# Long-run management of Greenland's fishery on Greenland halibut (Reinhardtius hippoglossoides)

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# ONLINE APPENDIX

## Appendix A. Data and Parameterization

### A.1. Introduction

We have constructed a number of scenarios for the Grl. halibut fishery on the west coast of Greenland. To construct these scenarios, data have been collected, and parameters in various functional forms have been estimated. This paper contains documentation for our empirical work on the Grl. halibut fishery. Specifically, we present all data that have been collected and estimation of parameter values in the relevant functions.

### A.2. Data and relevant information

*A.2.1. The fishing industry*

We obtained information from H Ogmundsson, personal communication, 2019, based on Ogmundsson (2019), about various economic indicators for the primary fishing sector in all parts of Greenland. Table A1 summarizes some of these indicators for the period between 2010 and 2015.

**Table A1.** Economic indicators for the primary fishing industry, 2010–2015

| **Year** | **Revenue** (million DKK) | **Accounting cost** (million DKK) | **Accounting profit** (million DKK) |
|---|---|---|---|
| **2010** | 2,013 | 1,801 | 212 |
| **2011** | 1,199 | 923 | 276 |
| **2012** | 2,123 | 1,847 | 276 |
| **2013** | 2,413 | 2,044 | 369 |
| **2014** | 2,314 | 1,836 | 478 |
| **2015** | 2,111 | 1,712 | 399 |

*Source:* H Ogmundsson, personal communication, 2019, based on Ogmundsson (2019).

From table A1, we see that the revenue (without subsidies), accounting costs, and accounting profit in the primary fisheries sector fluctuate (with a tendency to increase). It should be noted that the accounting costs in table A1 include fisheries taxes but it can be argued that these transfers ought to be excluded.

However, not only is the primary fishing sector important for Greenland but also the secondary fisheries-related industries. From Ogmundson and Haraldson (2017), we have information about economic indicators for the whole fishing industry and some of these indicators for the period between 2010 and 2015 can be found in table A2.

**Table A2.** Economic indicators for the whole fishing industry, 2010–2015

| **Year** | **Revenue** (million DKK) | **Accounting cost** (million DKK) | **Accounting profit** (million DKK) |
|---|---|---|---|
| **2010** | 3,734 | 3,483 | 251 |
| **2011** | 4,233 | 3,779 | 454 |
| **2012** | 4,301 | 3,760 | 541 |
| **2013** | 4,281 | 3,943 | 338 |
| **2014** | 4,590 | 4,239 | 351 |
| **2015** | 5,707 | 5,030 | 677 |

*Source:* Ogmundson and Haraldson (2017).

From table A2, we observe that the economic indicators, represented by the revenue, accounting costs, and accounting profits, have tended to increase. Two issues are important in relation to the accounting costs in table A2. First, the accounting costs include production-related taxes, and it is to be argued that these should be excluded. Second, part of the revenue earned by the primary fishery represents part of the accounting costs in the secondary fisheries-related industry, and this is reflected in the accounting costs in table A2.

*A.2.2. Regulation of vessels from Greenland*

The fishing territory in Greenland is placed within a 200 nautical mile limit from the coast and can be decomposed into a west and east coast. Furthermore, the commercial fisheries in both areas consist of high sea and coastal fleet segments. The high sea fisheries occur more than 3 nautical miles from the coast while the coastal fisheries take place within a 3 nautical mile limit.[1] High sea fisheries are mainly undertaken by large production vessels while small vessels and boats conduct coastal fishery.

For both the west and east coast, a total allowable catch (TAC) is fixed each year for the most important commercial fish species based on biological recommendations. For both the east and west coast, the TAC is allocated as total quotas to the high sea and coastal fleet segments, and then the total high sea quota is divided between vessels from Greenland and foreign vessels. Ogmundson and Haraldson (2017) contains information about the total high sea quota distributed to vessels from Greenland on the west and east coasts, and information about these quotas for the period between 2013 and 2016 is provided in table A3.

**Table A3.** High sea quotas on the west and east coast, 2013–2016

| Area | Fish species | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **West coast** | **Shrimp** (tons) | 49,802 | 47,262 | 41,075 | 47,425 |
| | **Grl. halibut** (tons) | 8,075 | 8,075 | 9,725 | 9,725 |
| | **Cod** (tons) | 5,000 | 5,000 | 7,000 | 5,000 |
| | **Other species** (tons) | 17,120 | 27,120 | 32,620 | 32,620 |
| **East coast** | **Shrimp** (tons) | 4,900 | 800 | 800 | 800 |
| | **Grl. halibut** (tons) | 3,685 | 3,685 | 3,803 | 1,797 |
| | **Other species** (tons) | 160,696 | 157,025 | 174,130 | 146,130 |
| **West and east coast** | **Cod** (tons) | 3,550 | 6,245 | 6,445 | 11,875 |

*Source:* Ogmundson and Haraldson (2017).

From table A3, we see that the total high sea shrimp quota on the west coast decreased between 2013 and 2015 while the quota increased in 2016. The total high sea cod quota on the west coast was constant while the total high sea Grl. halibut quota increased between 2014 and 2015. The high sea quota for other fish species on the west coast increased a lot between 2013

[1] There are some exemptions from this general rule. As an example, a limited amount of small coastal vessels can fish outside the 3 nautical mile limit.

and 2015, and this is due to a dramatic increase in the mackerel quota. On the east coast, the total high sea Grl. halibut quota decreased between 2015 and 2016. Note that a part of the total quota on cod can be used on both the east and west coasts.

Ogmundson and Haraldson (2017) also contains information about the total coastal quotas, and an overview of these quotas on the west coast can be found in table A4.

**Table A4.** Coastal quotas on the west coast, 2013–2016

| Fish species | Fleet segment | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **Shrimp** (tons) | | 36,061 | 35,654 | 30,986 | 35,776 |
| **Grl. halibut** (tons) | | 24,700 | 26,394 | 28,200 | 28,500 |
| | **Vessels above 6 m** | 11,577 | 11,577 | 12,270 | 12,270 |
| | **Boats below 6 m** | 13,123 | 14,817 | 15,930 | 15,930 |
| **Cod** (tons) | | 15,000 | 18,500 | 27,500 | 26,000 |
| **Other species** (tons) | | 2,780 | 2,800 | 4,300 | 3,900 |

*Source:* Ogmundson and Haraldson (2017).

From table A4, we see that the total coastal shrimp quota on the west coast decreased between 2013 and 2015 and increased in 2016 while the total coastal cod quota increased between 2013 and 2015. The total quota for harvesting other fish species on the west coast fluctuated. Regarding the total coastal Grl. halibut quota on the west coast, we must distinguish between vessels above 6 m and boats below 6 m. For vessels above 6 m, the total quota increased between 2014 and 2015 while the total quota for boats below 6 m increased over the whole time period.

Individual vessels are regulated by licenses and quotas. A license is required to undertake commercial fisheries for all fish species in Greenland, and two types of licenses are used: (1) Time-limited licenses; and (2) Time-unlimited licenses. Time-limited licenses are normally issued for one year and may contain a maximum harvest. Time-unlimited licenses normally contain a maximum harvest. In the coastal fishery targeting Grl. halibut in the Disko Bay, Uummannaq, and Upernavik, time-limited licenses without a maximum harvest are used for boats below 6 m while time-unlimited licenses with a maximum harvest are used for vessels above 6 m. Furthermore, time-limited licenses without a maximum harvest are used in the high sea fisheries targeting Grl. halibut while time-unlimited licenses with a maximum harvest are used in all fisheries targeting shrimp. Furthermore, individual transferable quotas (ITQs) are used to regulate part of the shrimp fishery. More importantly, an ITQ system was introduced for the coastal Grl. halibut fishery for vessels above 6 m in the Disko Bay, Uummannaq, and Upernavik in 2012.

*A.2.3. International fishing agreements*

As mentioned in section A.2.2, a part of the high sea quota is allocated to foreign vessels according to international fishing agreements. The fishing agreement with the EU is very important for Greenland, and this agreement was entered into for the first time in 1985. The agreement is enforced through protocols that cover a number of years. According to the fisheries agreement with the EU, Greenland obtains free access for fish products to the markets in the EU. Furthermore, Greenland receives economic compensation for providing vessels from the EU with access to the territory of Greenland. At present, a protocol for 2016–2020 determines the high sea quota distributed to the EU while the previous protocol covered the period between 2013 and 2016. Ogmundson and Haraldson (2017) contains information about the total high sea quota allocated to vessels from the EU on the east and west coasts, and table A5 summarizes this information.

**Table A5.** High sea quota of vessels from the EU on the west and east coasts, 2013–2016

| Area | Fish species | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **West coast** | **Shrimp** (tons) | 3,400 | 3,400 | 3,400 | 2,600 |
| | **Grl. Halibut** (tons) | 2,500 | 2,500 | 2,500 | 2,500 |
| | **Other species** (tons) | 300 | 100 | 100 | 100 |
| **East coast** | **Shrimp** (tons) | 7,500 | 7,500 | 7,500 | 5,100 |
| | **Grl. Halibut** (tons) | 4,315 | 4,315 | 4,315 | 4,315 |
| | **Other species** (tons) | 300 | 300 | 300 | 100 |
| **West and east coast** | **Cod** (tons) | 2,200 | 2,200 | 2,200 | 2,200 |
| | **Other species** (tons) | 65,250 | 65,250 | 65,250 | 24,000 |

*Source:* Ogmundson and Haraldson (2017).

From table A5 we see that under the protocol for 2013–2016, harvesting shrimp and Grl. halibut on the east coast is important for vessels from the EU. On the west coast, shrimp and Grl. halibut are also important species, but the total shrimp and Grl. halibut quotas on the east coast are approximately two times higher than on the west coast. Part of the quota allocated to the EU can be used on both the east and west coasts, and here other fish species are very important under the protocol for 2013–2016. This is due to a very large solder quota that can be harvested in both territories (see Statistics Greenland, 2020). However, in the protocol for 2016–2020, the solder total quota has been decreased dramatically, and an identical development has occurred for the shrimp quota on the east coast (see Statistics Greenland, 2020). The quota for harvesting other species in both territories is approximately unchanged with the protocol for 2016–2020.

Regarding fisheries agreements with other countries, Greenland has entered bilateral agreements with several fishing nations. These agreements provide vessels from Greenland with access to the fishing areas of other nations while other fishing nations obtain access to the areas in Greenland. These bilateral agreements are very complicated and can be difficult to summarize, but Ogmundson and Haraldson (2017) contains information about the total quotas distributed to other fishing nations. The total Grl. halibut quotas allocated to Russia, Norway, and the Faroe Islands on the west coast for 2013–2016 are summarized in table A6.

**Table A6.** High sea Grl. halibut quota of vessels from other countries on the west coast, 2013–2016

| Country | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| **Russia** (tons) | 1,775 | 1,775 | 1,775 | 1,775 |
| **Faroe Island** (tons) | 100 | 100 | 100 | 100 |
| **Norway** (tons) | 1,475 | 1,475 | 1,475 | 900 |

*Source:* Ogmundson and Haraldson (2017).

From table A6, we see that the total Grl. halibut quotas allocated to Russia, the Faroe Islands, and Norway on the west coast are approximately constant for the whole time period. This reflects the fact that normally bilateral agreements between independent fishing nations are formulated as a share of a biological recommended TAC that each nation obtains covering a long time period.

*A.2.4. Landing obligation*

In Greenland, a landing obligation has been introduced in order to secure land-based employment. For high sea vessels targeting Grl. halibut on the west coast, at least 25 per cent of their landings shall be delivered for land-based processing, and, in addition, 1500 tons of the harvest shall be supplied for filtering. For coastal vessels on both the west and east coasts, the entire harvest of all species is normally delivered for land-based processing.[2] Ogmundson and Haraldson (2017) contains information on the amount of fish delivered for land-based processing by both high sea and coastal vessels from Greenland on the west and east coasts,

[2] However, some coastal vessels are allowed to do on board processing of 75% of their harvest.

and this information is summarized in table A7 for the period between 2013 and 2015.

**Table A7.** Quantity of fish delivered for land-based processing on the west and east coasts, 2013–2015

| Fish species | 2013 | 2014 | 2015 |
|---|---|---|---|
| **Shrimp** (tons) | 50,167 | 45,551 | 36,880 |
| **Grl. Halibut** (tons) | 25,291 | 30,095 | 28,191 |
| **Cod** (tons) | 14,587 | 21,063 | 33,933 |
| **Stone chunks** (tons) | 14,791 | 8,127 | 7,162 |
| **Other species** (tons) | 4,003 | 4,385 | 3,766 |

*Source:* Ogmundson and Haraldson (2017).

From table A7, we see that the amount of shrimp delivered for land-based processing has decreased and that the same has occurred for stone chunks. The amount of cod has increased dramatically while the amount of Grl. halibut increased between 2013 and 2014 but decreased between 2014 and 2015. The amount of other fish species delivered for land-based processing is approximately constant.

We also have information from H Ogmundsson, personal communication, 2019, based on Ogmundsson (2019), about the quantity of fish supplied by land-based processing factories. Table A8 shows the quantity of shrimp, Grl. halibut, and cod supplied by all land-based factories between 2013 and 2015.

**Table A8.** Quantity of fish produced by land-based processing factories, 2013–2015

| Fish species | 2013 | 2014 | 2015 |
|---|---|---|---|
| **Shrimp** (tons) | 30,215 | 24,766 | 20,123 |
| **Grl. Halibut** (tons) | 20,120 | 22,233 | 21,256 |
| **Cod** (tons) | 10,113 | 15,215 | 20,122 |

*Source:* H Ogmundsson, personal communication, 2019, based on Ogmundsson (2019).

From table A8, we see that the quantity of shrimp delivered by land-based factories has decreased while the amount of cod has increased and the quantity of Grl. halibut is approximately constant. Furthermore, by comparing the numbers in tables A7 and A8, we see that the supply of shrimp, Grl. halibut, and cod by land-based factories is lower than the input of these species from primary fisheries due to a processing loss in land-based factories.

*A.2.5. High sea vessels*

The high sea vessels targeting Grl. halibut on the west coast perform this in a mixed fishery with cod and redfish, and the contribution of each of these species to the industry revenue and costs is not straightforward to identify. Furthermore, the vessels are production trawlers that harvest fish and do processing on board the vessel, but as mentioned above, a landing obligation implies that 25 per cent of the Grl. halibut harvest must be delivered for land-based processing.

Ogmundson and Haraldson (2017) have collected data on the industry revenue, costs, and harvest from tax authorities while Fiskerikommisionen (2021) contains information about the number of high sea vessels from Greenland. Since Ogmundson and Haraldson (2017) use tax information, the industry costs represent accounting information but ideally we should have obtained a measure for the opportunity costs. However, from the accounting costs in Ogmundson and Haraldson (2017), we are not able to obtain a measure for the opportunity costs. Therefore, we have chosen to use the industry revenue, accounting costs, and harvest from Ogmundson and Haraldson (2017) directly. It should also be noted that the industry revenue and accounting costs from Ogmundson and Haraldson (2017) cover all fish species for vessels targeting Grl. halibut. The relevant information is summarized in table A9 for the period between 2013 and 2016.

**Table A9.** Economic indicators for high sea vessels targeting Grl. halibut on the west coast, 2013–2015

| Indicator | Indicator | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| **Revenue** (million DKK) | | 435.4 | 543.7 | 614.4 |
| **Costs** (with taxes and depreciation) (million DKK) | | 297.3 | 369.5 | 433.3 |
| **Taxes and depreciation** (million DKK) | **Grl. halibut tax** | 15.4 | 19.8 | 27.1 |
| | **Mackerel tax** | | 4.1 | 3.5 |
| | **User payment** | 1.6 | 1.9 | 2.0 |
| | **Depreciation** | 26.2 | 36.5 | 49.9 |
| **Costs** (without taxes and depreciation) (million DKK) | | 254.1 | 307.2 | 350.8 |
| **Number of vessels** | | 4 | 4 | 4 |
| **Harvest** (tons) | **Grl. halibut** | 9,860 | 11,266 | 12,072 |
| | **Cod** | 9,078 | 8,491 | 9,630 |
| | **Redfish** | 5,700 | 4,230 | 3,776 |
| | **Chew** | 821 | 393 | 396 |
| | **Haddock** | 1,348 | 1,023 | 878 |
| | **Pelagic species** | 368 | 7,123 | 6,640 |
| | **Cod** | 82 | 84 | 84 |

*Source:* Ogmundson and Haraldson (2017) and Fiskerikommissionen (2021).

From table A9, we see that 4 production trawlers participated in the high sea fishery targeting Grl. halibut on the west coast of Greenland between 2013 and 2015. The industry revenue increased in the whole time period, and this can be partly due to a huge increase in the international Grl. halibut prices (see Statistics Greenland, 2021). The industry accounting costs (with and without taxes or depreciation) also increased over the whole time period. One explanation for this fact is that employees on fishing vessels may be remunerated according to a share of revenue rule, and since the revenue increased, the remuneration to employees also increased.

*A.2.6. Coastal vessels above 6 meters*

The coastal fishery for vessels above 6 m targeting Grl. halibut on the west coast mainly occurs in a mixed fishery with cod. Ogmundson and Haraldson (2017) contains information on industry revenue, costs, and harvest at industry level while Fiskerikommisionen (2021) report the number of coastal vessels above 6 m. However, as for high sea vessels, accounting costs (and not opportunity costs) are identified but we have chosen to use this cost measure for vessels above 6 m. The data for vessels above 6 m is presented in table A10 for the period between 2013 and 2015.

**Table A10.** Economic indicators for coastal vessels above 6 meters targeting Grl. halibut on the west coast, 2013–2015

| Indicator | Indicator | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| **Revenue** (million DKK) | | 117.3 | 124.7 | 64.2 |
| **Costs** (with depreciation) (million DKK) | | 72.9 | 85.5 | 34.9 |
| **Depreciation** (million DKK) | | 8.9 | 10.5 | 7 |
| **Costs** (without depreciation) (million DKK) | | 63 | 75 | 27.9 |
| **Number of vessels** | | 128 | 125 | 122 |
| **Harvest** (tons) | **Grl. halibut** | 10,350 | 11,203 | 8,907 |
| | **Cod** | 4,767 | 6,060 | 8,350 |
| | **Other species** | 1,894 | 1,662 | 1,684 |

*Source:* Ogmundson and Haraldson (2017) and Fiskerikommissionen (2021).

From table A10, we see a reasonably large amount of vessels participated in the fishery on the west coast between 2013 and 2015. The industry revenue increased between 2013 and 2014 but decreased between 2014 and 2015, and the industry accounting costs followed the same pattern. However, it should be noted that taxes are not included in the cost observations in table A10. This is due to the fact that taxes on coastal vessels above 6 m were introduced for the first time in 2016 while our data covers the period between 2013 and 2015.

*A.2.7. Coastal boats below 6 meters*

The coastal boats below 6 m targeting Grl. halibut do this in a mixed fishery with cod, but often they have a very limited sailing capacity, so they are dependent on local trading posts. Ogmundson and Haraldson (2017) summarize the revenue, costs and harvest for this fleet segment while Fiskerikommisionen (2021) report the number of coastal boats below 6 m. However, accounting costs (and not opportunity costs) are identified but, despite this fact, we choose to use the information in Ogmundson and Haraldson (2017) directly. Table A11 contains the relevant indicators for the period between 2013 and 2015.

**Table A11.** Economic indicators for coastal boats below 6 meters targeting Grl. halibut on the west coast, 2013–2015

| Indicator | Indicator | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| **Revenue**<br>(million DKK) | | 264.3 | 284.3 | 374.5 |
| **Costs**<br>(with depreciation)<br>(million DKK) | | 81.8 | 88.2 | 123.1 |
| **Depreciation**<br>(million DKK) | | 7.2 | 10.8 | 12.6 |
| **Costs**<br>(without depreciation)<br>(million DKK) | | 74.6 | 77.4 | 110.5 |
| **Number of vessels** | | 759 | 762 | 780 |
| **Harvest**<br>(tons) | **Grl.** h**alibut** | 13,069 | 15,300 | 16,009 |
| | **Cod** | 5,136 | 9,424 | 12,609 |

*Source:* Ogmundson and Haraldson (2017) and Fiskerikommissionen (2021)

From table A11, we see that a huge number of boats participated in the fishery. The industry cod and Grl. halibut harvest has increased, and the industry revenue and accounting costs (both with and without depreciation) follow the same pattern. Finally, as for vessels above 6 m, no taxes are included in table A11 because no harvest fees were used in the period between 2013 and 2015.

*A.2.8. Biological information with a common fish stock*

In this section we will describe the data we have used to estimate natural growth functions in the scenarios with a common Grl. halibut stock size for the west coast of Greenland. As indicated in section A.3.1.1, we have estimated a growth function using two alternative approaches. The first approach requires knowledge about the natural growth, stock size and harvest of Grl. halibut while information about the stock size and harvest must be obtained under the second approach. Thus, we must obtain data for stock size, harvest and natural growth for Grl. halibut on the west coast of Greenland.

Since 1997, the Northwest Atlantic Fisheries Organization (NAFO) has estimated stock size and harvest of the Grl. halibut for NAFO subareas 0 and 1 and we assume that these areas are identical to the west coast of Greenland. We have obtained relevant information about the stock size and harvest of Grl. halibut from MA Treble, personal communication, 2019, based on Treble and Nogueira (2018). The measure for the Grl. halibut stock size includes recruitments and can be defined as the total Grl. halibut biomass while the harvest is defined as the catches by all fishing nations in the relevant area. The measure for the stock size and harvest of Grl. halibut is collected on 1 October each year. If we assume an unchanged stock size and no harvest of Grl. halibut between 1 October and 31 December each year, we can calculate a time series for the natural growth by using:

$$G_t = x_t - x_{t-1} + h_t \, , \qquad \text{(A1)}$$

where $G_t$ is the natural growth, $x_t$ is the stock size in a given year, $x_{t-1}$ is the stock size in the previous year, and $h_t$ is the halibut harvest by all fishing nations.

Table A12 shows the time series for stock size, harvest, and natural growth of Grl. halibut on the west coast of Greenland between 1997 and 2017.

**Table A12.** Stock size, harvest and growth of Grl. halibut on the west coast, 1997–2017

| **Year** | **Stock size** (tons) | **Harvest by all nations** (tons) | **Natural growth** (tons) | **Quota utilization** (%) |
|---|---|---|---|---|
| **1997** | 63,453 | 9,101 | | |
| **1998** | 71,456 | 8,652 | 16,695 | |
| **1999** | 68,715 | 9,671 | 6,930 | |
| **2000** | 65,715 | 10,566 | 7,566 | |
| **2001** | 74,517 | 13,780 | 22,562 | |
| **2002** | 74,778 | 14,877 | 15,138 | |
| **2003** | 72,712 | 18,696 | 16,630 | |
| **2004** | 75,716 | 19,052 | 22,056 | |
| **2005** | 80,209 | 19,716 | 24,209 | |
| **2006** | 78,715 | 23,704 | 22,270 | |
| **2007** | 73,134 | 23,388 | 17,807 | |
| **2008** | 89,718 | 22,183 | 38,757 | |
| **2009** | 73,123 | 24,672 | 8,077 | |
| **2010** | 75,718 | 27,049 | 29,644 | |
| **2011** | 92,213 | 26,553 | 43,048 | |
| **2012** | 64,715 | 27,513 | 15 | |
| **2013** | 64,174 | 28,429 | 27,888 | 76 |
| **2014** | 62,671 | 31,433 | 29,930 | 85 |
| **2015** | 76,937 | 31,861 | 40,127 | 86 |
| **2016** | 75,841 | 31,145 | 30,049 | 84 |
| **2017** | 77,895 | 34,652 | 36,719 | |

*Source:* MA Treble, personal communication, 2019, based on Treble and Nogueira (2018); and own calculations.

The Grl. halibut stock size in table A12 tends to increase (with fluctuations) until 2011 and decrease after 2011. The Grl. halibut harvest by all fishing nations increases over the whole time period and, as indicated in table A12, the Grl. halibut natural growth fluctuated a lot over the whole time period.

A potential problem with our study is the definition of the area for measuring the stock size and harvest of Grl. halibut. Specifically, the area for which the time series in table A12 is identified differs from the area for which the quota is defined. Therefore, we calculate the Grl. halibut quota utilization by using the harvest in table A12 and the quotas from sections A.2.2 and A.2.3. From table A12 we see that the utilization of Grl. halibut quota is between 76 and

86 per cent, implying that using the Grl halibut harvest from MA Treble, personal communication, 2019, based on Treble and Nogueira (2018), constitutes a minor problem.

The data for stock size and harvest of Grl. halibut in table A12 differ from the observations in Treble and Nogueira (2018). This difference can be explained by the fact that the observations for stock size and harvest in table A12 are collected on 1 October each year while Treble and Nogueira (2018) measure the Grl. halibut stock size on 1 January while the harvest is identified on 31 January in each year. It is obvious that the measure for stock size and harvest will depend on the point in time where the data is collected. However, from MA Treble, personal communication, 2019, based on Treble and Nogueira (2018), it is preferable to measure the stock size and harvest of Grl. halibut as we do in table A12. However, the time for measuring the stock size and harvest has implications for the natural growth. If we measure the stock size on 1 January and the harvest on 31 January each year as in Treble and Nogueira (2018), the observations for the natural growth will be calculated by using $G_t = x_{t+1} - x_t + h_t$ instead of (1).

*A.2.9. Biological information with two separate fish stocks*

Now we assume that Grl. halibut in the high sea and coastal areas constitutes two different (sub) populations. Thus, we must distribute the stock size and harvest of Grl. halibut from table A12 to the high sea and coastal area. Regarding the Grl. halibut stock size, we have information about the relative distribution of one-year-old Grl. halibut in the Disko Bay between the coastal and high sea area for the period between 1992 and 2011 from OA Jørgensen, personal communication, 2019, based on Jorgensen (2013). We use these numbers to distribute the Grl. halibut stock size from table A12 to the high sea and coastal area for the period between 1997 and 2011. For the period between 2012 and 2017, we use the average distribution of one-year-old Grl. halibut in the Disko Bay for 1997 and 2011 given as 62 per cent. To distribute the Grl. halibut harvest we depart from the concept of relative stability. Within our context relative stability implies that a fixed share of the total Grl. halibut TAC on the west coast of Greenland is allocated as quotas to the high sea and coastal area each year. Thus, we can use a fixed quota share to allocate the harvest from table A12 to the high sea and coastal area. Here we use the Grl. halibut quotas from 2015 reported in sections A.2.2 and A.2.3. In calculating the quota share for 2015, we include the quota allocated to foreign vessels and we assume that all foreign vessels conduct high sea fisheries. Finally, we have identified a separate high sea and coastal Grl. halibut natural growth by using (A1).

**Table A13.** High sea and coastal stock size, harvest, and growth of Grl. halibut on the west coast, 1997–2017

| | **High sea** | | **High sea** | | | **Coastal** | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Stock size** (share) | **Harvest** (share) | **Stock size** (tons) | **Harvest** (tons) | **Growth** (tons) | **Stock size** (tons) | **Harvest** (tons) | **Growth** (tons) |
| **1997** | 0.61 | 0.7066 | 38,706 | 6,431 | | 24,747 | 2,670 | |
| **1998** | 0.49 | 0.7066 | 35,013 | 6,142 | 2,449 | 36,443 | 2,550 | 14,246 |
| **1999** | 0.73 | 0.7066 | 50,162 | 6,833 | 21,982 | 18,553 | 2,838 | -15,052 |
| **2000** | 0.58 | 0.7066 | 38,115 | 7,466 | -4,582 | 27,600 | 3,100 | 12,148 |
| **2001** | 0.59 | 0.7066 | 43,965 | 9,722 | 15,573 | 30,552 | 4,038 | 6,989 |
| **2002** | 0.60 | 0.7066 | 44,867 | 10,512 | 11,413 | 29,911 | 4,365 | 3,725 |
| **2003** | 0.61 | 0.7066 | 44,345 | 13,210 | 12,698 | 28,358 | 5,486 | 3,932 |
| **2004** | 0,58 | 0.7066 | 43,915 | 13,462 | 13,023 | 31,801 | 5,590 | 9,033 |
| **2005** | 0.66 | 0.7066 | 52,938 | 13, 931 | 22,953 | 27,271 | 5,785 | 1,256 |
| **2006** | 0.78 | 0.7066 | 61,398 | 16,781 | 25,251 | 17,317 | 6,963 | -2,981 |
| **2007** | 0.73 | 0.7066 | 53,388 | 16,525 | 8,515 | 19,746 | 6,863 | 9,292 |
| **2008** | 0.84 | 0.7066 | 75,363 | 15,674 | 37,649 | 14,355 | 6,509 | 1,118 |
| **2009** | 0.80 | 0.7066 | 58,498 | 17,433 | 567 | 14,625 | 7,239 | 7,509 |
| **2010** | 0.76 | 0.7066 | 57,546 | 19,112 | 18,159 | 18,172 | 7,937 | 11,485 |
| **2011** | 0.75 | 0.7066 | 69,160 | 18,762 | 30,376 | 23,053 | 7,791 | 12,672 |
| **2012** | 0.62 | 0.7066 | 40,123 | 19,440 | -9, 597 | 24,592 | 8,073 | 9,612 |
| **2013** | 0.62 | 0.7066 | 39,788 | 20,087 | 19,752 | 24,386 | 8,342 | 8,136 |
| **2014** | 0.62 | 0.7066 | 38,856 | 22,421 | 21,278 | 23,815 | 9,012 | 8,652 |
| **2015** | 0.62 | 0.7066 | 47,701 | 22,512 | 31,357 | 29,236 | 9,349 | 14,770 |
| **2016** | 0.62 | 0.7066 | 47,021 | 22,006 | 21,327 | 28,820 | 9,139 | 8,7223 |
| **2017** | 0.62 | 0.7066 | 48,295 | 24,491 | 25,765 | 29,600 | 10,170 | 10,951 |

*Source:* OA Jørgensen, personal communication, 2019, based on Jorgensen (2013); MA Treble, personal communication, 2019, based on Treble and Nogueira (2018); and own calculations.

Thus, we can identify a separate time series for the high sea and coastal stock size, harvest, and natural growth of Grl. halibut for the period 1997–2017, which is summarized in table A13. The high sea and coastal stock size and harvest of Grl. halibut follow the development in table A12 while the high sea and coastal natural growth fluctuate a lot.

### A.3. Functional forms and parameter estimates

*A.3.1. Common fish stock*

A.3.1.1. Natural growth function

A logistic growth function fulfills the assumptions about the derivations from the theoretical model, and this function is given by:

$$F(x) = rx(1 - \frac{x}{K}), \tag{A2}$$

where $r$ is the intrinsic growth rate and $K$ is the carrying capacity.

As mentioned in section A.2.8, we have used two alternative strategies to estimate a Grl. halibut growth function. First, we used the observations for the stock size and natural growth of Grl. halibut from table A12 to estimate (A2) directly. When doing so with ordinary least square (OLS), we obtain a U-shaped (not inverse U-shaped) Grl. halibut growth function, and this is inconsistent with conventional fisheries economics. Thus, we will not use the results when estimating a natural growth function directly but introducing restrictions on the carrying capacity may solve the problem with inconsistency.

Second, as in the theoretical model, we can assume that the Grl. halibut fish stock is in a steady-state equilibrium in each year the data set covers, and thereby we can estimate the Grl. halibut resource restriction directly. Specifically, by using the resource restriction and inserting (A2), we can estimate the following equation:

$$h_H + h_C + \beta h_H = rx - \frac{rx^2}{K}. \tag{A3}$$

From table A12, we have information about the total harvest by all countries ( $h_H + h_C + \beta h_H$ ) and the Grl. halibut stock size so (A3) can be estimated with OLS. A problem with this approach is that we assume that the stock size is in a steady-state equilibrium each year the data set is covered (apart from stochastic variation). However, a plot of the Grl. halibut stock size from table A12 indicates that this fluctuates around a mean of approximately 75,000 tons. Thus, the assumption about a steady-state equilibrium for the Grl. halibut fish stock holds as a rough approximation.

For estimation purposes, we transform (A3) into:

$$h = ax - bx^2, \tag{A4}$$

where $h$ is the aggregated Grl. halibut harvest while $a$ and $b$ are estimated parameters. By comparing (A3) and (A4), we get that:

$$a = r \tag{A5}$$

$$K = \frac{r}{b}. \tag{A6}$$

Thus, we estimate (A4) with OLS and then use (A5) and (A6) to calculate the intrinsic growth rate and carrying capacity. The estimation results are shown in table A14.

**Table A14.** Natural growth function

| **Parameter** | **Estimate** | **Standard derivation** | **t-value** | **Lower bound** | **Upper bound** |
|---|---|---|---|---|---|
| **Intrinsic growth rate** ($r$) | 0.34850 | 0.2289 | 1.52228 | 0.17423 | 0.52275 |
| **Parameter** ($b$) | 0.000000726 | 0.000003015 | 0.2411 | | |
| **Carrying capacity** ($K$) (tons) | 480,027 | | | 295,785 | 887,356 |
| $\mathbf{R^2}$ | 0.88 | | | | |
| **Durbin-Watson** (DW) | 0.178 | | | | |

From table A14, we see that both *r* and *b* are insignificant but have the expected sign. For *K*, we cannot investigate whether the parameter is significant because the carrying capacity is calculated by using *r* and *b* as stated in (A6). $R^2$ is reasonably high despite the fact that both estimated parameters are insignificant while the Durbin-Watson test value is 0.178. With a critical value of 0.810, we may have a problem with positive serial correlation, but in fisheries economics, it is not common practice to try to correct for serial correlation when estimating a growth function. As always, the estimated parameter values in table A14 are subject to statistical uncertainty, and the size of this uncertainty can be seen from the standard errors of *r* and *K*. To investigate the implications of statistical uncertainty, we will conduct sensitivity analyses. A normal procedure for doing this would be to vary the parameter values with 1.96 times the standard derivation, but this approach yields a negative value of *r* and *b*. For *r* we, therefore, choose to vary this parameter by +/– 50 per cent and an upper and lower bound generated by this variation is reported in table A14. To secure consistency, we also vary *b* by +/– 50 per cent, and then we assume that all parameter variation in *b* is due to variation in *K*. Thus, we can use (A6) to calculate upper and lower bounds for *K* which are reported in table A14.

A.3.1.2. High sea cost function

A high sea industry cost function that fulfills the assumptions about the derivatives from the theoretical model is:

$$C_H(h_H, x) = c_H \frac{{h_H}^2}{x}, \qquad \text{(A7)}$$

where $c_H$ is a high sea cost parameter, $h_H$ is the high sea harvest, $x$ is the stock size, and $C_H(h_H, x)$ is the total high sea Grl. halibut industry cost.

To identify the high sea cost parameter in (A7), we only have information about the total high sea industry costs and harvest for three years (2013–2015) in table A9, so we cannot estimate the parameter statistically. Instead, we must use one observation for the total high sea cost, harvest, and stock size to calculate the high sea cost parameter, and by using (A7), this can be done in the following way:

$$c_H = \frac{C_H(h_H, x)x}{h_H{}^2}. \tag{A8}$$

However, the total high sea industry costs in table A9 cover the harvest of all fish species, so from this information, we will find the total high sea Grl. halibut costs. The steps undertaken for performing this task are summarized in table A15.

**Table A15.** High sea cost parameter

| **Indicator** | **2013** | **2014** | **2015** | **Average** |
|---|---|---|---|---|
| **Industry costs** (million DKK) (all species) | 254.1 | 307.2 | 354.8 | |
| **Quota share, Grl. halibut** | 0.2674 | 0.2009 | 0.2259 | |
| **Industry costs** (million DKK) (Grl. halibut) | 67.9536 | 61.7151 | 80.1587 | 69.9425 |
| **Harvest** (tons) | 9,860 | 11,266 | 12,072 | 11,070 |
| **Stock size** (tons) | 64,174 | 62,671 | 76,937 | 67,909 |
| **Cost parameter, yearly measure** (million DKK/tons) | 0.04456 | 0.03047 | 0.04232 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Cost parameter, estimated value** (million DKK/tons) | 0.019384 | 0.03876 | 0.058151 | |

In table A15, we have inserted the total high sea industry costs of harvesting all fish species for 2013–2015 from table A9, and from this, we must find the total high sea Grl. halibut costs. One solution is to use the Grl. halibut harvest shares, which can be obtained using table A9, to identify the total high sea Grl. halibut cost. However, from (A8), the high sea Grl. halibut harvest is used to calculate the high sea cost parameter, so using harvest shares is not a good idea. Instead, we will use the Grl. halibut quota shares on the west coast, which can be calculated from table A3. From table A9, we know that the high sea vessels harvest Grl. halibut in a mixed fishery with cod and redfish, so the high sea quota shares for 2013–2015 are found by using the high sea quotas on Grl. halibut, cod, and other fish species. The high sea Grl. halibut quota shares can be seen in table A15, and these shares together with the total high sea cost of harvesting all species can be used to find the total high sea Grl. halibut costs for 2013–2015. The total high sea Grl. halibut costs are also shown in table A15 for 2013–2015, but these costs may reflect stochastic variation in fisheries-related conditions. To reduce the effect of random events, we use the average high sea Grl. halibut costs for the three years, and this average is also shown in table A15. From table A9, we also have information about the high sea Grl. halibut harvest for 2013–2015, and this is also reported in table A15 together with the average high sea harvest. Furthermore, from table A12, we have information about the total Grl. halibut stock size for 2013–2015, and from this, we can calculate the average Grl. halibut stock size reported in table A15. By using the total high sea cost, the total high sea harvest and the stock size of Grl. halibut, measured by the averages, we can calculate the high sea cost parameter by using (A8). This cost parameter is reported in table A15.

However, due to the calculation method, the parameter value is highly uncertain, implying that sensitivity analyses become important. Thus, we have varied the high sea cost parameter by +/– 50 per cent, and the upper and lower bound generated by this variation is also summarized in table A15. As a robustness test we have also calculated an annual high sea cost parameter by using the yearly observations for 2013–2015 for the total cost, harvest and stock size of Grl. halibut in (A8). The annual high sea cost parameter can also be found in table A15 and the variation in this parameter is very low. Furthermore, the annual high sea cost parameter is within the span generated by the upper and lower bound for the estimated parameter. Thus, the estimated high sea cost parameter seems to be reasonably robust to annual random variations in the total cost, harvest and stock size of Grl. halibut.

A.3.1.3. Coastal cost function

A coastal industry cost function that fulfills the assumptions about the derivatives from the theoretical model is:

$$C_C(h_C, x) = c_C \frac{{h_C}^2}{x}, \tag{A9}$$

where $c_C$ is a coastal cost parameter, $h_C$ is the coastal industry harvest, $x$ is the stock size, and $C_C(h_C, x)$ is the total coastal Grl. halibut industry cost.

As in section A.3.1.2, we only have information about the total coastal cost and harvest for three years, so we must calculate the coastal cost parameter by using:

$$c_C = \frac{C_C(h_C, x)x}{{h_C}^2}. \tag{A10}$$

However, compared to the high sea cost parameter, an additional problem arises with the coastal cost parameter. For the coastal area, the total industry cost and harvest of Grl. halibut are decomposed into two categories represented by vessels above 6 m (table A10) and boats below 6 m (table A11). Thus, we must aggregate the total costs and harvest information for these two fleet segments, and the method used for doing this is summarized in table A16.

From table A10, we have the total coastal costs of harvesting all species for vessels above 6 m for 2013–2015 while table A11 contains similar information for the coastal boats below 6 m, and this cost information has been inserted into table A16. One approach is to calculate the total Grl. halibut cost for each fleet segment by using Grl. halibut quota shares for vessels above 6 m and boats below 6 m. However, from table A4, only the total Grl. halibut quota is allocated to both fleet segments, so this method cannot be used. Thus, we must aggregate the total coastal industry costs of harvesting all species for the two fleet segments for 2013–2015, and this is also done in table A16.

**Table A16.** Coastal cost parameter

| Indicator | 2013 | 2014 | 2015 | Average |
|---|---|---|---|---|
| **Costs** (million DKK) (vessels above 6 m) (all species) | 63 | 75 | 27.9 | |
| **Costs** (million DKK) (boats below 6 m) (all species) | 74.6 | 77.4 | 110.5 | |
| **Costs** (million DKK) (all species) | 137.8 | 152.4 | 138.4 | |
| **Quota share, Grl. halibut** | 0.62217 | 0.58792 | 0.50628 | |
| **Cost** (million DKK) (Grl. halibut) | 85.6101 | 89.5987 | 70.0679 | 81.7595 |
| **Harvest** (tons) (vessels above 6 m) | 10,350 | 11,203 | 8,907 | |
| **Harvest** (tons) (boats below 6 m) | 13,069 | 15,300 | 16,009 | |
| **Harvest** (tons) | 23,417 | 26,503 | 24,917 | 24,917 |
| **Stock size** (tons) | 64,174 | 62,671 | 76,937 | 67,909 |
| **Cost parameter, yearly measure** (million DKK/tons) | 0.01002 | 0.007994 | 0.008683 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Cost parameter, estimated value** (million DKK/tons) | 0.00446 | 0.00892 | 0.01339 | |

To calculate the total coastal Grl. halibut costs, we use the Grl. halibut quota shares and from tables A10 and A11 both fleet segments mainly harvested Grl. halibut in a mixed fishery with cod. Thus, based on table A4, we can calculate the coastal Grl. halibut quota share for both fleet segments and this share is also reported in table A16 for 2013–2015. By using these quota shares, we can calculate the total coastal Grl. halibut cost for the period between 2013 and 2015, but to reduce the implications of stochastic events, we take a simple average of these three observations which is reported in table A16. From tables A10 and A11, we also have information on the Grl. halibut harvest for vessels above 6 m and boats below 6 m, and this information can be found in table A16 together with the aggregated total and average Grl.

halibut harvest for both fleet segments. As in table A15, we also use the Grl. halibut stock size for 2013–2015 and the average Grl. halibut stock size. By using the average total coastal cost, the average harvest, and the average stock size of Grl. halibut, we can calculate a coastal cost parameter by using (A10) and this parameter is reported in table A16.

However, for obvious reasons, this parameter estimate is highly uncertain, so we conduct sensitivity analyses by varying the coastal cost parameter by +/– 50 per cent. The upper and lower bounds for the cost parameter are also reported in table A16. As for the high sea cost parameter in section A.3.1.2, we have also calculated a yearly coastal cost parameter and this parameter is also reported in table A16. As for the high sea cost parameter, the variation in the yearly coastal cost parameter is very low and the annual measure is within the span generated by the upper and lower bound for the estimated parameter. Thus, the estimated coastal cost parameter seems to be reasonably robust to annual random variations.

A.3.1.4. High sea price

From the theoretical model, the high sea Grl. halibut price is assumed to be constant. From Statistics Greenland (2021) we could have obtained information about the price directly but to identify the high sea cost parameter and price consistently, we will use a similar procedure as in table A15. This procedure is summarized in table A17.

From table A9, we have information about the total high sea revenue of harvesting all species for 2013–2015, and now we can calculate the high sea Grl. halibut revenue by using the quota shares from table A15. This information is provided in table A17 for 2013–2015, but to reduce the implications of random events, we take a simple average of these three observations. From table A9, we have information about the Grl. halibut harvest for 2013–2015 and the average harvest for these three years. By using the average revenue and the harvest of Grl. halibut, we can calculate a high sea Grl. halibut price which is reported in table A17.

**Table A17.** High sea price

| **Indicator** | **2013** | **2014** | **2015** | **Average** |
|---|---|---|---|---|
| **Revenue** (million DKK) (all species) | 435.4 | 543.7 | 614.4 | |
| **Quota share, Grl. halibut** | 0.2674 | 0.2009 | 0.2259 | |
| **Revenue** (million DKK) (Grl. halibut) | 116.44 | 109.23 | 121.09 | 115.58 |
| **Harvest** (tons) | 9,860 | 11,266 | 12,072 | 11,070 |
| **Price, yearly measure** (million DKK/tons) | 0.01181 | 0.00970 | 0.01003 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Price, estimated value** (million DKK/tons) | 0.00549 | 0.01097 | 0.01646 | |

However, this procedure generates a highly uncertain high sea Grl. halibut price, so we conduct a sensitivity analysis by varying the price by +/– 50 per cent. This generates an upper and lower bound for the high sea price which can be found in in table A17. By using the annual observations for the revenue and harvest, we have also calculated a yearly high sea Grl. halibut price which is reported in table A17. As indicated in table A17, the annual variation in the high sea price is low and the yearly price is within the span generated by the upper and lower bound. Thus, our parameter estimate for the high sea Grl. halibut price is reasonably robust to random variations in the revenue and costs.

A.3.1.5. Coastal price

The constant coastal price is found by combining the methods described in sections A.3.1.3 and A.3.1.4. The calculations are summarized in table A18.

**Table A18.** Coastal price

| Indicator | 2013 | 2014 | 2015 | Average |
|---|---|---|---|---|
| **Revenue** (million DKK) (vessels above 6 m) (all species) | 117.3 | 124.7 | 64.2 | |
| **Revenue** (million DKK) (boats below 6 m) (all species) | 264.3 | 284.3 | 374.5 | |
| **Revenue** (million DKK) (all species) | 381.6 | 409 | 438.7 | |
| **Quota share, Grl. halibut** | 0.62217 | 0.58792 | 0.50628 | |
| **Revenue** (million DKK) (Grl. halibut) | 237.42 | 240.46 | 222.11 | 233.33 |
| **Harvest** (tons) (vessels above 6 m) | 10,350 | 11,203 | 8,907 | |
| **Harvest** (tons) (boats below 6 m) | 13,069 | 15,300 | 16,009 | |
| **Harvest** (tons) | 23,417 | 26,503 | 24,917 | 24,917 |
| **Price, yearly measure** (million DKK/tons) | 0.01014 | 0.009070 | 0.00891 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Price, estimated value** (million DKK/tons) | 0.00468 | 0.00935 | 0.01403 | |

From tables A10 and A11, we have information about the total coastal revenue of harvesting all species for vessels above 6 m and boats below 6 m. The revenue for these two fleet segments can be aggregated, and the total coastal revenue for both fleet segments for 2013–2015 can be found in table A18. By using the coastal Grl. halibut quota shares from table A16, we can now calculate the total coastal Grl. halibut revenue for 2013–2015 and, based on this, an average measure can be found. From table A16, we also have information about the average Grl. halibut harvest for both fleet segments, and by using this information together with the average coastal revenue, a coastal Grl. halibut price can be calculated. This coastal price has been inserted into table A18.

However, again the coastal price is highly uncertain so we have created upper and lower bounds generated by varying the coastal Grl. halibut price by +/– 50 per cent. We have also calculated a yearly coastal price which is reported in table A18. As for the high sea price, we have that the yearly variation in the coastal price is low and that the yearly price is within the span generated by the upper and lower bound. Thus, our parameter estimate for the coastal price seems to be reasonably robust.

A.3.1.6. Scaling factor for vessels from other fishing nations

In the theoretical model, $\beta$ denoted the scaling factor for the high sea harvests allocated to other fishing nations. Because the Grl. halibut harvest by other nations is determined through international fishing agreements which normally cover a long time period, $\beta$ can be found by using the information about the total Grl. halibut quotas. It should be noted that even though we have quota information for 2013–2016, we chose to exclude the observations for 2016 in order to secure consistency with the data period for price and cost information. The calculations of the scaling factor for other fishing nations are summarized in table A19.

**Table A19.** Scaling factor for vessels from other fishing nations

| **Indicator** | **2013** | **2014** | **2015** | **Average** |
|---|---|---|---|---|
| **Quota, Grl. halibut, Greenland** (tons) | 8,075 | 8,075 | 9,725 | 8,625 |
| **Quota, Grl. halibut, EU** (tons) | 2,500 | 2,500 | 2,500 | 2,500 |
| **Quota, Grl. halibut, Other nations** (tons) | 3,350 | 3,350 | 3,350 | 3,335 |
| **Scaling factor, yearly measure** | 0.7226 | 0.7094 | 0.6000 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Scaling factor, estimated value** | 0.3385 | 0.677 | 1.0155 | |

From table A3, we have the total Grl. halibut quota allocated to high sea vessels from Greenland for 2013–2015. The Grl. halibut quota allocated to the EU is obtained from table

A5 while the quota allocated to other fishing nations can be found in table A6. To be consistent with the method used for the other parameters, we have calculated the average Grl. halibut quota to Greenland, the EU, and other fishing nations which is reported in table A19. Now the scaling factor for vessels from other fishing nations is easy to find, and this scaling factor is reported in table A19.

The scaling factor is reasonably certain, but to secure consistency with the other parameter values, we vary the factor by +/– 50 per cent to generate an upper and lower bound which is reported in table A19. Even though the scaling factor is reasonably certain, we have also calculated an annual scaling factor which is reported in table A19. Of course the annual variation in the scaling factor is very low because the yearly variation in the quota is low.

A.3.1.7. Land-based cost function

Coastal vessels normally deliver all Grl. halibut landings for land-based processing while high sea vessels are restricted by a land obligation that requires that at least 25 per cent of their Grl. halibut harvest shall be delivered for land-based processing. We assume that high sea vessels have no incentive to deliver more than 25 per cent for land-based processing, so a land-based industry cost function, which fulfills the assumptions about the derivatives from the theoretical model, is:

$$C_L(h_C, h_H) = c_L(h_C + 0.25h_H)^2, \tag{A11}$$

where $c_L$ is a land-based cost parameter and $C_L(h_C, h_H)$ is the total land-based Grl. halibut cost on the west coast of Greenland. With this cost function, we obtain the following marginal cost functions:

$$\frac{\partial C_L}{\partial h_C} = 2c_L(h_C + 0.25h_H) \tag{A12}$$

$$\frac{\partial C_L}{\partial h_H} = 0.5c_L(h_C + 0.25h_H)\,. \tag{A13}$$

For calculating the land-based cost parameter, we only have information for three years for the total land-based cost of the high sea and coastal harvest of Grl. halibut, so we must calculate $c_L$ in a simple way by rewriting (A11) as:

$$c_L = \frac{C_L(h_C, h_H)}{(h_C + 0.25h_H)^2} . \tag{A14}$$

Compared to the previous industry cost functions, three issues arise in relation to (A14). First, we can only obtain an indirect measure for the total land-based costs. From table A1, we have information about the total costs for the primary fishery industry while the total costs for the whole fishing sector are obtained from table A2. We use the difference between these two cost numbers to obtain a measure of the total land-based costs. Second, the total land-based cost observations cover both the west and east coasts and all fish species. Thus, we must allocate the total land-based costs to the west coast and, after this, to Grl. halibut. Third, since we consider the processing industry, it is not obvious that the costs will be allocated by using quota shares as for the primary fishery. However, for our purposes, it is important that the cost observations are as comparable as possible, and, therefore, we choose to use quota shares to allocate the land-based costs.

The exact way these three issues have been addressed can be seen in table A20, in which we start by subtracting the total costs of the whole fishing sector from the total costs of the primary fishing industry. This generates the total land-based processing costs for 2013–2015. Next, from Statistics Greenland (2021), we can find the total quota of all fish species in each area and, based on this, the quota share for the west coast can be found. This share can be used to find the total land-based costs of all species on the west coast of Greenland. From this, we must find the total land-based processing Grl. halibut costs on the west coast; here we choose to use high sea Grl. halibut quota shares from tables A3–A4. The total land-based Grl. halibut costs on the west coast cover 2013–2015, and we use a simple average of these observations.

From tables A10–A11, we have the total coastal Grl. halibut harvest and by using the information from table A9, we can find 25% of the total high sea harvest. These two harvest numbers can be aggregated, and an average harvest can be found. Now we can calculate the land-based cost parameter by using (A14), and this parameter has been inserted in table A20.

**Table A20.** Land-based cost parameter

| Indicator | 2013 | 2014 | 2015 | Average |
|---|---|---|---|---|
| **Costs** (million DKK) (fishing industry) (both areas) (all species) | 3,943 | 4,239 | 5,030 | |
| **Costs** (million DKK) (primary fishery) (both areas) (all species) | 2,044 | 1,836 | 1,712 | |
| **Costs** (million DKK) (land-based processing) (both areas) (all species) | 1,899 | 2,402 | 3,310 | |
| **Quota share, West coast** | 0.321 | 0.351 | 0.336 | |
| **Cost** (million DKK) (land-based processing) (west coast) (all species) | 609 | 844 | 1,108 | |
| **Quota share, Grl. halibut** | 0.2674 | 0.2009 | 0.2259 | |
| **Cost** (million DKK) (land-based processing) (west coast) (Grl. halibut) | 162.86 | 169.56 | 250.33 | 194.15 |
| **Coastal harvest** (tons) | 23,417 | 26,503 | 24,917 | |
| **25% of high sea harvest** (tons) | 2,468 | 2,817 | 3,019 | |
| **Total harvest** (tons) (land-based processing) | 25.687 | 29.320 | 27.935 | 27,714 |
| **Cost parameter, yearly measure** (million DKK/tons) | $2.46 * 10^{-7}$ | $1.97 * 10^{-7}$ | $3.21 * 10^{-7}$ | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Cost parameter, estimated value** (million DKK/tons) | $1.26 * 10^{-7}$ | $2.53 * 10^{-7}$ | $3.97 * 10^{-7}$ | |

However, this method generates a highly uncertain estimate for the land-based cost parameter, so we have constructed an upper and lower bound by varying the cost parameter by +/– 50 per cent, and these two bounds can also be found in table A20. By using the annual observations for the total land-based costs and the aggregated harvest of Grl. halibut, we have also calculated yearly measures for the land-based cost parameter by using (A14). The annual measures are reported in table A20 and the yearly variation in the cost parameter is very low. Furthermore, all annual measures are within the span generated by the upper and lower bound for the estimated land-based cost parameter.

A.3.1.8. Land-based price

Now we want to find the land-based Grl. halibut price (the price on Grl. halibut delivered from land-based processing factories), and here we combine the methods used in sections A.3.1.4 and A.3.1.7. The exact procedure is summarized in table A21.

By subtracting the total revenue for the whole fishing industry from table A2 from the total revenue for the primary fishing sector in table A1, we obtain the total land-based revenue. Now we can use the quota shares from table A20 to find the total land-based revenue for the west coast and then we can use the Grl. halibut quota share from table A20 to find the total land-based Grl. halibut revenue on the west coast. We can obtain information about this land-based revenue for 2013–2015, and we take a simple average of these observations. From table A8, we have information about the amount of Grl. halibut delivered from land-based processing factories for 2013–2015, and we can also take a simple average of these observations. Now we can calculate the land-based price by sharing the land-based revenue with the quantity, and this price can be found in table A21.

**Table A21.** Land-based price

| Indicator | 2013 | 2014 | 2015 | Average |
|---|---|---|---|---|
| **Revenue** (million DKK) (fishing industry) (both areas) (all species) | 4,281 | 4,590 | 5,707 | |
| **Revenue** (million DKK) (primary fishery) (both areas) (all species) | 2,413 | 2,314 | 2,111 | |
| **Revenue** (million DKK) (land-based processing) (both areas) (all species) | 1,868 | 2,276 | 3,596 | |
| **Quota share, West coast** | 0.321 | 0.351 | 0.336 | |
| **Revenue** (million DKK) (land-based processing) (west coast) (all species) | 599.17 | 799.51 | 1,208.65 | |
| **Quota share, Grl. halibut** | 0.2674 | 0.2009 | 0.2259 | |
| **Revenue** (million DKK) (land-based processing) (west coast) (Grl. halibut) | 160.24 | 160.62 | 272.07 | 197.97 |
| **Production** (tons) | 20,120 | 22,233 | 21,256 | 21,229 |
| **Price, yearly measure** (million DKK/tons) | 0.00798 | 0.00723 | 0.00828 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Price, estimated value** (million DKK/tons) | 0.00357 | 0.00714 | 0.01072 | |

However, this calculation method generates a very uncertain measure for the price, so we construct upper and lower bounds by varying the land-based price by +/– 50 per cent, and these bounds can also be found in table A21. As for the land-based cost parameter, we have also calculated annual observations for the land-based price which is reported in table A20. Again the yearly variation in the price is low and all yearly measures are within the span generated by the upper and lower bound for the estimated land-based price.

A.3.1.9. Land-based utilization rate

Now we want to determine $\alpha$ which measures the land-based utilization rate. This parameter measures the share of the Grl. halibut harvest which is utilized by the land-based industry and the calculations of this rate are summarized in table A22.

**Table A22.** Land-based utilization rate

| **Indicator** | **2013** | **2014** | **2015** | **Average** |
|---|---|---|---|---|
| **Grl. halibut** (tons)<br>(for land-based processing) | 25,291 | 30,095 | 28,191 | 26,192 |
| **Grl. halibut** (tons)<br>(from land-based processing**)** | 20,120 | 22,233 | 21,256 | 21,229 |
| **Land-based utilization rate, yearly measure** | 0.9859 | 0.8577 | 0.7588 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Land-based utilization rate, estimated value** | 0.46 | 0.92 | 1 | |

From table A7, we have the quantity of Grl. halibut which is delivered for land-based processing for 2013–2015 while table A8 contains the quantity of Grl. halibut delivered by land-based processing factories. This information has been inserted inτo table A22, and average values have been calculated. Now we can identify the share of the Grl. halibut harvest that is utilized by land-based industry by sharing the quantity delivered from land-based processing with the quantity that enters. This share has been inserted inτo table A22.

In table A22 we have also reported an upper and a lower bound for the rate by varying this by +/– 50 per cent. It should be noted that because the upper bound for the rate becomes larger than one, we have set this equal to one, implying that nothing is lost during land-based processing. By using the yearly observations for the Grl. halibut harvest that is delivered for land-based processing and the quantity of halibut that is left after land-based processing, we have also calculated an annual utilization rate. From table A22 we see that the annual variation in the rate is very low and all yearly measures are within the span generated by the upper and lower bound for the parameter value.

A.3.1.10. Equity weight

In the theoretical model, $\lambda$ represents an equity weight, and we will assume that $\lambda \geq 1$, implying that the coastal profit has a higher value than the high sea profit. However, we have no information about the equity weight, so we will vary $\lambda$ in order to investigate how our results are affected by the weight imposed on the coastal profit.

*A.3.2. Two separate fish stocks*

A.3.2.1. High sea and coastal natural growth functions and migration function

For the high sea fish stock, a logistic growth function fulfills the assumptions about the derivatives of the growth function. The logistic function for the high sea fish stock is given by:

$$G_H(x_H) = r_H x_H (1 - \frac{x_H}{K_H}), \tag{A15}$$

where $r_H$ is the high sea intrinsic growth rate and $K_H$ is the high sea carrying capacity. For the coastal fish stock, we also assume a logistic function:

$$G_C(x_C) = r_C x_C (1 - \frac{x_C}{K_C}), \tag{A16}$$

where $r_C$ is the coastal intrinsic growth rate and $K_C$ is the coastal carrying capacity. A net Grl. halibut migration function, which fulfills the assumptions about the derivatives from the theoretical model, is:

$$M(x_H, x_C) = m\frac{x_H}{x_C}, \tag{A17}$$

where $m$ is a net Grl. halibut migration parameter.

To estimate the high sea and coastal growth and migration functions for Grl. halibut, we can (as in section A.3.1.1) use two strategies. First, we can use the fact that the observations for the coastal natural growth from table A13 to estimate:

$$G_C(x_C, x_H) = r_C x_C - \frac{r_C {x_C}^2}{K_C} + m\frac{x_H}{x_C}, \tag{A18}$$

where $G_C(x_C, x_H)$ are the observations for the coastal natural growth from table A13. By using the estimated parameter for $m$ and the time series for $x_H$ and $x_C$ from table A13, we can now calculate a time series for the net Grl. halibut migration. Since the net Grl. halibut migration has to be identical for the high sea and coastal areas, we can now estimate:

$$G_H(x_C, x_H) + m\frac{x_H}{x_C} = r_H x_H - \frac{r_H x_H^{\;2}}{K_H}, \tag{A19}$$

where $G_H(x_C, x_H)$ is the time series for the high sea natural growth from table A13, and $m\frac{x_H}{x_C}$ is a calculated time series for the net Grl. halibut migration.

Second, we can assume a steady-state equilibrium and estimate the following relation for the coastal fish stock:

$$h_C = r_C x_C - \frac{r_C x_C^{\;2}}{K_C} + m\frac{x_H}{x_C}. \tag{A20}$$

As before, we can now calculate a time series for the net Grl. halibut migration by using $m$ and the time series for $x_H$ and $x_C$ from table A13. By assuming a steady-state equilibrium for the high sea fish stock, we can then estimate:

$$h_H + \beta h_H + m\frac{x_H}{x_C} = r_H x_H - \frac{r_H x_H^{\;2}}{K_H}, \tag{A21}$$

where $m\frac{x_H}{x_C}$ is the calculated time series for the net Grl. halibut migration.

Equations (A20) and (A21) can be estimated by using the time series for the high sea and coastal stock size and harvest. However, as in section A.3.1.1, an important problem with this approach is that we assume that both the high sea and coastal stock sizes are in a steady-state equilibrium. A plot of the high sea and coastal stock sizes from table A13 shows that this assumption may be potentially critical for both fish stocks, because these do not necessarily fluctuate stochastically around mean values. However, to secure consistency with the way that we have estimated the growth function in section A.3.1.1, we assume that both stock sizes are in a steady-state equilibrium, so we have chosen to estimate (A20) and (A21). For estimation purposes, we transform (A20) into:

$$h_C = a_C x_C - b_C x_C^{\ 2} + m \frac{x_H}{x_C}, \tag{A22}$$

where $a_C$, $b_C$ and *m* are estimated coastal parameters. Now, by comparing (A20) and (A22), we get that:

$$a_C = r_C \tag{A23}$$

$$K_C = \frac{r_C}{b_C}. \tag{A24}$$

For estimation purposes, we also transform (A21) into:

$$y = a_H x_H - b_H x_H^{\ 2}, \tag{A25}$$

where *y* is the sum of the high sea harvest and the calculated net Grl. halibut migration while $a_H$ and $b_H$ are estimated high sea parameters. By comparing (A20) and (A25), we get that:

$$a_H = r_H \tag{A26}$$

$$K_H = \frac{r_H}{b_H}. \tag{A27}$$

The results of estimating (A22) with OLS and using (A23) and (A24) to calculate the relevant parameter values is shown in table A23.

From table A23, we see that $r_C$ is positive and significant while $b_C$ is insignificant. *m* is positive but insignificant, and the positive value of *m* implies a net migration from the high sea area to the coastal fish area as we assume in our paper. By using (A24), we can calculate $K_C$ by using $r_C$ and $b_C$, and the coastal carrying capacity is also reported in table A23. $R^2$ is reasonably high, but the Durbin-Watson test generates a value of 0.234. With a critical level of

0.727, we have a potential problem with positive serial correlation, but we follow the main tradition within fisheries economics and make no attempt to correct for serial correlation. As for the common fish stock, we conduct sensitivity analyses by varying $r_C$ and *m* by +/– 50 %, and the upper and lower bounds generated by this variation are shown in table A23. We also vary $b_C$ by +/– 50 per cent and assume that all variation in $b_C$ is due to variation in $K_C$. Thus, we can use (A24) to generate upper and lower bounds for $K_C$ which are reported in table A23.

**Table A23.** Coastal natural growth and migration function

| **Parameter** | **Estimate** | **Standard derivation** | **t-value** | **Lower bound** | **Upper bound** |
|---|---|---|---|---|---|
| **Intrinsic growth rate** ($r_C$) | 0.579 | 0.242 | 2.839 | 0.2895 | 0.8685 |
| **Parameter** ($b_C$) | 0.00001305 | 0.000007276 | 1.794 | | |
| **Carrying capacity** ($K_C$) | 44,367 | | | 29,578 | 88,735 |
| **Migration parameter** (*m*) | 237.009 | 643.789 | 0.3681 | 118.5045 | 355.5125 |
| $\mathbf{R^2}$ | 0.82 | | | | |
| **Durbin-Watson (**DW) | 0.234 | | | | |

The results of estimating (A25) with OLS and using (A26) and (A27) to calculate $r_H$ and $K_H$ are shown in table A24.

**Table A24.** High sea natural growth function

| **Parameter** | **Estimate** | **Standard derivation** | **t-value** | **Lower bound** | **Upper bound** |
|---|---|---|---|---|---|
| **Intrinsic growth rate** ($r_H$) | 0.483 | 0.114 | 4.225 | 0.2415 | 0.7242 |
| **Parameter** ($b_H$) | 0.00000307 | 0.0000028 | 1.477 | | |
| **Carrying capacity** ($K_H$) | 157,339 | | | 104,885 | 314,057 |
| $\mathbf{R^2}$ | 0.84 | | | | |
| **Durbin-Watson** (DW) | 0.1350 | | | | |

From table A24, we see that $r_H$ is positive and significant while $b_H$ is insignificant, and by using (A27) we can calculate $K_H$ from $r_H$ and $b_H$. $R^2$ is reasonably high, but with a Durbin-Watson test value of 0.135 and a critical level of 0.810, we have a potential problem with positive serial correlation. However, as mentioned above, it is common not to try to correct for serial correlation in fisheries economics. To discuss the implications of statistical uncertainty, we vary the estimated parameter of $r_H$ by +/– 50 per cent to yield an upper and lower bound that are reported in table A24. We also vary $b_H$ by +/– 50 per cent and assume that all variation in $b_H$ is due to variation in $K_H$. This implies that we can use (A27) to find an upper and a lower bound for $K_H$, which are reported in table A24.

Given that the observations for the high sea and coastal stock sizes and harvest for Grl. halibut are found by distributing the observations for the common fish stock and harvest to the two areas, we should have obtained that the carrying capacity with a common fish stock is equal to the sum of the carrying capacities with two separate fish stocks. However, by comparing tables A14, A23 and A24, it is clear that the carrying capacity with a common fish stock is much higher than that with two separate fish stocks. To explain this, it is a well-known result that an estimated parameter value for a carrying capacity is very sensitive to small changes in stock observations. Specifically, we mainly have observations for the stock size to the left of MSY, so when estimating a carrying capacity, we make statistical extrapolation. A solution to this problem is to estimate a natural growth function with restrictions on the carrying capacity. However, a priori, we do not know whether the carrying capacity with a common or two separate fish stocks will be restricted. Therefore, we have chosen not to impose restrictions on the estimated parameters for the carrying capacities, and thereby, the carrying capacity with a common fish stock is higher than the sum of the carrying capacities with two separate fish stocks in our paper.

A.3.2.2. High sea cost function

A high sea industry cost function that fulfills the assumptions about the derivatives from the theoretical model is:

$$C_H(h_H, x_H) = c_H \frac{{h_H}^2}{x_H}, \qquad \text{(A28)}$$

where $c_H$ is a high sea cost parameter and $x_H$ is the high sea Grl. halibut stock size. By reorganizing (A28) we get that:

$$c_H = \frac{C_H(h_H, x_H) x_H}{{h_H}^2}. \qquad \text{(A29)}$$

By comparing (A8) and (A29), we see that the only difference is that now we shall use the high sea Grl. halibut stock size from table A13 instead of the common stock size from table A12. Thus, the calculations are exactly the same as in table A15, apart from the fact that the Grl. halibut stock size differs. The procedure is summarized in table A25.

**Table A25.** High sea cost parameter

| **Indicator** | **2013** | **2014** | **2015** | **Average** |
|---|---|---|---|---|
| **Costs** (million DKK) (all species) | 254.1 | 307.2 | 354.8 | |
| **Quota share, Grl. halibut** | 0.2674 | 0.2009 | 0.2259 | |
| **Cost** (million DKK) (Grl. halibut) | 67.9536 | 61.7151 | 80.1587 | 69.9425 |
| **Harvest** (tons) | 9,860 | 11,266 | 12,072 | 11,070 |
| **Stock size** (tons) | 39,788 | 38,856 | 47,701 | 42,102 |
| **Cost parameter, yearly measure** (million DKK/tons) | 0.02781 | 0.01889 | 0.02624 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Cost parameter, estimated value** (million DKK/tons) | 0.012018 | 0.024036 | 0.036054 | |

In table A25, we have inserted the high sea Grl. halibut stock size between 2013 and 2015 and used these observations to calculate an average high sea stock size. By using the average high sea Grl. halibut stock size, we can calculate the high sea costs parameter by using (A29). Compared to the scenarios with a common fish stock, the high sea cost parameter is lower because the high sea stock size is lower. However, this way of quantifying a high sea cost parameter implies huge uncertainty, so we will perform sensitivity analyses by varying the high sea cost parameter by +/– 50 per cent. The upper and lower bounds generated by this variation are summarized in table A25. As for a common fish stock, we have also calculated an annual measure for the high sea cost parameter which is reported in table A25. Again the annual variation in the high sea cost parameter is very low and all yearly measures are within the span generated by the upper and lower bound for the estimated parameter.

A.3.2.3. Coastal cost function

A coastal industry cost function that fulfills the assumptions about the derivatives from the theoretical model is:

$$C_C(h_C, x_C) = c_C \frac{h_C^{\,2}}{x_C}, \tag{A30}$$

where $c_C$ is a coastal cost parameter and $x_C$ is the coastal stock size. (A30) can be rewritten as:

$$c_C = \frac{C_C(h_C, x_C)x_C}{h_C^{\,2}}. \tag{A31}$$

Thus, the only difference compared to the scenarios with a common fish stock is that the coastal Grl. halibut stock size from table A13 will be used instead of the common stock size in table A12. The coastal Grl. halibut stock size is included in table A26.

Naturally enough, the coastal cost parameter in table A26 decreases compared to a common fish stock because the stock size is lower. We have inserted the coastal cost parameter into table A26, together with the upper and lower bounds generated by varying the cost parameter by +/– 50 per cent. In table A26 we also report annual measures for the coastal cost parameter.

As before, the variation in the yearly measures is low and all annual measures are within the span generated by the upper and lower bound.

**Table A26.** Coastal cost parameter

| Indicator | 2013 | 2014 | 2015 | Average |
|---|---|---|---|---|
| **Costs** (million DKK) (vessels above 6 m) (all species) | 63 | 75 | 27.9 | |
| **Costs** (million DKK) (boats below 6 m) (all species) | 74.6 | 77.4 | 110.5 | |
| **Costs** (million DKK) (all species) | 137.8 | 152.4 | 138.4 | |
| **Quota share, Grl. halibut** | 0.62217 | 0.58792 | 0.50628 | |
| **Cost** (million DKK) (Grl. halibut) | 85.6101 | 89.5987 | 70.0679 | 81.7595 |
| **Harvest** (tons) (vessels above 6 m) | 10,350 | 11,203 | 8,907 | |
| **Harvest** (tons) (boats below 6 m) | 13,069 | 15,300 | 16,009 | |
| **Harvest** (tons) | 23,417 | 26,503 | 24,917 | 24,917 |
| **Stock size** (tons) | 24,386 | 23,815 | 29,236 | 25,812 |
| **Cost parameter, yearly measure** (million DKK/tons) | 0.003807 | 0.003038 | 0.003300 | |
| | **Lower bound** | **Benchmark** | **Upper bound** | |
| **Cost parameter, estimated value** (million DKK/tons) | 0.0017 | 0.00339 | 0.00509 | |

A.3.2.4. High sea price

The high sea Grl. halibut price is unchanged compared to the scenarios with a common fish stock. Thus, the high sea price can be found by performing the calculations in table A17, and the price together with the upper and lower bounds is summarized in table A17.

A.3.2.5. Coastal price

The coastal price has already been found in section A.3.1.5, and the calculations are summarized in table A18. Furthermore, the coastal price together with the upper and lower bound can be found in table A18.

A.3.2.6. Scaling factor for vessels from other fishing nations

The scaling factor for vessels from other fishing nations is the same as in the scenarios with a common fish stock. Thus, the calculations are summarized in table A19, and the calculated scaling factor is summarized in table A19 together with the upper and lower bounds.

A.3.2.7. Land-based cost function

The land-based cost function is the same as with a common fish stock, implying that the calculations can be found in table A20. The land-based costs parameter and the upper and lower bound can be seen in table A20.

A.3.2.8. Land-based price

The land-based price is also unchanged compared to the scenarios with a common fish stock. Thus, table A21 summarizes the method used for calculation of the land-based price, and the price together with the upper and lower bound are summarized in table A21.

A.3.2.9. Land-based utilization rate

The land-based utilization rate is the same as with a common stock. Thus, the calculations can be found in table A22, and the estimated value can be found in table A22 as well as the upper and lower bounds.

A.3.2.10. Equity weight

As in the scenarios with a common fish stock, we vary the equity weight to investigate how our results are affected by the weight imposed on the coastal profit.

## References


**Fiskerikommissionen** (2021) Fiskerikommissionens Betænkning, Government of Greenland, Nuuk.

**Jørgensen OA** (2013) Distribution of small Greenland halibut in Baffin Bay. Technical Report no. 89, Greenland Institute of Natural Resources, Nuuk.

**Ogmundsson H (**2019) Baggrundsnotat. Relevante data om økonomi og beskæftigelse i fiskerierhvervet, Government of Greenland, Nuuk.

**Ogmundson H and Haraldson G** (2017) Redegørelse af ressourcerenten i det grønlandske fiskeri og forslag til nye ressourcerentafgiftsmodeller, Department for Finance and Taxes, Government of Greenland, Nuuk (available from the the authors of this paper upon request).

**Statistics Greenland** (2020) Fisheries and harvest, Statistics Greenland, Nuuk.

**Treble MA and Nogueira A** (2018) Assessment of the Greenland halibut stock components in NAFO subarea 0 + division 1.A (offshore) and divisions 1B – 1F. Paper presented at *Scientific Council Meeting*, June 2018, Northwest Atlantic Fisheries Organization.

## Appendix B. Cost Function

### B.1. Deriving a cost function

Now we want to use a production function to derive a cost function. We assume a Cobb-Douglas production function given as:

$$h = qE^{\gamma} x^{\mu}, \tag{B1}$$

where $q$ is a catchability coefficient, $E$ is the high sea effort while $\gamma > 0$ and $\mu > 0$ are parameters in the production function. By differentiating (B1) we get that:

$$\frac{\partial h}{\partial E} = \gamma q E^{\gamma-1} x^{\mu} \text{ and } \frac{\partial^2 h}{\partial E^2} = \gamma(\gamma-1) q E^{\gamma-1} x^{\mu}. \tag{B2}$$

From (B2) it follows that the marginal product to effort is positive but decreasing ($\frac{\partial h}{\partial E} > 0$ and $\frac{\partial^2 h}{\partial E^2} < 0$) if $\gamma < 1$. Furthermore, from basic microeconomic theory we have increasing returns to scale if $\gamma + \mu > 1$, constant returns to scale if $\gamma + \mu = 1$ and decreasing returns to scale if $\gamma + \mu < 1$.

By reorganizing the production function in (B1), we get that:

$$E^{\gamma} = \frac{1}{q} \frac{h}{x^{\mu}}. \tag{B3}$$

From (B3) we can obtain:

$$E = (\frac{1}{q})^{\frac{1}{\gamma}} \frac{h^{\frac{1}{\gamma}}}{x^{\frac{\mu}{\gamma}}}. \tag{B4}$$

Next we assume that the stock size of fish is a costless input while the marginal cost of effort is constant and equal to $w$. Thus, the total costs become:

$$C = wE. \tag{B5}$$

When inserting (B4) into (B5) we get that:

$$C = w(\frac{1}{q})^{\frac{1}{\gamma}} \frac{h^{\frac{1}{\gamma}}}{x^{\frac{\mu}{\gamma}}}. \tag{B6}$$

By using (B6) we are ale to define a cost function, $C(h,x)$, as:

$$C(h,x) = c\frac{h^{\frac{1}{\gamma}}}{x^{\frac{\mu}{\gamma}}}, \tag{B7}$$

where:

$$c = w(\frac{1}{q})^{\frac{1}{\gamma}}. \tag{B8}$$

From (B8) it is clear that the cost parameter, $c$, is constant, so by differentiating (B7) we get that:

$$\frac{\partial C}{\partial h} = \frac{1}{\gamma}c\frac{h^{\frac{1^{\gamma}-\gamma}{\gamma}}}{x^{\frac{\mu}{\gamma}}} \text{ and } \frac{\partial^2 C}{\partial h^2} = (\frac{1-\gamma}{\gamma})\frac{1}{\gamma}c\frac{h^{\frac{1-2\gamma}{\gamma}}}{x^{\frac{\mu}{\gamma}}}. \tag{B9}$$

From (B9) it follows that the marginal harvesting cost is positive and increasing ($\frac{\partial C}{\partial h} > 0$ and $\frac{\partial^2 C}{\partial h^2} > 0$) if $\gamma < 1$, and from (B2) the marginal product of effort is positive and decreasing if $\gamma < 1$. Thus, we can conclude that if the marginal product of effort in a Cobb-Douglas production function is positive but decreasing, the marginal harvesting cost becomes positive and increasing.

Finally, we can assume that $\gamma = \mu = 0.5$, implying that (B7) becomes:

$$C(h,x) = c\frac{h^2}{x}. \tag{B10}$$

This is our cost function from (16) in the main text and, since $\gamma < 1$, we have positive and increasing marginal harvesting costs. The cost function in (B10) corresponds to a Cobb-Douglas production function given as:

$$h = qE^{0.5}x^{0.5}. \qquad \text{(B11)}$$

With the production function in (B11), we have constant returns to scale since $\gamma + \mu = 1$.

## B.2. Vessel-level cost parameter

Now we assume that *n* vessels in the industry exist and that the vessels are symmetrically distributed around a representative vessel (for example, either a normal or uniform distribution). To obtain a cost parameter for a representative vessel, we can divide the total industry costs and harvest in (B10) with *n* to obtain:

$$\frac{C(h,x)}{n} = c\frac{(\frac{h}{n})^2}{x}. \qquad \text{(B12)}$$

We can write (B12) as:

$$\frac{C(h,x)}{n} = c\frac{\frac{h^2}{n^2}}{x}. \qquad \text{(B13)}$$

By solving (B13) for $c$, we get that:

$$c = \frac{C(h,x)x}{h^2}n. \qquad \text{(B14)}$$

Equation (B14) is our expression for the vessel-level cost parameter.

## Appendix C. Sensitivity Analyses

In this appendix, we present a number of sensitivity analyses regarding our model for Grl. halibut.

### C.1. Scenario 1

The results of the sensitivity analyses in scenario 1 are reported in tables C1–C3. From these tables we obtain the following numerical comparative static results:

A. An increase (decrease) in the carrying capacity and intrinsic growth rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size.

B. An increase (decrease) in the scaling factor for other fishing nations will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size.

C. An increase (decrease) in the high sea cost parameter and a decrease (increase) in the high sea price will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size.

D. An increase (decrease) in the coastal cost parameter and a decrease (increase) in the coastal price will: (1) Decrease (increase) the optimal coastal harvest and profit; (2) Increase (decrease) the optimal high sea harvest and profit; (3) Increase (decrease) the optimal stock size.

Based on the theoretical model, these numerical comparative static results correspond to the expectations. Concerning the robustness of our results, we have the following:

A. In the benchmark case, the optimal coastal harvest and profit are higher than the optimal high sea harvest and profit. From tables C1–C3, this result does not hold for the lower bound of the coastal price.

Finally, from tables C1–C3, the optimal high sea harvest is zero in the following cases:

A. The lower bound of the intrinsic growth rate, the upper bound for the scaling factor to other nations, the lower bound of the high sea price, the lower bound of the coastal cost parameter and the upper bound of the coastal price.

**Table C1.** Sensitivity analyses for the parameters in the resource restriction, scenario 1

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Carrying capacity** | **High sea harvest** | Tons | 148 | 240 | 443 |
| | Greenland | Tons | 88 | 143 | 264 |
| | Other fishing nations | Tons | 60 | 97 | 179 |
| | **Coastal Harvest** | Tons | 25,387 | 41,200 | 76,161 |
| | **Stock size** | Tons | 162,462 | 263,010 | 486,413 |
| | **Shadow price** | Million DKK | 0.0066 | 0.0066 | 0.0066 |
| | **High sea profit** | Million DKK | 0.0965 | 1.57 | 2.89 |
| | **Coastal profit** | Million DKK | 201.86 | 327.66 | 605.68 |
| **Intrinsic growth rate** | **High sea harvest** | Tons | 0 | 403 | 4,672 |
| | Greenland | Tons | 0 | 240 | 1,557 |
| | Other fishing nations | Tons | 0 | 163 | 3,116 |
| | **Coastal Harvest** | Tons | 20,869 | 41,200 | 54,003 |
| | **Stock size** | Tons | 251,026 | 263,010 | 269,035 |
| | **Shadow price** | Million DKK | 0.0079 | 0.0066 | 0.0058 |
| | **High sea profit** | Million DKK | 0 | 1.57 | 41.11 |
| | **Coastal profit** | Million DKK | 179.64 | 327.66 | 408.738 |
| **Scaling factor, other nations** | **High sea harvest** | Tons | 7,283 | 240 | 0 |
| | Greenland | Tons | 5,441 | 143 | 0 |
| | Other fishing nations | Tons | 1,842 | 97 | 0 |
| | **Coastal harvest** | Tons | 34,319 | 41,200 | 41,430 |
| | **Stock size** | Tons | 257,142 | 263,010 | 263,412 |
| | **Shadow price** | Million DKK | 0.070 | 0.0066 | 0.0065 |
| | **High sea profit** | Million DKK | 55.24 | 1.57 | 0 |
| | **Coastal profit** | Million DKK | 280.07 | 327.66 | 329.21 |

**Table C2.** Sensitivity analyses for the high sea economic parameter, scenario 1

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **High sea cost parameter** | **High sea harvest** | Tons | 357 | 240 | 179 |
| | Greenland | Tons | 213 | 143 | 107 |
| | Other fishing nations | Tons | 144 | 97 | 72 |
| | **Coastal harvest** | Tons | 41,086 | 41,200 | 41,257 |
| | **Stock size** | Tons | 263,068 | 263,010 | 263,001 |
| | **Shadow price** | Million DKK | 0,0066 | 0.0066 | 0.0066 |
| | **High sea profit** | Million DKK | 2.34 | 1.57 | 1.17 |
| | **Coastal profit** | Million DKK | 326.88 | 327.66 | 328.04 |
| **High sea price** | **High sea harvest** | Tons | 0 | 240 | 15,280 |
| | Greenland | Tons | 0 | 143 | 11,497 |
| | Other fishing nations | Tons | 0 | 97 | 7,783 |
| | **Coastal harvest** | Tons | 41,429 | 41,200 | 22,528 |
| | **Stock size** | Tons | 264,266 | 263,010 | 262,068 |
| | **Shadow price** | Million DKK | 0.0065 | 0.0066 | 0.0066 |
| | **High sea profit** | Million DKK | 0 | 1.57 | 169.13 |
| | **Coastal profit** | Million DKK | 329.27 | 327.66 | 192.82 |

**Table C3.** Sensitivity analyses for the coastal economic parameter, scenario 1

| **Parameter** | **Indicator** | **Measurement unit** | **Lower bound** | **Benchmark** | **Upper bound** |
|---|---|---|---|---|---|
| **Coastal cost parameter** | **High sea harvest** | Tons | 0 | 240 | 6,721 |
| | Greenland | Tons | 0 | 143 | 4,008 |
| | Other fishing nations | Tons | 0 | 97 | 2,713 |
| | **Coastal harvest** | Tons | 41,737 | 41,200 | 34,601 |
| | **Stock size** | Tons | 251,027 | 263,010 | 267,413 |
| | **Shadow price** | Million DKK | 0.0079 | 0.0066 | 0.0059 |
| | **High sea profit** | Million DKK | 0 | 1.57 | 41.64 |
| | **Coastal profit** | Million DKK | 359.27 | 327.66 | 263.64 |
| **Coastal price** | **High sea harvest** | Tons | 27,449 | 240 | 0 |
| | Greenland | Tons | 16,368 | 143 | 0 |
| | Other fishing nations | Tons | 11,081 | 97 | 0 |
| | **Coastal harvest** | Tons | 13,869 | 41,200 | 41,663 |
| | **Stock size** | Tons | 270,675 | 263,010 | 255,423 |
| | **Shadow price** | Million DKK | 0.0038 | 0.0066 | 0.0111 |
| | **High sea profit** | Million DKK | 141.15 | 1.57 | 0 |
| | **Coastal profit** | Million DKK | 58.56 | 327.66 | 523.77 |

### C.2. Scenario 2

The results of the sensitivity analyses in scenario 2 are reported in tables C4–C7. From these tables, we obtain the following numerical comparative static results:

A. A decrease (increase) in the high sea carrying capacity and intrinsic growth rate will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Decrease (increase) the optimal high sea stock size; (4) Decrease (increase) the optimal coastal stock size.

B. A decrease (increase) in the coastal carrying capacity and intrinsic growth rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal coastal harvest and profit; (3) Decrease (increase) the optimal coastal seas stock size; (4) Decrease (increase) the optimal high sea stock size.

C. An increase (decrease) in the scaling factor for other fishing nations will: (1) Increase (decrease) the optimal high sea harvest; (2) Decrease (increase) the optimal high sea profit; (3) Decrease (increase) the optimal coastal harvest and profit; (4) Decrease (increase) the optimal high sea stock size: (5) Increase (decrease) the optimal coastal stock size.

D. An increase (decrease) in the migration parameter will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal high sea stock size; (3) Increase (decrease) the optimal coastal harvest and profit; (4) Increase (decrease) the optimal coastal stock size.

E. An increase (decrease) in the high sea cost parameter and a decrease (increase) in the high sea price will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal coastal stock size; (3) Increase (decrease) the optimal coastal harvest and profit; (4) Increase (decrease) the optimal high sea stock size.

F. An increase (decrease) in the coastal cost parameter and a decrease (increase) in the coastal price will: (1) Decrease (increase) the optimal coastal harvest and profit; (2) Decrease (increase) the optimal high sea stock size; (3) Increase (decrease) the optimal high sea harvest and profit; (4) Increase (decrease) the optimal coastal stock size.

Based on the theoretical model, these numerical comparative static results correspond to the expectations. Concerning the robustness of our results, we have the following:

A. In the benchmark case, the optimal high sea harvest and profit are higher than the optimal coastal harvest and profit. From tables C4–C7, this result does not hold for the lower bound of the high sea price and the upper bound of the coastal price.

**Table C4.** Sensitivity analyses for the parameters in the high sea resource restriction, scenario 2

| **Parameter** | **Indicator** | **Measurement unit** | **Lower bound** | **Benchmark** | **Upper bound** |
|---|---|---|---|---|---|
| **High sea carrying capacity** | **High sea harvest** | Tons | 11,988 | 17,382 | 34,700 |
| | Greenland | Tons | 6,910 | 10,365 | 20,692 |
| | Other fishing nations | Tons | 4,678 | 7,017 | 14,008 |
| | **Coastal Harvest** | Tons | 7,048 | 7,375 | 8,349 |
| | **High sea profit** | Million DKK | 57.56 | 86.34 | 172.30 |
| | **Coastal profit** | Million DKK | 56.66 | 61.00 | 67.80 |
| | **High sea stock size** | Tons | 62,919 | 94,114 | 108,032 |
| | **High sea shadow price** | Million DKK | 0.0036 | 0.0036 | 0.0036 |
| | **Coastal stock size** | Tons | 23,257 | 22,805 | 22,603 |
| | **Coastal shadow price** | Million DKK | 0.0093 | 0.0087 | 0.0082 |
| | **Migration** | Tons | 641 | 975 | 1,133 |
| **High sea intrinsic growth rate** | **High sea harvest** | Tons | 8,598 | 17,382 | 24,841 |
| | Greenland | Tons | 5,127 | 10,365 | 14,813 |
| | Other fishing nations | Tons | 3,471 | 7,017 | 10,028 |
| | **Coastal Harvest** | Tons | 7,271 | 7,375 | 7,479 |
| | **High sea profit** | Million DKK | 68.90 | 86.34 | 111.30 |
| | **Coastal profit** | Million DKK | 60.34 | 61.00 | 61.66 |
| | **High sea stock size** | Tons | 86,009 | 94,114 | 103,314 |
| | **High sea shadow price** | Million DKK | 0.0049 | 0.0036 | 0.0024 |
| | **Coastal stock size** | Tons | 23,740 | 22,805 | 22,924 |
| | **Coastal shadow price** | Million DKK | 0.0085 | 0.0087 | 0.0089 |
| | **Migration** | Tons | 860 | 975 | 1,068 |

| | | | | | |
|---|---|---|---|---|---|
| **Scaling factor, other nations** | **High sea harvest** | Tons | 16,828 | 17,382 | 17,872 |
| | Greenland | Tons | 12,571 | 10,365 | 8,697 |
| | Other fishing nations | Tons | 4,255 | 7,017 | 9,175 |
| | **Coastal Harvest** | Tons | 7,412 | 7,375 | 7,350 |
| | **High sea profit** | Million DKK | 99.22 | 86.34 | 75.60 |
| | **Coastal profit** | Million DKK | 61.27 | 61.00 | 60.81 |
| | **High sea stock size** | Tons | 99,177 | 94,114 | 91,808 |
| | **High sea shadow price** | Million DKK | 0.0036 | 0.0036 | 0.0042 |
| | **Coastal stock size** | Tons | 23,201 | 22,805 | 22,537 |
| | **Coastal shadow price** | Million DKK | 0.0071 | 0.0087 | 0.0072 |
| | **Migration** | Tons | 1,009 | 975 | 965 |
| **Migration** | **High sea harvest** | Tons | 17,850 | 17,382 | 16,919 |
| | Greenland | Tons | 10,644 | 10,365 | 10,089 |
| | Other fishing nations | Tons | 7,206 | 7,017 | 6,830 |
| | **Coastal Harvest** | Tons | 6,887 | 7,375 | 7,859 |
| | **High sea profit** | Million DKK | 87.96 | 86.34 | 84.68 |
| | **Coastal profit** | Million DKK | 57.49 | 61.00 | 64.42 |
| | **High sea stock size** | Tons | 94,548 | 94,114 | 94,115 |
| | **High sea shadow price** | Million DKK | 0.0033 | 0.0036 | 0.0035 |
| | **Coastal stock size** | Tons | 23.297 | 22,805 | 23,105 |
| | **Coastal shadow price** | Million DKK | 0.0073 | 0.0087 | 0.0070 |
| | **Migration** | Tons | 481 | 975 | 1,433 |

**Table C5.** Sensitivity analyses for the parameters in the coastal resource restriction, scenario 2

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Coastal carrying capacity** | **High sea harvest** | Tons | 16,966 | 17,382 | 17,850 |
| | Greenland | Tons | 10,093 | 10,365 | 10,644 |
| | Other fishing nations | Tons | 6,833 | 7,017 | 7,206 |
| | **Coastal Harvest** | Tons | 5,725 | 7,375 | 13,286 |
| | **High sea profit** | Million DKK | 84.68 | 86.34 | 87.97 |
| | **Coastal profit** | Million DKK | 46.30 | 61.00 | 78.43 |
| | **High sea stock size** | Tons | 94,022 | 94,114 | 94,599 |
| | **High sea shadow price** | Million DKK | 0.0035 | 0.0036 | 0.0033 |
| | **Coastal stock size** | Tons | 15,370 | 22,805 | 46,760 |
| | **Coastal shadow price** | Million DKK | 0.0068 | 0.0087 | 0.0074 |
| | **Migration** | Tons | 1,450 | 975 | 479 |
| **Coastal intrinsic growth rate** | **High sea harvest** | Tons | 17,275 | 17,382 | 17,446 |
| | Greenland | Tons | 10,301 | 10,365 | 10,403 |
| | Other fishing nations | Tons | 6,974 | 7,017 | 7,243 |
| | **Coastal Harvest** | Tons | 4,257 | 7,375 | 10,471 |
| | **High sea profit** | Million DKK | 80.03 | 86.34 | 86.49 |
| | **Coastal profit** | Million DKK | 36.47 | 61.00 | 82.57 |
| | **High sea stock size** | Tons | 94,570 | 94,114 | 94,163 |
| | **High sea shadow price** | Million DKK | 0.0034 | 0.0036 | 0.0034 |
| | **Coastal stock size** | Tons | 21,326 | 22,805 | 24,242 |
| | **Coastal shadow price** | Million DKK | 0.0080 | 0.0087 | 0.0064 |
| | **Migration** | Tons | 1,039 | 975 | 925 |

| | | | | | |
|---|---|---|---|---|---|
| **Migration** | **High sea harvest** | Tons | 17,850 | 17,382 | 16,919 |
| | Greenland | Tons | 10,644 | 10,365 | 10,089 |
| | Other fishing nations | Tons | 7,206 | 7,017 | 6,830 |
| | **Coastal Harvest** | Tons | 6,887 | 7,375 | 7,859 |
| | **High sea profit** | Million DKK | 87.96 | 86.34 | 84.68 |
| | **Coastal profit** | Million DKK | 57.49 | 61.00 | 64.42 |
| | **High sea stock size** | Tons | 94,548 | 94,114 | 94,115 |
| | **High sea shadow price** | Million DKK | 0.0033 | 0.0036 | 0.0035 |
| | **Coastal stock size** | Tons | 23,297 | 22,805 | 23,105 |
| | **Coastal shadow price** | Million DKK | 0.0073 | 0.0087 | 0.0070 |
| | **Migration** | Tons | 481 | 975 | 1,433 |

**Table C6.** Sensitivity analyses for the high sea economic parameters, scenario 2

| **Parameter** | **Indicator** | **Measurement unit** | **Lower bound** | **Benchmark** | **Upper bound** |
|---|---|---|---|---|---|
| **High sea cost parameter** | **High sea harvest** | Tons | 18,073 | 17,382 | 16,259 |
| | Greenland | Tons | 10,777 | 10,365 | 9,695 |
| | Other fishing nations | Tons | 7,296 | 7,017 | 6,564 |
| | **Coastal Harvest** | Tons | 7,272 | 7,375 | 7.475 |
| | **High sea profit** | Million DKK | 101.99 | 86.34 | 73.37 |
| | **Coastal profit** | Million DKK | 60.34 | 61.00 | 61.63 |
| | **High sea stock size** | Tons | 85,968 | 94,114 | 103,243 |
| | **High sea shadow price** | Million DKK | 0.0048 | 0.0036 | 0.0025 |
| | **Coastal stock size** | Tons | 23,426 | 22,805 | 22,960 |
| | **Coastal shadow price** | Million DKK | 0.0082 | 0.0087 | 0.0089 |
| | **Migration** | Tons | 870 | 975 | 1,066 |
| **High sea price** | **High sea harvest** | Tons | 16,259 | 17,382 | 17,957 |
| | Greenland | Tons | 8,709 | 10,365 | 10,708 |
| | Other fishing nations | Tons | 6,564 | 7,017 | 7,249 |
| | **Coastal Harvest** | Tons | 7,591 | 7,375 | 7,273 |
| | **High sea profit** | Million DKK | 31.46 | 86.34 | 144.94 |
| | **Coastal profit** | Million DKK | 62.32 | 61.00 | 60.43 |
| | **High sea stock size** | Tons | 112,542 | 94,114 | 88,006 |
| | **High sea shadow price** | Million DKK | 0.0010 | 0.0036 | 0.0064 |
| | **Coastal stock size** | Tons | 22,567 | 22,805 | 23,691 |
| | **Coastal shadow price** | Million DKK | 0.0091 | 0.0087 | 0.0082 |
| | **Migration** | Tons | 1,182 | 975 | 880 |

**Table C7.** Sensitivity analyses for the coastal economic parameters, scenario 2

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Coastal cost parameter** | **High sea harvest** | Tons | 17,303 | 17,382 | 17,451 |
| | Greenland | Tons | 10,318 | 10,365 | 10,406 |
| | Other fishing nations | Tons | 6,985 | 7,017 | 7,045 |
| | **Coastal Harvest** | Tons | 7,439 | 7,375 | 7,282 |
| | **High sea profit** | Million DKK | 86.15 | 86.34 | 86.50 |
| | **Coastal profit** | Million DKK | 65.15 | 61.00 | 56.98 |
| | **High sea stock size** | Tons | 94,636 | 94,114 | 93,131 |
| | **High sea shadow price** | Million DKK | 0.0034 | 0.0036 | 0.0037 |
| | **Coastal stock size** | Tons | 22,060 | 22,805 | 24,296 |
| | **Coastal shadow price** | Million DKK | 0.0092 | 0.0087 | 0.0082 |
| | **Migration** | Tons | 1,017 | 975 | 901 |
| **Coastal price** | **High sea harvest** | Tons | 17,593 | 17,382 | 17,193 |
| | Greenland | Tons | 10,491 | 10,365 | 10,252 |
| | Other fishing nations | Tons | 7,102 | 7,017 | 6,941 |
| | **Coastal Harvest** | Tons | 7,098 | 7,375 | 7,444 |
| | **High sea profit** | Million DKK | 86.73 | 86.34 | 86.06 |
| | **Coastal profit** | Million DKK | 26.62 | 61.00 | 95.97 |
| | **High sea stock size** | Tons | 93,279 | 94,114 | 95,669 |
| | **High sea shadow price** | Million DKK | 0.0038 | 0.0036 | 0.0035 |
| | **Coastal stock size** | Tons | 25,880 | 22,805 | 21,187 |
| | **Coastal shadow price** | Million DKK | 0.0029 | 0.0087 | 0.012 |
| | **Migration** | Tons | 854 | 975 | 1,070 |

### C.3. Scenario 3

The results of the sensitivity analyses in scenario 3 are reported in tables C8–C11. From these tables, we obtain the following numerical comparative static results:

A. An increase (decrease) in the carrying capacity and intrinsic growth rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size; (4) Decrease (increase) the optimal land-based profit.

B. An increase (decrease) in the scaling factor for other fishing nations will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Decrease (increase) the optimal stock size; (4) Decrease (increase) the optimal land-based profit.

C. An increase (decrease) in the high sea cost parameter and a decrease (increase) in the high sea price will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size; (4) Decrease (increase) the optimal land-based profit.

D. An increase (decrease) in the coastal cost parameter and a decrease (increase) in the coastal price will: (1) Decrease (increase) the optimal coastal harvest and profit; (2) Increase (decrease) the optimal high sea harvest and profit; (3) Increase (decrease) the optimal stock size; (4) Increase (decrease) the optimal land-based profit.

E. An increase (decrease) in the land-based cost parameter, a decrease (increase) in the land-based price and an increase (decrease) in the land-based utilization rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal stock size; (4) Decrease (increase) the optimal land-based profit.

Based on the theoretical model, these numerical comparative static results correspond to the expectations. Concerning the robustness of our results, we have the following:

A. In the benchmark case, the optimal high sea harvest is higher than the optimal coastal harvest while the optimal coastal profit is higher than the optimal high sea profit. From tables C8–C11, this result does not hold for the lower bound of the carrying capacity, the lower bound for the intrinsic growth rate, the lower bound for the high sea cost parameter, the upper bound for the high sea price, the lower bound for the coastal price, the upper bound for the land-based cost parameter, the lower bound for the land-based price, and the upper bound for the land-based utilization rate.

**Table C8.** Sensitivity analyses for the parameters in the resource restriction, scenario 3

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Carrying capacity** | **High sea harvest** | Tons | 3,872 | 22,774 | 39,495 |
| | Greenland | Tons | 2,309 | 13,580 | 23,551 |
| | Other fishing nations | Tons | 1,561 | 9,194 | 15,994 |
| | **Coastal Harvest** | Tons | 17,022 | 18,632 | 19,315 |
| | **Stock size** | Tons | 250,568 | 267,817 | 301,816 |
| | **Shadow price** | Million DKK | 0.0058 | 0.0035 | 0.0020 |
| | **High sea profit** | Million DKK | 24.50 | 122.28 | 187.12 |
| | **Coastal profit** | Million DKK | 148.84 | 162.58 | 182.12 |
| | **Land-based profit** | Million DKK | 37.51 | 24.93 | 11.78 |
| **Intrinsic growth rate** | **High sea harvest** | Tons | 8,494 | 22,774 | 59,232 |
| | Greenland | Tons | 5,065 | 13,580 | 34,724 |
| | Other fishing nations | Tons | 3,429 | 9,194 | 23,508 |
| | **Coastal Harvest** | Tons | 17,138 | 18,632 | 19,535 |
| | **Stock size** | Tons | 160,548 | 267,817 | 529,479 |
| | **Shadow price** | Million DKK | 0.0047 | 0.0035 | 0.0026 |
| | **High sea profit** | Million DKK | 49.37 | 122.28 | 292.66 |
| | **Coastal profit** | Mill DKK | 143.93 | 162.58 | 179.99 |
| | **Land-based profit** | Million DKK | 37.54 | 24.93 | 3.46 |
| Scaling factor, other nations | **High sea harvest** | Tons | 32,333 | 22,774 | 22,181 |
| | Greenland | Tons | 17,432 | 13,580 | 10,794 |
| | Other fishing nations | Tons | 5,901 | 9,194 | 11,388 |
| | **Coastal harvest** | Tons | 17,566 | 18,632 | 19,650 |
| | **Stock size** | Tons | 275,701 | 267,817 | 263,982 |
| | **Shadow price** | Million DKK | 0.0037 | 0.0035 | 0.0033 |
| | **High sea profit** | Million DKK | 148.51 | 122.28 | 101.30 |
| | **Coastal profit** | Million DKK | 154.26 | 162.58 | 170.68 |
| | **Land-based profit** | Million DKK | 25.16 | 24.93 | 22.92 |

**Table C9.** Sensitivity analyses for the high sea economic parameters, scenario 3

| **Parameter** | **Indicator** | **Measurement unit** | **Lower bound** | **Benchmark** | **Upper bound** |
|---|---|---|---|---|---|
| **High sea cost parameter** | **High sea harvest** | Tons | 25,596 | 22,774 | 20,399 |
| | Greenland | Tons | 15,263 | 13,580 | 12,164 |
| | Other fishing nations | Tons | 10,333 | 9,194 | 8,235 |
| | **Coastal harvest** | Tons | 16,204 | 18,632 | 20,410 |
| | **Stock size** | Tons | 255,542 | 267,817 | 279,514 |
| | **Shadow price** | Million DKK | 0.0047 | 0.0035 | 0.0028 |
| | **High sea profit** | Million DKK | 149.76 | 122.28 | 102.66 |
| | **Coastal profit** | Million DKK | 142.76 | 162.58 | 177.54 |
| | **Land-based profit** | Million DKK | 32.68 | 24.93 | 18.04 |
| **High sea price** | **High sea harvest** | Tons | 14,290 | 22,774 | 29,076 |
| | Greenland | Tons | 8,521 | 13,580 | 17,338 |
| | Other fishing nations | Tons | 5,769 | 9,194 | 11,738 |
| | **Coastal harvest** | Tons | 24,607 | 18,632 | 12,616 |
| | **Stock size** | Tons | 304,420 | 267,817 | 260,493 |
| | **Shadow price** | Million DKK | 0.00095 | 0.0035 | 0.0065 |
| | **High sea profit** | Million DKK | 37.54 | 122.28 | 240.65 |
| | **Coastal profit** | Million DKK | 212.33 | 162.58 | 112.51 |
| | **Land-based profit** | Million DKK | 2.32 | 24.93 | 40.20 |

**Table C10.** Sensitivity analyses for the coastal economic parameters, scenario 3

| **Parameter** | **Indicator** | **Measurement unit** | **Lower bound** | **Benchmark** | **Upper bound** |
|---|---|---|---|---|---|
| **Coastal cost parameter** | **High sea harvest** | Tons | 21,637 | 22,774 | 23,745 |
| | Greenland | Tons | 12,902 | 13,580 | 14,159 |
| | Other fishing nations | Tons | 8,735 | 9,194 | 9,586 |
| | **Coastal harvest** | Tons | 19,924 | 18,632 | 17,505 |
| | **Stock size** | Tons | 263,186 | 267,817 | 271,363 |
| | **Shadow price** | Million DKK | 0.0035 | 0.0035 | 0.0035 |
| | **High sea profit** | Million DKK | 117.02 | 122.28 | 126.69 |
| | **Coastal profit** | Million DKK | 179.02 | 162,58 | 148.55 |
| | **Land-based profit** | Million DKK | 19.70 | 24.93 | 28.95 |
| **Coastal price** | **High sea harvest** | Tons | 31,258 | 22,774 | 14,134 |
| | Greenland | Tons | 18,639 | 13,580 | 8,428 |
| | Other fishing nations | Tons | 12,619 | 9,194 | 5,706 |
| | **Coastal harvest** | Tons | 9,704 | 18,632 | 27,349 |
| | **Stock size** | Tons | 277,985 | 267,817 | 264,187 |
| | **Shadow price** | Million DKK | 0.0034 | 0.0035 | 0.0038 |
| | **High sea profit** | Million DKK | 156.03 | 122.28 | 82.03 |
| | **Coastal profit** | Million DKK | 42.39 | 162.58 | 358.46 |
| | **Land-based profit** | Million DKK | 42.59 | 24.93 | -22.56 |

**Table C11.** Sensitivity analyses for the land based economic parameters, scenario 3

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Land-based cost parameter** | **High sea harvest** | Tons | 9,532 | 22,774 | 29,539 |
| | Greenland | Tons | 5,684 | 13,580 | 17,614 |
| | Other fishing nations | Tons | 3,848 | 9,194 | 11,925 |
| | **Coastal Harvest** | Tons | 32,054 | 18,632 | 11,234 |
| | **Stock size** | Tons | 260,084 | 267,817 | 282,100 |
| | **Shadow price** | Million DKK | 0.0053 | 0.0035 | 0.0028 |
| | **High sea profit** | Million DKK | 57.54 | 122.28 | 150.45 |
| | **Coastal profit** | Million DKK | 264.47 | 162.28 | 101.03 |
| | **Land-based profit** | Million DKK | 79.22 | 24.93 | 10.48 |
| **Land-based price** | **High sea harvest** | Tons | 27,738 | 22,774 | 17,694 |
| | Greenland | Tons | 16,540 | 13,580 | 10,551 |
| | Other fishing nations | Tons | 11,198 | 9,194 | 7,143 |
| | **Coastal Harvest** | Tons | 13,267 | 18,632 | 23,866 |
| | **Stock size** | Tons | 276,807 | 267,817 | 262,487 |
| | **Shadow price** | Million DKK | 0.0029 | 0.0035 | 0.0042 |
| | **High sea profit** | Million DKK | 143.14 | 122.28 | 99.31 |
| | **Coastal profit** | Million DKK | 118.37 | 162.58 | 203.79 |
| | **Land-based profit** | Million DKK | -15.07 | 24.93 | 85.47 |
| **Land-based utilization rate** | **High sea harvest** | Tons | 47,862 | 22,774 | 12,644 |
| | Greenland | Tons | 28,540 | 13,580 | 7,540 |
| | Other fishing nations | Tons | 19,322 | 9,194 | 5,105 |
| | **Coastal harvest** | Tons | 13,267 | 18,632 | 19,540 |
| | **Stock size** | Tons | 276,807 | 267,817 | 266,639 |
| | **Shadow price** | Million DKK | 0.0029 | 0.0035 | 0.0036 |
| | **High sea profit** | Million DKK | 143.14 | 122.28 | 118.49 |
| | **Coastal profit** | Million DKK | 118.37 | 162.58 | 169.93 |
| | **Land-based profit** | Million DKK | -28.77 | 24.93 | 38.20 |

### C.4. Scenario 4

The results of the sensitivity analyses in scenario 4 are reported in tables C12–C16. From tables C12–C16, we obtain the following numerical comparative static results:

A. An increase (decrease) in the high sea carrying capacity and intrinsic growth rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal high sea stock size; (4) Decrease (increase) the optimal coastal stock size; (5) Increase (decrease) the optimal land-based profit.
B. An increase (decrease) in the coastal carrying capacity and intrinsic growth rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Increase (decrease) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal coastal seas stock size; (4) Decrease (increase) the optimal high sea stock size; (5) Increase (decrease) the optimal land-based profit.
C. An increase (decrease) in the scaling factor for other fishing nations will: (1) Increase (decrease) the optimal high sea harvest; (2) Decrease (increase) the optimal high sea profit; (3) Decrease (increase) the optimal coastal harvest and profit; (4) Decrease (increase) the optimal high sea stock size; (5) Decrease (increase) the optimal coastal stock size; (6) Decrease (increase) the optimal land-based profit.
D. An increase (decrease) in the migration parameter will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal high sea stock size; (3) Increase (decrease) the optimal coastal harvest and profit; (4) Increase (decrease) the optimal coastal stock size; (5) Increase (decrease) the optimal land-based profit.
E. An increase (decrease) in the high sea cost parameter and a decrease (increase) in the high sea price will: (1) Decrease (increase) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal coastal stock size; (3) Increase (decrease) the optimal coastal harvest

and profit; (4) Increase (decrease) the optimal high sea stock size; (5) Increase (decrease) the optimal land-based profit.

F. An increase (decrease) in the coastal cost parameter and a decrease (increase) in the coastal price will: (1) Decrease (increase) the optimal coastal harvest and profit; (2) Decrease (increase) the optimal high sea stock size; (3) Increase (decrease) the optimal high sea harvest and profit; (4) Increase (decrease) the optimal coastal stock size; (5) Decrease (increase) the optimal land-based profit.

G. An increase (decrease) in the land-based cost parameter, a decrease (increase) in the land-based price, and an increase (decrease) in the land-based utilization rate will: (1) Increase (decrease) the optimal high sea harvest and profit; (2) Decrease (increase) the optimal coastal harvest and profit; (3) Increase (decrease) the optimal high sea stock size; (4) Increase (decrease) the optimal coastal stock size; (5) Decrease (increase) the optimal land-based profit.

Based on the theoretical model, these numerical comparative static results correspond to the expectations. Concerning the robustness of our results, we have the following:

A. In the benchmark case, the optimal high sea harvest and profit are higher than the optimal coastal harvest and profit. From tables C12–C16, this result does not hold for the lower bound for the high sea carrying capacity, the upper bound for the coastal carrying capacity, the lower bound of the high sea price, and the upper bound for the coastal price.

**Table C12.** Sensitivity analyses for the parameters in the high sea resource restriction, scenario 4

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **High sea carrying capacity** | **High sea harvest** | Tons | 10,600 | 17,393 | 34,702 |
| | Greenland | Tons | 6,917 | 10,371 | 20,693 |
| | Other fishing nations | Tons | 4,683 | 7,021 | 14,009 |
| | **Coastal Harvest** | Tons | 7,067 | 7,395 | 8,338 |
| | **High sea profit** | Million DKK | 57.54 | 86.30 | 172.33 |
| | **Coastal profit** | Million DKK | 58.66 | 61.02 | 67.78 |
| | **Land-based profit** | Million DKK | 37.44 | 39.52 | 42.57 |
| | **High sea stock size** | Tons | 62,699 | 94,114 | 188,415 |
| | **High sea shadow price** | Million DKK | 0.0037 | 0.0036 | 0.0034 |
| | **Coastal stock size** | Tons | 22,851 | 22,805 | 23,150 |
| | **Coastal shadow price** | Million DKK | 0.0094 | 0.0087 | 0.0066 |
| | **Migration** | Tons | 650 | 978 | 1,929 |
| **High sea intrinsic growth rate** | **High sea harvest** | Tons | 8,558 | 17,393 | 24,919 |
| | Greenland | Tons | 5,103 | 10,371 | 14,859 |
| | Other fishing nations | Tons | 3,455 | 7,021 | 10,069 |
| | **Coastal Harvest** | Tons | 7,311 | 7,395 | 7,490 |
| | **High sea profit** | Million DKK | 48.76 | 86.30 | 111.30 |
| | **Coastal profit** | Million DKK | 37.17 | 61.02 | 61.66 |
| | **Land-based profit** | Million DKK | 37.75 | 39.52 | 41.03 |
| | **High sea stock size** | Tons | 86,596 | 94,114 | 103,453 |
| | **High sea shadow price** | Million DKK | 0.0052 | 0.0036 | 0.0025 |
| | **Coastal stock size** | Tons | 22,920 | 22,805 | 22,712 |
| | **Coastal shadow price** | Million DKK | 0.0094 | 0.0087 | 0.0080 |
| | **Migration** | Tons | 895 | 978 | 1,080 |

| | | | | | |
|---|---|---|---|---|---|
| **Scaling factor, other nations** | **High sea harvest** | Tons | 16,862 | 17,393 | 17,860 |
| | Greenland | Tons | 12,598 | 10,371 | 8,691 |
| | Other fishing nations | Tons | 4,264 | 7,021 | 9,169 |
| | **Coastal Harvest** | Tons | 7,428 | 7,395 | 7,375 |
| | **High sea profit** | Million DKK | 99.20 | 86.30 | 75.55 |
| | **Coastal profit** | Million DKK | 61.28 | 61.02 | 60.84 |
| | **Land-based profit** | Million DKK | 40.31 | 39.52 | 39.03 |
| | **High sea stock size** | Tons | 97,805 | 94,114 | 91,748 |
| | **High sea shadow price** | Million DKK | 0.0038 | 0.0036 | 0.0034 |
| | **Coastal stock size** | Tons | 22,892 | 22,805 | 22,726 |
| | **Coastal shadow price** | Mill, DKK | 0.0084 | 0.0087 | 0.0089 |
| | **Migration** | Tons | 1,013 | 978 | 957 |
| **Migration** | **High sea harvest** | Tons | 17,842 | 17,393 | 16,899 |
| | Greenland | Tons | 10,669 | 10,371 | 10,077 |
| | Other fishing nations | Tons | 7,243 | 7,021 | 6,822 |
| | **Coastal Harvest** | Tons | 6,899 | 7,395 | 7,892 |
| | **High sea profit** | Million DKK | 87.96 | 86.30 | 84.60 |
| | **Coastal profit** | Million DKK | 57.48 | 61.02 | 64.49 |
| | **Land-based profit** | Million DKK | 38.69 | 39.52 | 40.24 |
| | **High sea stock size** | Tons | 94,068 | 94,114 | 94,052 |
| | **High sea shadow price** | Million DKK | 0.0036 | 0.0036 | 0.0037 |
| | **Coastal stock size** | Tons | 22,988 | 22,805 | 22,696 |
| | **Coastal shadow price** | Million DKK | 0.0090 | 0.0087 | 0.0083 |
| | **Migration** | Tons | 485 | 978 | 1,455 |

**Table C13.** Sensitivity analyses for the parameters in the coastal resource restriction, scenario 4

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Coastal carrying capacity** | **High sea harvest** | Tons | 16,879 | 17,393 | 17,810 |
| | Greenland | Tons | 10,065 | 10,371 | 10,620 |
| | Other fishing nations | Tons | 6,814 | 7,021 | 7,190 |
| | **Coastal Harvest** | Tons | 5,790 | 7,395 | 13,259 |
| | **High sea profit** | Million DKK | 84.43 | 86.30 | 87.97 |
| | **Coastal profit** | Million DKK | 46.43 | 61.02 | 111.40 |
| | **Land-based profit** | Million DKK | 35.85 | 39.52 | 41.82 |
| | **High sea stock size** | Tons | 93,910 | 94,114 | 95,010 |
| | **High sea shadow price** | Million DKK | 0.0038 | 0.0036 | 0.0031 |
| | **Coastal stock size** | Tons | 14,758 | 22,805 | 47,407 |
| | **Coastal shadow price** | Million DKK | 0.0091 | 0.0087 | 0.0060 |
| | **Migration** | Tons | 1,508 | 978 | 475 |
| **Coastal intrinsic growth rate** | **High sea harvest** | Tons | 17,280 | 17,393 | 17,478 |
| | Greenland | Tons | 10,304 | 10,371 | 10,422 |
| | Other fishing nations | Tons | 6,976 | 7,021 | 7,056 |
| | **Coastal Harvest** | Tons | 4,279 | 7,395 | 10,469 |
| | **High sea profit** | Million DKK | 85.94 | 86.30 | 86.50 |
| | **Coastal profit** | Million DKK | 36.99 | 61.02 | 82.57 |
| | **Land-based profit** | Million DKK | 31.48 | 39.52 | 42.59 |
| | **High sea stock size** | Tons | 94,167 | 94,114 | 94,172 |
| | **High sea shadow price** | Million DKK | 0.0039 | 0.0036 | 0.0034 |
| | **Coastal stock size** | Tons | 20,586 | 22,805 | 24,257 |
| | **Coastal shadow price** | Million DKK | 0.01 | 0.0087 | 0.0064 |
| | **Migration** | Tons | 1,084 | 978 | 920 |

| | | | | | |
|---|---|---|---|---|---|
| **Migration** | **High sea harvest** | Tons | 17,892 | 17,393 | 16,899 |
| | Greenland | Tons | 10,669 | 10,371 | 10,077 |
| | Other fishing nations | Tons | 7,223 | 7,021 | 6,822 |
| | **Coastal Harvest** | Tons | 6,899 | 7,395 | 7,892 |
| | **High sea profit** | Million DKK | 87.96 | 86.30 | 84.60 |
| | **Coastal profit** | Million DKK | 57.48 | 61.02 | 64.49 |
| | **Land-based profit** | Million DKK | 38.69 | 39.52 | 40.24 |
| | **High sea stock size** | Tons | 94,068 | 94,114 | 94,052 |
| | **High sea shadow price** | Million DKK | 0.0036 | 0.0036 | 0.0037 |
| | **Coastal stock size** | Tons | 22,988 | 22,805 | 22,696 |
| | **Coastal shadow price** | Million DKK | 0.0090 | 0.0087 | 0.0083 |
| | **Migration** | Tons | 485 | 978 | 1,455 |

**Table C14.** Sensitivity analyses for the high sea economic parameters, scenario 4

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **High sea cost parameter** | **High sea harvest** | Tons | 18,055 | 17,393 | 16,322 |
| | Greenland | Tons | 10,766 | 10,371 | 9,733 |
| | Other fishing nations | Tons | 7,289 | 7,021 | 6,589 |
| | **Coastal Harvest** | Tons | 7,297 | 7,395 | 7,493 |
| | **High sea profit** | Million DKK | 101.91 | 86.30 | 73.93 |
| | **Coastal profit** | Million DKK | 60.40 | 61.02 | 61.63 |
| | **Land-based profit** | Million DKK | 39.48 | 39.52 | 39.56 |
| | **High sea stock size** | Tons | 86,039 | 94,114 | 102,819 |
| | **High sea shadow price** | Million DKK | 0.0050 | 0.0036 | 0.0027 |
| | **Coastal stock size** | Tons | 23,050 | 22,805 | 22,584 |
| | **Coastal shadow price** | Million DKK | 0.0087 | 0.0087 | 0.0086 |
| | **Migration** | Tons | 884 | 978 | 1,079 |
| **High sea price** | **High sea harvest** | Tons | 14,864 | 17,393 | 17,858 |
| | Greenland | Tons | 8,864 | 10,371 | 10,649 |
| | Other fishing nations | Tons | 6,001 | 7,021 | 7,209 |
| | **Coastal Harvest** | Tons | 7,598 | 7,395 | 7,302 |
| | **High sea profit** | Million DKK | 31.52 | 86.30 | 144.84 |
| | **Coastal profit** | Million DKK | 62.22 | 61.02 | 60.51 |
| | **Land-based profit** | Million DKK | 39.34 | 39.52 | 39.64 |
| | **High sea stock size** | Tons | 112,346 | 94,114 | 87,988 |
| | **High sea shadow price** | Million DKK | 0.0012 | 0.0036 | 0.0087 |
| | **Coastal stock size** | Tons | 22,201 | 22,805 | 23,282 |
| | **Coastal shadow price** | Million DKK | 0.0086 | 0.0087 | 0.0087 |
| | **Migration** | Tons | 1,199 | 978 | 896 |

**Table C15.** Sensitivity analyses for the coastal economic parameters, scenario 4

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Coastal cost parameter** | **High sea harvest** | Tons | 17,317 | 17,393 | 17,459 |
| | Greenland | Tons | 10,326 | 10,371 | 10,411 |
| | Other fishing nations | Tons | 6,991 | 7,021 | 7,048 |
| | **Coastal Harvest** | Tons | 7,445 | 7,395 | 7,325 |
| | **High sea profit** | Million DKK | 86.13 | 86.30 | 86.45 |
| | **Coastal profit** | Million DKK | 65.30 | 61.02 | 57.00 |
| | **Land-based profit** | Million DKK | 39.55 | 39.52 | 39.41 |
| | **High sea stock size** | Tons | 94,416 | 94,114 | 93,859 |
| | **High sea shadow price** | Million DKK | 0.0037 | 0.0036 | 0.0036 |
| | **Coastal stock size** | Tons | 21,845 | 22,805 | 23,766 |
| | **Coastal shadow price** | Million DKK | 0.0097 | 0.0087 | 0.0078 |
| | **Migration** | Tons | 1,024 | 978 | 936 |
| **Coastal price** | **High sea harvest** | Tons | 17,582 | 17,393 | 17,213 |
| | Greenland | Tons | 10,484 | 10,371 | 10,264 |
| | Other fishing nations | Tons | 7,098 | 7,021 | 6,949 |
| | **Coastal Harvest** | Tons | 7,242 | 7,395 | 7,449 |
| | **High sea profit** | Million DKK | 86.59 | 86.30 | 86.06 |
| | **Coastal profit** | Million DKK | 26.66 | 61.02 | 95.96 |
| | **Land-based profit** | Million DKK | 39.28 | 39.52 | 39.57 |
| | **High sea stock size** | Tons | 92,949 | 94,114 | 95,415 |
| | **High sea shadow price** | Million DKK | 0.0036 | 0.0036 | 0.0037 |
| | **Coastal stock size** | Tons | 24,597 | 22,805 | 22,019 |
| | **Coastal shadow price** | Mill, DKK | 0.0043 | 0.0087 | 0.0013 |
| | **Migration** | Tons | 934 | 978 | 1,027 |

**Table C16.** Sensitivity analyses for the land based economic parameters, scenario 4

| Parameter | Indicator | Measurement unit | Lower bound | Benchmark | Upper bound |
|---|---|---|---|---|---|
| **Land-based cost parameter** | **High sea harvest** | Tons | 17,374 | 17,393 | 17,421 |
| | Greenland | Tons | 10,381 | 10,371 | 10,360 |
| | Other fishing nations | Tons | 7,028 | 7,021 | 7,014 |
| | **Coastal Harvest** | Tons | 7,415 | 7,395 | 7,346 |
| | **High sea profit** | Million DKK | 86.26 | 86.30 | 86.38 |
| | **Coastal profit** | Million DKK | 61.00 | 61.02 | 60.93 |
| | **Land-based profit** | Million DKK | 50.99 | 39.52 | 26.65 |
| | **High sea stock size** | Tons | 93,712 | 94,114 | 94,598 |
| | **High sea shadow price** | Million DKK | 0.0040 | 0.0036 | 0.0032 |
| | **Coastal stock size** | Tons | 22,371 | 22,805 | 23,606 |
| | **Coastal shadow price** | Million DKK | 0.0011 | 0.0087 | 0.0059 |
| | **Migration** | Tons | 993 | 978 | 976 |
| **Land-based price** | **High sea harvest** | Tons | 17,414 | 17,393 | 17,344 |
| | Greenland | Tons | 10,359 | 10,371 | 10,384 |
| | Other fishing nations | Tons | 7,013 | 7,021 | 7,030 |
| | **Coastal Harvest** | Tons | 7,333 | 7,395 | 7,419 |
| | **High sea profit** | Million DKK | 86.39 | 86.30 | 86.25 |
| | **Coastal profit** | Million DKK | 60.90 | 61.02 | 61.99 |
| | **Land-based profit** | Million DKK | 7.68 | 39.52 | 70.84 |
| | **High sea stock size** | Tons | 94,682 | 94,114 | 93,680 |
| | **High sea shadow price** | Million DKK | 0.0032 | 0.0036 | 0.0041 |
| | **Coastal stock size** | Tons | 23,772 | 22,805 | 22,277 |
| | **Coastal shadow price** | Million DKK | 0.0055 | 0.0087 | 0.012 |
| | **Migration** | Tons | 944 | 978 | 997 |

| | | | | | |
|---|---|---|---|---|---|
| **Land-based utilization rate** | **High sea harvest** | Tons | 17,397 | 17,393 | 17,359 |
| | Greenland | Tons | 10,359 | 10,371 | 10,374 |
| | Other fishing nations | Tons | 7,013 | 7,021 | 7,023 |
| | **Coastal Harvest** | Tons | 7,333 | 7,395 | 7,401 |
| | **High sea profit** | Million DKK | 86.40 | 86.30 | 86.29 |
| | **Coastal profit** | Million DKK | 60.61 | 61.02 | 61.02 |
| | **Land-based profit** | Million DKK | 8.51 | 39.52 | 44.94 |
| | **High sea stock size** | Tons | 94,682 | 94,114 | 94,031 |
| | **High sea shadow price** | Million DKK | 0.0032 | 0.0036 | 0.0037 |
| | **Coastal stock size** | Tons | 23,772 | 22,805 | 22,691 |
| | **Coastal shadow price** | Million DKK | 0.0055 | 0.0087 | 0.0092 |
| | **Migration** | Tons | 944 | 978 | 982 |