear fishing and catches, the respondent was asked whether he/she also fished with rod, i.e. angled. To that 62% confirmed. This high number led us to analyze the fishery of this group separately from the rest of the anglers. A Fishery referred to as "angling with a license for passive gear".

3.2.2 Anglers

Of the 1,929 anglers that participated in the interview only 73 % had actually been fishing within the last 12 months, although they had a valid license. Cod was caught and kept by 16%. The majority, 87%, that caught cod did it from boats, 63% from tour boats and the rest from some kind of smaller boat.

Close to 15% of anglers fished in more than one area and the main part of those that operated in more areas did it from four boats (73%).

To estimate the total catch in kg a conversion key between numbers and weight were used, 1/3 of all respondents answered in kg and 2/3 answered in numbers.

3.3 Calculating cod and eel catches in the Danish recreational fishery

Table 6. All values used in equation 1 except for the average catches which can be found in table 7 or annex 1A to 1E.

| | License (p) | Respondent (r) | Effort illegal (E _i) | Effort license (E _p) | Pct. illegal (i) |
|--------------|-------------|----------------|----------------------------------|----------------------------------|------------------|
| Passive gear | 34,000 | 1,585 | 13.6 | 24.7 | 28.3 |
| Angling | 156,000 | 1,929 | 3.2 | 9.2 | 22.9 |

3.3.1 Passive gear -cod in gillnets

Of the persons interviewed 12% (184 persons) had caught cod in gillnet fishing within the last year. A total of 8.6 tons cod were caught by these fishermen. Up-scaling to total amount of cod caught in the legal and illegal gillnet fishery this corresponds to 212 t in the recreational gillnet fishing. The largest part of the cod was captured in the period February to April, were 38 % of the total catches was caught. The period with the lowest catches were in the summer (May-July) were only 8% of the total cod catches in gillnets were taken (Table 7).

Table 7. Cod and eel catches reported from recreational fishing in this study.

| Month | Cod in gillnets | | Cod in fykenet | | Eel in fykenets | | Cod angling (angling license) | | Cod angling (passive gear license) | |
|------------|-----------------|----|----------------|----|-----------------|----|-------------------------------|----|------------------------------------|----|
| | kg | % | Kg | % | kg | % | kg | % | kg | % |
| Aug-Oct | 2,285 | 27 | 631 | 81 | 3,065 | 79 | 1,901 | 26 | 3,168 | 35 |
| May-July | 712 | 8 | 17 | 2 | 300 | 8 | 1,570 | 22 | 2,453 | 27 |
| Feb- April | 3,263 | 38 | 74 | 10 | 395 | 10 | 1,890 | 26 | 2,117 | 23 |
| Nov-Jan | 2,299 | 27 | 59 | 7 | 132 | 3 | 1,898 | 26 | 1,333 | 15 |

3.3.2 Passive gear - cod in fykenets

Of the persons interviewed 6% (96 persons) had caught cod in their fykenets within the last year. Less than 1 ton (777kg) cod were caught by these fishermen. Up-scaling to total amount of cod caught in the legal fykenet fishery this corresponds to 17 t and 19 t if the illegal fishery is included. The main part of the cod catches (81%) were taken the period August to October. As was the case in the gillnet fishery the period with lowest catches were in May-July.

3.3.3 Passive gear - eel in fykenets

Of the persons interviewed 23% (362 persons) had caught eel fishing with fykenets within the last year. Just less than 4 t eels were caught by these fishermen. Up-scaling to total amount of eel caught in the legal fykenet fishery this correspond to 86 t and 99 tons if up-scaled to included the illegal fishery as well.

3.3.4 Angling with a passive gear license - cod

Fishermen holding a license for passive gear have automatically a license to fish with rod as well. A separate interview was therefore conducted on this group as we expected the fishing pattern in this group to differ from that in the general group of anglers. In this group a total of 244 persons caught cod within the last year and the areas they fished in differed

compared to the group only fishing with rod. Skagerrak and the North Sea were the most important areas where 50% of all persons had fished, in the Sound it was 10%.

In our investigation this group fished close to 9 tons cod, corresponding to 225 t cod when up-scaling to include all with a license and the illegal fishery as well (annex 1E). In the period from August to October 35% was caught and only 15% during the period from November to January.

Table 8. Relative distribution of fishing areas where anglers targeting cod has fished.

| Area | Aug-Oct | Nov-Jan | Feb-April | May-July | Total nr. anglers |
|-------------|---------|---------|-----------|----------|-------------------|
| West Baltic | 0.27 | 0.23 | 0.19 | 0.31 | 26 |
| Skagerrak | 0.33 | 0.09 | 0.29 | 0.29 | 66 |
| East Baltic | 0.23 | 0.15 | 0.19 | 0.42 | 26 |
| The Sound | 0.23 | 0.26 | 0.29 | 0.23 | 253 |
| North Sea | 0.30 | 0.15 | 0.27 | 0.28 | 60 |
| Limfjord | 0.33 | 0.00 | 0.00 | 0.67 | 3 |
| Kattegat | 0.44 | 0.15 | 0.10 | 0.31 | 39 |
| Belt Sea | 0.31 | 0.26 | 0.20 | 0.23 | 124 |

3.3.5 Anglers - cod

From our data close to 600 persons targeting cod were registered and the main part of those fished in the Sound (42%), followed by the Belt Sea (21%) and Skagerrak (11%) (Fig. 3).

In the four different periods we investigated the allocation of persons that had fished within a period was equally distributed with a small overweight in the period Aug-Oct (28%) and lesser in the period Nov-Jan (21%). Although there are some differences between periods and areas the data material is rather limited for some areas (Table 8). The respondents in our investigation caught close to 7 tons cod on rod corresponding to 634 t cod when up-scaled to include all with an annual license and the illegal fishery as well (annex 1D). Daily and weekly license holders caught 15.7 t and 27.2 t, respectively (annex 1F).

The fishery was fairly equally distributed in time. The Sound was the most important area with 31% of the total catches followed by the Belt Sea (21%) and the North Sea (18%).

Anglers fishing cod by area



Fig. 3. Relative distribution of fishing areas where anglers targeting cod has fished.

4 Discussion

In present study the total Danish recreational eel and cod catches was found by; 1) estimating the catches from a subsample of persons that has issued a license within the last 12 month and 2) estimating the amount of illegal fishing from a interview round targeting the entire Danish population between the age of 16 and 74. It was found that the numbers of angler between 16 and 74 years which had practiced their hobby within the last 12 month was between 450,000 and 402,000. This corresponds to between 12 and 14 % which is very close to 12.5 % which was found in 1997 (Bohn and Roth, 1997). The number of anglers that claimed to have issued a license was between 240,000 and 201,000 which are very close to the 196,000 license that are issued. According to the interview survey between 24,000 and 28,000 had a license for passive gear fishing which is lower than the actual licenses sold, which is 34,000. This means that the numbers are somewhat overestimated for anglers but underestimated for passive gear fishers.

4.1 Eel

In recreational fishing eels are mostly caught in fykenets in saltwater, even though some freshwater fishing for eel exists. The intensity of the freshwater fishing is unknown since it can be carried out legally for all landowners along lakes and rivers. Limitations are that fykenets has to be 100 m apart, the gear must not cover more the one third of the river and fishing is only allowed from the 1st of August to the 15th of October. In the commercial fishery the catches from lakes are very low compared to those in saltwater. Of the total catches reported from 2005 to 2009 only between 2 and 3 % was from lakes (www.fd.dk).

Since fykenets set in saltwater are rather sensitive to wave and current action this fishing is mainly carried out in the inner Danish waters where wind and wave protected Fjords, Belts and Sounds are located. This is reflected in the very low catches of eel in the North Sea, Skagerrak and Eastern Baltic. The Belts Sea was the area with the highest catches followed by Kattegat and the Limfjord. Eel were not caught equally throughout the season. The highest catches were reported in the period from August to October where the high water temperature prompts a high activity level and hence a higher catchability. The majority of effort is in this period as well. From 2009 the fishery with fykenets for eels is closed from the 10th of May to the 31st of July (Anon 2008). This is reflected in low catches during the period from May to July which has traditionally been months with a high CPUE of eel (Pedersen et al., 2005). The total catch, including fishery without license was in our investigation estimated to be 96.5 t. In 1997 the total catch of eel in the legal recreational fishery was estimated to be 138 t, which at that time corresponded to 20 % of the total catch (Anon, 2008). That the recreational catches were estimated lower in 2009 was expected since 1) the eel stock has continued to decrease, 2) the eel recovery plan has been implemented with the objective to decrease the total catch in the recreational fishery with 50 %. The commercial catches were in 2008 448 t and if this number remains the same in 2009 the recreational fishing caught an equivalent of 18 % of the total Danish eel catches.

4.2 Cod

We estimated that nearly 1,150 t cod are caught in recreational fishing. From these, approximately 230 t cod were caught in the passive fishery; 212 t with gillnets and 20 t with fykenets. These catches cover cod caught by Danes within the Swedish zone. However this is probably only the case in the Sound and Kattegat. The main part (~80%) of cod was taken by anglers (677 t by angler license holders and 225 t by passive gear license

holders). In the gillnet fishery the cod were caught in all areas, but the highest total catch was in the Skagerrak area where almost 50 % of the cod were taken.

Anecdotal information has highlighted the Sound as an important cod fishing area which was reflected in total catches of 211 t, 23.6 t and 21 t in the angling with an angling license, angling with a passive gear license and the passive gear fishery, respectively. Commercial catches in the Sound has the last 5 years fluctuated around 1,900 t (ICES 2009), hence recreational fishing caught 12 % of the total catch. However, the commercial catches are mainly from a small area north of Helsingør called "Kilen" where it has been legal to trawl. The rest of the Sound has had a trawling ban since 1932. Since 1st of January 2009 all fishing, commercial as well as recreational, was banned in February and March in an area covering the northern part of the Sound (bilateral agreement between Denmark and Sweden to protect the Kattegat cod). Therefore it can be expected that the commercial cod fishery in the Sound will be significantly decreased in 2009 compared to earlier and preliminary numbers from the Danish Fishery ministry indicate a reduction to 550 t in the Sound in 2009. If this number is true, then recreational fishing could account for 32% of the total Danish Sound cod catches and angling alone for 29 %. The angling catches might be even higher since we converted number of cod into weight assuming an average weight of 1.5 kg in the entire country. The average weight in the Sound is likely higher at least during the winter. The fishery during this season is very popular due to the very high average weight of cod captured.

In the Western and Eastern Baltic Danish commercial fishing for cod accounted for 8,600 t and 7,400 t in 2008, respectively (ICES 2009). In this light recreational fishing was minor and only accounted for an equivalent of 1.2 % and <1 % of the total cod catches, respectively. Anecdotal information has highlighted a large fraction of German anglers fishing in the Danish part of the Western Baltic. However, it has not been possible to quantify the amount fished by foreigners as it is possible in Denmark to purchase a license for a day or a week without providing any personal information. Therefore, it has not been possible to contact this group of fishermen.

In Kattegat, 35 t cod was caught in recreational fishing; 32 t was from angling and 3 t from gillnet and fykenet fishery. However, due to the present very low commercial quota (359 t) and landings (296 t) in this area the recreational catches are equivalent to 11% of the total official Danish commercial cod catch in this area.

In the North Sea and Skagerrak the commercial Danish catches were by ICES estimated to be 3,800 t and 2,500 t, respectively in 2008 (ICES 2009b). The catches in the recreational fishing from these areas was estimated to be 177 t and 255 t respectively corresponding to an equivalent of 4.4 % and 9.3 % of the total cod catches. Overall, our investigations indicate that 4.8% of the total Danish cod catches was taken in recreational fishing.

4.3 Sources of error

As illustrated for the gillnet cod catches one weakness in this type of survey is how to treat very high reports. A single respondent reported catches of cod as high as 1000, 0, 1500 and 600 kg for the periods Aug-Oct, May-July, Feb- April and Nov-Jan, respectively. If this single respondent was excluded from the results the total catches of cod in gillnet decreases from 225 t to 135 t. This specific respondent also reported the highest number (400) cod caught within one quarter for any respondent that fished as an angler.

The interview presented in this report targets Danish citizens, which means that the proportion of fish caught by tourists is unknown. This is a specific problem in the angling fishery for cod where anecdotal information states a quite large catch in some areas, especially by German tourists. The Belt Sea area is expected to be the area where the highest numbers of cod are caught by German tourists. This is due to a combination of

a rather high number of summerhouses for rent during the summer season; the possibility to rent smaller fishing-boats and a generally calm sea. One could expect the same pattern along the Western Coast of Denmark where lots of summerhouses are for rent during the summer, but the exposed nature of this shoreline makes it impossible to sail with smaller boats most of the time. The Sound and The North Sea/Skagerrak areas are probably also witnessing some cod catches from fishing tourist that travel to Denmark and fish from chartered boats either during the winter in the Sound area or in the North Sea/Skagerrak area.

4.4 Fishing without license

The inclusion of illegal fishing in was significant. Approximately 20-25 % reported that they fished illegally, though with a lower effort. One exception was in the November omnibus survey where 41 % of the passive gear fishers reported they fished without a license. However, there seemed - at least during the first interview round - to be a problem for respondents to differentiate between being fishing with passive gear ("fritidsfisker" in Danish) and angling ("lystfisker" in Danish). Indication of some misunderstanding of the classification during the two first interview rounds in October and November was that respectively 3 and 2 respondents claimed to not need a license. As arguments for that they used reasons that do not make sense when fishing with a passive gear. E.g. claiming to only fish in put & take lakes. In December, where the confusion had been resolved none of the respondents claimed not to need a license. Therefore, this single high percentage of illegal fishery (41%) should be treated with caution. Another aspect when asking people whether they have fished illegally is the risk of under estimating the numbers since the respondents might be tempted to claim to hold a license when they actually do not. Furthermore the licenses are issued for a one year period; hence many might choose to renew their license the first time they go fishing after the expiration date and not at the exact expiration date. Even though some legal reasons for fishing without a license exist, illegal fishery without license takes place. In Table 1 the yearly number of license purchased from 1999 and until 2009 are shown.

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6 Appendix

Annex 1A. Cod catches reported by respondents using gillnet. Based on these catches and the values in table 5 the total catch, including illegal fishery, of cod in the Danish recreational gillnet fishery are calculated.

| Cod caught in gillnets | Reported catch from respondents (kg) | | | | | | | | | | Estimated total Danish catch (t) | | | | | | | | | |
|------------------------|--------------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|-------------------|----------------------------------|------------|----------|-----------|----------|----------------|----------------|-------|--|--|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | | |
| Aug-Oct | 15.7 | 1151 | 29.6 | 18.7 | 130 | 343 | 506 | 91.2 | 2285 | 0.4 | 28.5 | 0.7 | 0.5 | 3.2 | 8.5 | 12.5 | 2.3 | 56.7 | | |
| May-July | 92.9 | 62.3 | 10 | 4.88 | 106 | 161 | 104 | 171 | 712 | 2.3 | 1.5 | 0.2 | 0.1 | 2.6 | 4.0 | 2.6 | 4.2 | 17.7 | | |
| Feb- Apr | 134 | 1701 | 60 | 0 | 263 | 474 | 528 | 104 | 3263 | 3.3 | 42.2 | 1.5 | 0.0 | 6.5 | 11.7 | 13.1 | 2.6 | 80.9 | | |
| Nov-Jan | 30 | 841 | 0 | 20.9 | 243 | 795 | 329 | 39.4 | 2299 | 0.7 | 20.8 | 0.0 | 0.5 | 6.0 | 19.7 | 8.2 | 1.0 | 57.0 | | |
| Total | 272 | 3756 | 99.6 | 44.5 | 742 | 1773 | 1466 | 405 | 8559 | 6.8 | 93.1 | 2.5 | 1.1 | 18.4 | 44.0 | 36.4 | 10.0 | 212.2 | | |

Annex 1B. Cod catches reported by respondents using fykenets. Based on these catches and the values in table 5 the total catch, including illegal fishery, of cod in the Danish recreational fykenet fishery are calculated.

| Cod caught in fykenets | Reported catch from respondents (kg) | | | | | | | | | | Estimated total Danish catch (t) | | | | | | | | | |
|------------------------|--------------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|-------------------|----------------------------------|------------|----------|-----------|----------|----------------|----------------|-------|--|--|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | | |
| Aug-Oct | 2.7 | 0 | 6.7 | 81 | 104 | 415 | 21 | 631 | 0.07 | 0.00 | 0.17 | 2.01 | 2.59 | 10.30 | 0.53 | 0.00 | 0.00 | 15.66 | | |
| May-July | 0 | 0 | 0 | 0.5 | 0 | 16 | 0 | 17 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.41 | | |
| Feb- Apr | 0 | 0 | 0 | 0 | 0 | 43 | 31 | 74 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 0.77 | 0.00 | 0.00 | 1.85 | | |
| Nov-Jan | 0 | 0 | 0 | 0 | 0 | 57 | 1.6 | 59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.41 | 0.04 | 0.00 | 0.00 | 1.45 | | |
| Total | 2.7 | 0 | 6.7 | 81.7 | 104 | 532 | 53.8 | 781 | 0.07 | 0.00 | 0.17 | 2.03 | 2.59 | 13.18 | 1.33 | 0.00 | 0.00 | 19.36 | | |

Annex 1C. Eel catches reported by respondents using fykenets. Based on these catches and the values in table 5 the total catch, including illegal fishery, of eel in the Danish recreational fykenet fishery are calculated.

| Eel caught in fykenets | Reported catch from respondents (kg) | | | | | | | | | | Estimated total Danish catch (t) | | | | | | | | | |
|------------------------|--------------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|-------------------|----------------------------------|------------|----------|-----------|----------|----------------|----------------|-------|--|--|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | | |
| Aug-Oct | 57 | 25 | 350 | 894 | 209 | 1227 | 273 | 30 | 3065 | 1.4 | 0.6 | 8.7 | 22.2 | 5.2 | 30.4 | 6.8 | 0.7 | 76.0 | | |
| May-July | 5.8 | 1 | 78 | 46 | 18 | 118 | 25 | 7 | 300 | 0.1 | 0.0 | 1.9 | 1.2 | 0.5 | 2.9 | 0.6 | 0.2 | 7.4 | | |
| Feb-Apr | 0 | 0 | 26 | 60 | 0 | 269 | 39 | 0 | 395 | 0.0 | 0.0 | 0.7 | 1.5 | 0.0 | 6.7 | 1.0 | 0.0 | 9.8 | | |
| Nov-Jan | 0.8 | 0.8 | 11 | 15 | 2.3 | 86.8 | 16 | 0.8 | 132 | 0.0 | 0.0 | 0.3 | 0.4 | 0.1 | 2.2 | 0.4 | 0.0 | 3.3 | | |
| Total | 63.3 | 26.9 | 466 | 1016 | 229 | 1701 | 353 | 37.8 | 3893 | 1.6 | 0.7 | 11.6 | 25.2 | 5.7 | 42.2 | 8.7 | 0.9 | 96.5 | | |

Annex 1D; Cod catches reported by respondents that holds an annual angler license. Based on these catches and the values in table 5 the total catch, including illegal fishery, of cod caught by persons that holds an annual angling license are calculated.

| Cod caught by anglers holding a angler license | Reported catch from respondents (kg) | | | | | | | | | | Estimated total Danish catch (t) | | | | | | | | | |
|--|--------------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|-------------------|----------------------------------|------------|----------|-----------|----------|----------------|----------------|-------|--|--|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | | |
| Aug-Oct | 439 | 270 | 2 | 106 | 405 | 373.5 | 144 | 163 | 1901 | 38.3 | 23.6 | 0.2 | 9.3 | 35.3 | 32.6 | 12.5 | 14.2 | 166.0 | | |
| May-July | 300 | 144 | 3 | 38 | 597 | 395.5 | 71.5 | 22 | 1570 | 26.2 | 12.5 | 0.3 | 3.3 | 52.1 | 34.5 | 6.2 | 1.9 | 137.1 | | |
| Feb-Apr | 238 | 330 | 0 | 78 | 614 | 413.6 | 126 | 91 | 1890 | 20.8 | 28.8 | 0.0 | 6.8 | 53.6 | 36.1 | 11.0 | 7.9 | 165.0 | | |
| Nov-Jan | 324 | 323 | 4 | 70.3 | 645 | 329.2 | 109 | 92.3 | 1898 | 28.3 | 28.2 | 0.3 | 6.1 | 56.4 | 28.7 | 9.6 | 8.1 | 165.7 | | |
| Total | 1301 | 1066 | 9 | 292 | 2261 | 1512 | 450 | 368 | 7259 | 113.6 | 93.1 | 0.8 | 25.5 | 197.4 | 132.0 | 39.3 | 32.1 | 634 | | |

Annex 1E; Reported catches of cod by passive gear licence holders that also fish as anglers. Based on these catches and the values in table 5 the total catch, including illegal fishery, of cod caught by persons that holds a passive gear license and fish as angler are calculated.

| Cod caught by anglers holding a passive gear license | Reported catch from respondents (kg) | | | | | | | | | Estimated total Danish catch (t) | | | | | | | | |
|--|--------------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|----------------------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total |
| Aug-Oct | 1180 | 640 | 0 | 34.5 | 356 | 373.5 | 373 | 212 | 3168 | 29.24 | 15.87 | 0.00 | 0.86 | 8.81 | 9.26 | 9.25 | 5.26 | 78.55 |
| May-July | 397 | 645 | 0 | 107 | 174 | 397 | 391 | 343 | 2453 | 9.84 | 15.99 | 0.00 | 2.65 | 4.30 | 9.84 | 9.69 | 8.49 | 60.82 |
| Feb- Apr | 199 | 870 | 0 | 18 | 239 | 337.5 | 194 | 260 | 2117 | 4.93 | 21.56 | 0.00 | 0.45 | 5.93 | 8.37 | 4.80 | 6.45 | 52.48 |
| Nov-Jan | 183 | 374 | 0 | 27 | 184 | 395.5 | 50.5 | 120 | 1333 | 4.54 | 9.27 | 0.00 | 0.67 | 4.55 | 9.81 | 1.25 | 2.96 | 33.05 |
| Total | 1959 | 2529 | 0 | 187 | 952 | 1504 | 1008 | 934 | 9071 | 48.56 | 62.69 | 0.00 | 4.62 | 23.59 | 37.28 | 24.99 | 23.16 | 225 |

Annex 1F; Estimated cod catches of anglers holding a daily or weekly license. Illegal fishing is included.

| Cod caught by anglers holding a weekly or daily license | Estimated total catch by daily license holders (t) | | | | | | | | Estimated total catch by weekly license holders (t) | | | | | | | | | |
|---|--|-----------|------------|----------|-----------|----------|----------------|----------------|---|-------------------|-----------|------------|----------|-----------|----------|----------------|----------------|-------|
| | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total | Central North Sea | Skagerrak | Limfjorden | Kattegat | The Sound | Belt Sea | Western Baltic | Eastern Baltic | Total |
| Aug-Oct | 1.0 | 0.6 | 0 | 0.2 | 0.9 | 0.8 | 0.3 | 0.4 | 4.1 | 1.6 | 1.0 | 0 | 0.4 | 1.5 | 1.4 | 0.5 | 0.6 | 7.1 |
| May-July | 0.6 | 0.3 | 0 | 0.1 | 1.3 | 0.9 | 0.2 | 0 | 3.4 | 1.1 | 0.5 | 0 | 0.1 | 2.2 | 1.5 | 0.3 | 0.1 | 5.9 |
| Feb- Apr | 0.5 | 0.7 | 0 | 0.2 | 1.3 | 0.9 | 0.3 | 0.2 | 4.1 | 0.9 | 1.2 | 0 | 0.3 | 2.3 | 1.5 | 0.5 | 0.3 | 7.1 |
| Nov-Jan | 0.7 | 0.7 | 0 | 0.2 | 1.4 | 0.7 | 0.2 | 0.2 | 4.1 | 1.2 | 1.2 | 0 | 0.3 | 2.4 | 1.2 | 0.4 | 0.3 | 7.1 |
| Total | 2.8 | 2.3 | 0 | 0.6 | 4.9 | 3.3 | 1.0 | 0.8 | 15.7 | 4.9 | 4.0 | 0 | 1.1 | 8.5 | 5.7 | 1.7 | 1.4 | 27.2 |

DTU Aqua has carried out an interview survey in 2009 in cooperation with Statistic Denmark in order to estimate cod and eel catches in the Danish recreational fishery.

Recreational fishing was separated into anglers (with rod and reel) and passive gear fishing (with fyke- and gillnets).

Eel was caught and kept by 23 % of the interviewed passive-gear fishermen, while cod was caught and kept in gillnet and fykenet by 6 % and 12 %, respectively. By anglers cod was caught and kept by 16 % with the majority of these catches from boats.

The survey showed that a little more than 1000 t cod was caught in 2009, corresponding to almost 5 % of the total Danish landings. There was caught almost 100 t eel which corresponds to 18 % of the total eel catches. About 80 % of the recreational caught cod was taken with reel and rod whereas all eel was taken in the fykenet fishery.

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