

Supplementary Appendix S2 - Description of background for input values to Ecopath models

Overview

The supplement give an overview of the sources and methods used to derive the initial input values for all groups in the Ecopath models for year 2000 and 1950

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Initial values to models for year 2000 and 1950

Values given in the tables S1-1 to S1-108 were used as initial values for the parametrization of the Ecopath models for year 2000 and year 1950. If values are not assigned to a specific year, the same values were used as initial values in the year 2000 and year 1950-models. If values for year 2000 and not for 1950, the same value was used in 1950 as in year 2000. During balancing of the Ecopath model, these values may be modified.

Carbon-wet weight ratio (C/WW)

The C/WW-ratio will affect the biomass values in carbon (B) when biomass is calculated from average wet body mass and abundance, as is common for upper trophic level organisms. The values of C/WW-ratios will also affect the value of the consumption-biomass (Q/B) ratio since Q/B is calculated as consumption in carbon units divided by predator body mass in carbon. Body mass in carbon is calculated as the product of average wet body mass and C/WW. When consumption in carbon-units is calculated in the Ecopath model as: $Q = B \cdot (Q/B)$, the effect of the value of predator C/WW is canceled out.

The carbon-based (Q/B) can be converted to a wet mass-based (Q/B)_w using the equation:

$$(Q/B)_w = (Q/B) * (C/WW)_{pred} / (C/WW)_{prey},$$

where (C/WW)_{prey} and (C/WW)_{pred} are the carbon wet weight ratios for the prey and predator, respectively. For example, a harp seal of 100 kg WW has a (C/WW)_{pred} of 0.37 and a carbon biomass of 37 kg. It has a carbon-based (Q/B) of 4.8 year⁻¹ and a wet mass-based (Q/B)_w of 14.8 year⁻¹ given a (C/WW)_{prey} of 0.12.

Mammal groups

Arctic marine mammals contain much blubber and energy-rich fat. Generally, there is a large inter-annual variability in blubber thickness and carbon-wet mass ratio (C/WW) for many mammals. C/WW-ratios of these mammals may be high compared to fish and most invertebrates that may be prey.

1 Polar bear

Abundance was estimated to 2650 individuals from a mostly helicopter-based survey in 2004 Aars et al. (2009). Recent estimates from 2015 of abundance for the western part of the Barents Sea showed no significant change despite loss of ice-habitat (Aars et al. 2017). Polar bear was exploited until 1973, and in the period 1945-1970, between 150 and 500 individuals were taken each year (Larsen 1986). After 1973, very low numbers (< 10 ind.) have been killed each year. Average body mass (BM (kg ww)) was calculated as average of male and female asymptotic body mass from Svalbard (Table SM2-1)(Derocher & Wiig 2002).

P/B was computed as Z (total mortality rate) from numbers at age data using the Chapman-Robson catch-curve method, and values varied from 0.19 year⁻¹ in the period 1954-1977 to 0.10 year⁻¹ in the period 1977-1982 (Larsen 1986). For the period 1988-1993, mortality rate of females was estimated to 0.04 year⁻¹ (Wiig 1998). The value of 0.10 year⁻¹ was used in the model for year 2000. The model Q/B was the average (Q/B = 5.63 year⁻¹) of values from two studies; a rather low Q/B-value of 3.3 year⁻¹ based on energetic requirements (Stirling & Øritsland 1995), calculated from the Kleiber equation (Kleiber 1961), and a higher value of 8.0 year⁻¹ based on field measurements (Pagano et al. 2018).

The diet is mainly comprised of seals with bearded, ring and harp seals dominating (Lønø 1970, Derocher et al. 2002), but walrus, reindeer, seabirds, carcasses, and terrestrial food is also common (Lønø 1970, Stempniewicz 1993, Iversen et al. 2013). Unassimilated consumption (UC) for ring seal prey has been estimated to 0.092 (Best 1985).

| Table S2-1 Polar bear | | | | | |
|--|-------------------------|---------|-------------|---|---|
| Variable | Value (95% CI) | | Time-period | Comments | Reference |
| Months present | 12 | Pe. | | | |
| Abundance | 2650 (1900, 3600) | 5 (32) | 2004 | Whole Barents Sea | (Aars et al. 2009) |
| | 973 (665, 1884) | 5 (63) | 2015 | Western part only | (Aars et al. 2017) |
| Bm (kg ww) | 287 | | | From asymptotic mass, average of female and male | (Derocher & Wiig 2002) |
| C/WW | 0.35 | | | Calculated from average adult male and female of 16 MJ/kg | (Molnár et al. 2009) |
| P/B (year ⁻¹) | 0.192 (0.167, 0.218) | 8 (13) | 1954-1970 | Age-distribution, catch-curve | (Larsen 1986) |
| | 0.099 (0.045, 0.155) | 5* (56) | 1977-1982 | Age-distribution, catch-curve | (Larsen 1986) |
| | 0.04 | | 1988-1993 | Age 2-15 | (Wiig 1998) |
| | 0.192 | 8 (13) | 1950 | As for 1954-1970 | |
| | 0.099 | 5 (56) | 2000 | As for 1977-82 | |
| Q/B (year ⁻¹) | 5.63 | 4 | | Average of Q/B from two studies | (Stirling & Øritsland 1995) (Pagano et al. 2018) |
| UC | 0.092 (0.020, 0.164) | | | | (Best 1985) |
| Catch | | 6 | 1871-2019 | | http://www.mosj.no/no/pavikt-fangst/uttak-isbjorn.html |
| Diet (Pe. = 5) 1964-1965, Edgeøya, Svalbard, n = 77 stomachs (Lønø 1970), 1984-2001, Svalbard, n = 135 observation of kills (Derocher et al. 2002) 2003-2010, Svalbard, n = 119 scats (Iversen et al. 2013) 1992, Franz Josef land, visual obs. in little auk colonies (Stempniewicz 1993) | | | | | |

Baleen whales

Unless otherwise stated, a value for unassimilated consumption (UC) of 0.08 measured for minke whale (Mårtensson et al. 1994) has been used for baleen whales. Values for P/B for several groups have been taken from modeled estimates of annual non-calf survival rates (Taylor et al. 2007). There was sparse information regarding values for C/WW in the literature, but for Fin whale, a C/WW of 0.25 could be calculated based on Víkingsson (1995). However, since values were not found for other whale species, we assumed a common C/WW of 0.15 for all whale baleen whale groups in the calculations.

2 Minke whale

Minke whales are seasonal migrants and are present during summer in the Barents Sea for about six months. Abundance has been estimated by sighting surveys about every 5th year since 1989, and estimates for the Barents Sea has ranged from 48000 to 81400 without any clear trend over time, and the variability between estimates may reflect varying numbers of animals migrating into the Barents Sea (Skaug et al. 2004). Minke whales have been exploited since around 1930 and have persisted except for the period of 1987-1992 when whaling was banned.

Average body mass (WW) was calculated to 4304 kg WW from measured proportions of immature and mature and their average body masses (immatures: 76%, 3800 kg; adults: 24%, 5900 kg) (Folkow et al. 2000).

A P/B-value of 0.040 year⁻¹ was computed from model estimates on non-calf survival rate by (Taylor et al. 2007)(Table S2-2). A Q/B of 6.8 year⁻¹ was calculated from modelled consumption (Folkow et al. 2000), and the proportion of unassimilated food (UC = 0.08) was estimated as the average for the major prey types herring, capelin and krill (Mårtensson et al. 1994). Minke whale feed on a number of fish species; herring, capelin, cod, haddock, saithe, sandeel and krill (Bogstad et al. 2015), and diet proportions were estimated from stomachs sampled from harvested animals. The model diet was comprised of capelin, large and small herring, *Thysanoessa*, Large krill, Northeast Arctic cod, saithe, haddock, other small gadoids, polar cod and sandeel.

| Table S2-2 Minke whale | | | | | |
|---|--------------------------|--------|-------------|--|---------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | | Ulf Lindstrøm, IMR, pers. Comm. |
| Abundance | 48082 (33083, 63081) | 5 (31) | 1989 | Area match quite well | (Bøthun et al. 2009) |
| | 82299 (65910, 98688) | 8 (20) | 1995 | | |
| | 62009 (46024, 77994) | 6 (26) | 1996-2001 | | |
| | 67377 (22908, 111846) | 5*(66) | 2002-2007 | | |
| | 47294 (CV = 0.20) | 5(39) | 2008-2013 | | (Solvang et al. 2015) |
| Bm (kg ww) | 4520 | | | | (Folkow et al. 2000) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.040 | 7 | | From modelled annual noncalf survival rate | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 6.8 | 4 | | Calculated from Folkow. | (Folkow et al. 2000) |
| UC | 0.08 | | | Av. For krill, herring and capelin | (Mårtensson et al. 1994) |
| Catch (ind.) | | 8 | | 1970-2009 | (Johannesen et al. 2012a) |
| Diet (Pe. = 6) | | | | | |
| 1992-1999, Barents Sea, May-August, n = 289 st., Wp (Haug et al. 2002) | | | | | |
| 2000-2004, Barents Sea, May-June, n = 163 st., Wp (Windsland et al. 2007) | | | | | |
| 2010-2011, Bearents Sea, Norw. Coast, n = 47 st., Wp (Meier et al. 2016) | | | | | |

3 Fin whale

Fin whales are present in the Barents Sea with higher abundances during summer (Christensen et al. 1992b, Kovacs et al. 2009), and were assumed to be present in the Barents Sea for six months. Abundance was estimated during 1995-2001 by sighting surveys to about 1800-2900 animals in the Barents Sea (Table S2-3). Fin whales were exploited from the late part of the 1800s when large baleen whales and sperm whales were shot at sea and towed to land stations for processing. The catches declined from 1950 and ended in 1971 (Christensen et al. 1992b), but precise catch statistics for the Barents Sea were not found. A value of 42279 kg WW has been assumed for average body mass (Sigurjonsson & Vikingsson 1997).

P/B was assumed to be 0.04 year⁻¹ (Table S2-3). Q/B was computed to 4.55 year⁻¹. Fin whales feed mainly on krill and fish, and according to (Pauly et al. 1998), zooplankton and fish on average comprise 80 and 20% of the diet on weight basis, while Sigurjonsson and Vikingsson (1997) gave weight proportions of 0.97 and 0.03 for zooplankton and fish in Icelandic waters. In Icelandic waters, the whales were caught west of Iceland and fed predominantly on the large krill (*Meganyctiphanes norvegicus*) (Vikingsson 1997). In the Barents Sea, fish may be more important than in Iceland (Jonsgård 1966, Christensen 1988, Christensen et al. 1992a). Based on spatial distributions of whales and prey when capelin abundance was low during 2003-2007, Skern-Mauritzen et al. (2011) suggested that krill was a primary prey in the Barents Sea. In the model, it was assumed that 20% of the diet was comprised of fish with capelin and herring as the main fish prey and with large krill as the main zooplankton prey.

| Table S2-3 Fin whale | | | | | |
|---|------------------|-----|-------------|--|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | Seasonal migrant | (Kovacs et al. 2009) |
| Abundance | 2875 | 5 | 1995 | Barents Sea | (Øien 2009) |
| | 1796 | 5 | 1996-2001 | Barents Sea | |
| | 4962 (CV = 0.22) | 5 | 2002-2007 | Barents Sea | (Leonard & Øien 2020a) |
| | 4120 (CV = 0.30) | 5 | 2008-2013 | Barents Sea | |
| | 2176 (CV = 0.27) | 5 | 2014-2018 | Barents Sea | (Leonard & Øien 2020b) |
| Bm (kg ww) | 42279 | | | From Iceland | (Sigurjonsson & Vikingsson 1997) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.04 | 4 | | From modelled annual noncalf survival rate | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 4.55 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.08 | | | Same as for minke whale | |
| Catch | | 6 | | | (Christensen et al. 1992b) |
| Diet (Pe. = 4) | | | | | |
| 1952-1953, Barents Sea, n = 93, st., Foc., also feeding review (Jonsgård 1966) | | | | | |
| Review, Norwegian and Barents Sea (Christensen et al. 1992a, b) | | | | | |
| Review of studies outside the Barents Sea (Pauly et al. 1998) | | | | | |
| 2003-2007, Barents Sea, feeding inferred from predator-prey distributions (Skern-Mauritzen et al. 2011) | | | | | |

4 Blue whale

Blue whale is a seasonal migrant visiting the Barents Sea during summer (Kovacs et al. 2009), and their abundance is low and highly uncertain (Pike et al. 2009), and our guesstimate of 200 animals have been used in the model. Recently (2015), blue whales have been observed west and north of Svalbard (Vacquié-Garcia et al. 2017). Blue whales were exploited from the last part of the 1880'ies and the blue whale in the North Atlantic was protected in 1955 (Christensen et al. 1992b).

Body mass has been set to 69235 kg (Sigurjonsson & Vikingsson 1997), and a P/B-value of 0.025 year^{-1} is used (Ramp et al. 2006). Q/B was set to 4.09 year^{-1} (Sigurjonsson & Vikingsson 1997). Blue whales are pure plankton (krill) feeders that feed mainly on small krill (*Thyssanoessa* sp.) (Christensen et al. 1992a).

| Table S2-4 Blue whale | | | | | |
|--|-------|-----|-------------|-------------------------|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | Seasonal migrants | (Kovacs et al. 2009) |
| Abundance | 200 | 3 | 2015 | Guesstimate | (Pike et al. 2009, Vacquié-Garcia et al. 2017) |
| Bm (kg ww) | 69235 | | | Iceland | (Sigurjonsson & Vikingsson 1997) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year^{-1}) | 0.025 | 5 | | Gulf of St Lawrence | (Ramp et al. 2006) |
| Q/B (year^{-1}) | 4.09 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.08 | | | Same as for minke whale | |
| Catch | | | | | (Christensen et al. 1992b) |
| Diet (Pe. = 3) Review, Norwegian and Barents Sea (Christensen et al. 1992a) and (Christensen et al. 1992b) Review of studies outside the Barents Sea (Pauly et al. 1998) | | | | | |

5 Bowhead

Bowhead has been observed north of and around Svalbard, and there is a few observations in the central and southern Barents Sea (Wiig et al. 2010b). Bowhead was exploited in the Northeast Atlantic from around the year 1600, and the East-Greenland-Spitsbergen stock was depleted to a very low level around the year 1900 when hunting on the species stopped (Allen & Keay 2006). Back-calculated population size at the commence of the hunting on the species range from 25 000 to 52 500 individuals (Weslawski et al. 2000a, Allen & Keay 2006). Numbers present in the Barents Sea has been assumed to in the orders of tens (Wiig et al. 2010a, Wiig et al. 2010b). Recently (2015), the abundance north of Svalbard was estimated to about 350 individuals, and there are signs of increasing abundance (Vacquié-Garcia et al. 2017). Average body mass in the population was calculated to 43440 kg based on proportions and body masses of calves, immatures and adults (Weslawski et al. 2000a).

Values for Q/B of 5.26 year⁻¹ (Whitehouse et al. 2014) and 6.04 year⁻¹ (Laidre et al. 2007) are given in the literature, and the mean of these (Q/B of 5.5 year⁻¹) was used in the models (Table S2-5). Bowhead feed on zooplankton, and large calanoid copepods (*C. glacialis*, *C. hyperboreus*), and small krill (*Thysanoessa* sp.) are food sources in other areas (Lowry et al. 2004, Laidre et al. 2007). Pteropods are assumed to be prey at Svalbard (Weslawski et al. 2000a). In our model for the Barents Sea, including Svalbard, large calanoid copepods were assumed to be the main prey, with some feeding on small krill and pteropods.

| Table S2-5 Bowhead | | | | | |
|--|-------------------|----|-------------|-------------------------|--|
| Variable | Value | Pe | Time period | Comments | Reference |
| Months present | 12 | | | | (Kovacs et al. 2009) |
| Abundance | 343 (140, 860) | 5 | 2015 | Survey around Svalbard | (Vacquié-Garcia et al. 2017) |
| Bm (kg ww) | 43440 | | | | (Weslawski et al. 2000a) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.01 | 5 | | Chucki Sea | (Whitehouse et al. 2014) |
| Q/B (year ⁻¹) | 5.5 | 4 | | | (Laidre et al. 2007, Whitehouse et al. 2014) |
| UC | 0.08 | | | Same as for minke whale | |
| Catch | | | | | (Allen & Keay 2006) |
| Diet (Pe. = 3) | | | | | |
| Review, Barents Sea and other areas (Christensen et al. 1992a) | | | | | |
| Barents Sea, review of older studies (Weslawski et al. 2000a) | | | | | |
| 1969-2000, Alaskan Beaufort Sea, n = 242 st., Wp (Lowry et al. 2004) | | | | | |
| 2001-2006, West-Greenland, n = 30 whales with satellite transmitters, feeding inferred from predator-prey distributions (Laidre et al. 2007) | | | | | |

6 Humpback whale

Humpbacks are seasonal migrants using the Barents sea as feeding areas during summer (Kovacs et al. 2009). Humpbacks have been exploited in Norwegian waters since 1881. From beginning of harvesting and until 1904 about 1500 individuals were taken (Christensen et al. 1992b). From 1904 to 1955 less than 50 animals were taken and humpbacks were protected in 1955 (*ibid.*). The abundance estimated from sighting surveys from the mid 1990's amounts to about 700 animals (Øien 2009), and the abundance has been increasing in recent years (Kovacs et al. 2009). The biomass value for the year 2000 model was based on 713 animals (Table S2-6).

Body mass is about 30 000 kg, and a P/B-value of 0.04 year⁻¹ and a Q/B of 4.85 year⁻¹ were used (Table S2-6). Humpback feeds on krill (*Thysanoessa* sp.) during spring and early summer, and later in summer they feed on capelin in the Barents Sea (Christensen et al. 1992a). During 2012-2016, humpbacks also consumed herring during autumn at the herring overwintering grounds in the fjords and outside Troms, Northern Norway (T. Pedersen, UiT, pers. comm.)

| Table S2-6 Humpback whale | | | | | |
|---|------------------|--------|-------------|-------------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | Seasonal migrant | (Kovacs et al. 2009) |
| Abundance | 772 (CV ~ 0.25) | 5 (50) | 1995 | Barents Sea | Øien (2009) |
| | 713 | 5 | 1996-2001 | Barents Sea | |
| | 6278 (CV = 0.37) | 5 | 2002-2007 | Barents Sea | (Leonard & Øien 2020a) |
| | 8301 (CV = 0.34) | 5 (67) | 2008-2013 | Barents Sea | |
| | 6682 (CV = 0.54) | 5 | 2014-2018 | Barents Sea | (Leonard & Øien 2020b) |
| Bm (kg ww) | 31782 | | | Iceland | (Sigurjonsson & Vikingsson 1997) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.04 | 6 | | Gulf of Maine | (Barlow & Clapham 1997) |
| Q/B (year ⁻¹) | 4.85 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.08 | | | Same as for minke whale | |
| Catch | | 6 | | | (Christensen et al. 1992b) |
| Diet (Pe. = 4) | | | | | |
| Review, Norwegian and Barents Sea (Christensen et al. 1992a, b) | | | | | |
| Review of studies outside the Barents Sea (Pauly et al. 1998) | | | | | |
| 2003-2007, Barents Sea, feeding inferred from predator-prey distributions (Skern-Mauritzen et al. 2011) | | | | | |

Toothed whales

The toothed whales species that are present in the Barents Sea are predominantly feeding on fish and cephalopods (Pauly et al. 1998), and the value for unassimilated consumption (UC) was set to 0.075 based on Lockyer (2007). We assumed a common C/WW of 0.15 for all toothed whale groups in the calculations.

7 White whale

White whales are found in coastal areas in the arctic and ice edge or drift ice (Lydersen et al. 2001, Vacquié-Garcia et al. 2017). A likely number of 10000 animals are present in the Barents Sea (Kovacs et al. 2009). The species has been hunted in the past. From the year 1866 up to the end of whaling around 1960, about 15000 whales were caught (Lydersen et al. 2001). Body mass (1350 kg) was taken as the average adult body mass of males and females (Kovacs et al. 2009).

A P/B-value of 0.05 year⁻¹ was used (Taylor et al. 2007). Q/B was calculated to 9.62 year⁻¹ based on the allometric bioenergetic method b described by Sigurjonsson and Vikingsson (1997). White whales feed on fish and crustaceans and based on feeding behaviour and migrations, stomach and fatty acid analysis (Dahl et al. 2000, Lydersen et al. 2001, Boltunov & Belikov 2002). The model diet was composed of polar cod as major prey with capelin, herring and deep-water shrimp as additional prey.

| Table S2-7 White whale | | | | | |
|---|-------|-----|-------------|-------------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | (Kovacs et al. 2009) |
| Abundance | 10000 | 3 | | | (Kovacs et al. 2009) |
| Bm (kg ww) | 1350 | | | Av. of male and female | (Kovacs et al. 2009) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.05 | 4 | | Model | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 9.62 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.075 | | | Ass. range 0.05 to 0.10 | (Lockyer 2007) |
| Catch | | 6 | | | (Lydersen et al. 2001) |
| Diet (Pe. = 4) | | | | | |
| 1996-1997, Svalbard, n = 9 st., diet inferred from fatty acid analysis (Dahl et al. 2000) | | | | | |
| 1995-1999, Svalbard, diet inferred from distribution studies (Lydersen et al. 2001) | | | | | |
| Barents Sea, review (Boltunov & Belikov 2002) | | | | | |

8 Narwhale

Narwhales are distributed mainly in the north-easter part in open water and pack-ice in the Barents Sea (Kovacs et al. 2009). The population size of narwhales is highly uncertain but has been suggested to be around 1000 individuals (Kovacs et al. 2009), and 837 individuals were estimated from a sighting survey north of Svalbard in 2015 (Vacquié-Garcia et al. 2017).

Very few narwhales have been hunted in the past (Gjertz 1991). Body mass (1300 kg WW) was taken as the average of adult body mass of male and females (Kovacs et al. 2009).

A modelled P/B-value of 0.04 year⁻¹ was used (Taylor et al. 2007). Q/B was calculated to 9.69 year⁻¹ based on the allometric bioenergetic method b described by (Sigurjonsson & Vikingsson 1997). Narwhales are deep-divers and may dive down to more than 500 m depth (Kovacs et al. 2009). Diet investigations from Canadian Arctic (Finley & Gibb 1982), West Greenland (Laidre & Heide-Jørgensen 2005) and East Greenland show that diet is dominated by polar cod, Greenland halibut, redfish and cephalopods. A similar diet was assumed for the Barents Sea and used in the models.

| Table S2-8 Narwhale | | | | | |
|--|-----------------|--------|-------------|------------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | (Kovacs et al. 2009) |
| Abundance | 837 (CV = 0.50) | 5 (98) | 2015 | North of Svalbard | (Vacquié-Garcia et al. 2017) |
| Bm (kg ww) | 1300 | | | Av. of male and female | (Kovacs et al. 2009) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.04 | 4 | | Model | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 9.69 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.075 | | | | (Lockyer 2007) |
| Catch | 0 | 6 | | | |
| Diet (Pe. = 4) | | | | | |
| 1978-1979, Baffin Island area, n = 73 st., Wp (Finley & Gibb 1982) | | | | | |
| East-Greenland, Fram Strait and northern Barents Sea, review (Dietz et al. 1994) | | | | | |
| 1999-2003, Canadian High Arctic and West-Greenland, n = 121 st., Foc (Laidre & Heide-Jørgensen 2005) | | | | | |

9 Dolphins

The group is dominated by white-beaked dolphins (*Lagenorhynchus albirostris*), which are mainly distributed west of Svalbard, and in the southwestern and central part of the Barents Sea (Øien 1996, Fall & Skern-Mauritzen 2014). Some Atlantic white-sided dolphins (*Lagenorhynchus acutus*) may also be present in the Barents Sea LME (Øien 1996). White-beaked dolphins are whole-year residents, and the abundance has been estimated by sighting-surveys to about 60000 individuals in 1989 and 1995 (Øien 1996). The survey abundance of 57949 animals from 1995 was used in the model. Later surveys have given higher abundance estimates (Table S2-9). They have not been exploited to any large extent. Body mass was measured to 225 kg at Iceland (Sigurjonsson & Vikingsson 1997).

P/B was set to a modelled value of 0.051 year⁻¹ (Taylor et al. 2007) (Table S2-9). Q/B was calculated to 14.2 year⁻¹ based on the allometric bioenergetic method b described by (Sigurjonsson & Vikingsson 1997). Diet has been described for Scottish waters and the North Sea (Canning et al. 2008, Jansen et al. 2010) and showed a predominance of gadoid fish. A study of the distribution of white-beaked dolphins and potential prey in the Barents Sea support that gadoid prey may be important (Fall & Skern-Mauritzen 2014). Thus, a similar diet as for the North Sea has been assumed for the Barents Sea. The average composition by weight of the two studies above mentioned has been adjusted to the species composition in the Barents Sea (Table SM2-9). The assumed model diet is comprised by Northeast Arctic cod, haddock, other small gadoids, other small bentivorous fish, capelin, long rough dab and cephalopods.

| Table S2-9 Dolphins | | | | | |
|--|--------------------|---------|-------------|---------------------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | (Kovacs et al. 2009) |
| Abundance (no. individ.) | 62143 (CV = 0.34) | 5*(67) | 1989 | Barents Sea | (Øien 1996) |
| | 57949 (CV = 0.89) | 5*(174) | 1995 | Barents Sea, used in 2000 model | |
| | 128695 (CV = 0.22) | 5* (43) | 2002-2007 | Barents Sea | (Leonard & Øien 2020a) |
| | 112592 (CV = 0.21) | 5 (41) | 2008-2013 | Barents Sea | |
| | 140588 (CV = 0.31) | 5 (61) | 2014-2018 | Barents Sea | (Leonard & Øien 2020b) |
| Bm (kg ww) | 225 | | | Iceland | (Sigurjonsson & Vikingsson 1997) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.051 | 4 | | Model | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 14.2 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.075 | | | | (Lockyer 2007) |
| Diet (Pe. = 3) | | | | | |
| 1907-2003, Great Britain and Ireland, n = 349 stranded animals, Wp (Canning et al. 2008) | | | | | |
| 1968-2005, Dutch coastal waters, n = 45 stranded animals, Wp (Jansen et al. 2010) | | | | | |
| 2003-2009, Barents Sea, diet inferred from predator-prey distributions (Fall & Skern-Mauritzen 2014) | | | | | |

10 Harbour porpoise

Harbor porpoises are distributed mostly in near-coastal waters and the southern and south-eastern Barents Sea (Bjørge et al. 1991). Harbour porpoises are all-year residents, and abundance was estimated to about 11000 individuals in 1989 and 54000 individuals in 2002-2007 (Bjørge et al. 1991), (Leonard & Øien 2020a). Later surveys have given higher abundances (Table S2-10). The abundance within the Barents Sea LME is uncertain (Bjørge et al. 2013), and the value of 54139 individuals was used in the models. Bycatch in gill-net fisheries has been described (Bjørge et al. 2013), but values for the Barents Sea LME were not available. A Body mass of 57.5 kg was taken as an average of male and female adult weight (Kovacs et al. 2009).

Lockyer (2003) gave a P/B-value of 0.133 year^{-1} that was used in the model. Q/B has been estimated to 12.8 year^{-1} (Santos & Pierce 2003). Harbour porpoise feed on small fish, and the diet is based on weight proportions from an analysis of 21 animals from the coastal part of the Barents Sea in the period 1985-1990 (Aarefjord & Bjørge 1995). Small saithe, capelin, herring and blue whiting made up most of the diet.

| Table S2-10 Harbour porpoise | | | | | |
|--|-------------------|--------|-------------|-------------------------------------|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | (Kovacs et al. 2009) |
| Abundance | 10994 (CV = 0.44) | 5 (86) | 1989 | Barents Sea, used in 2000 model | (Bjørge et al. 1991) |
| | 54139 (CV = 0.31) | 5 (61) | 2002-2007 | Barents Sea | (Leonard & Øien 2020a) |
| | 23021 (CV = 0.46) | 5 (90) | 2008-2013 | Barents Sea | |
| | 72983 (CV = 0.36) | 5 (71) | 2014-2018 | Barents Sea | (Leonard & Øien 2020b) |
| Bm (kg ww) | 57.5 | | | Av. of adult male and female weight | (Kovacs et al. 2009) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year^{-1}) | 0.133 | 7 | | North Atlantic | (Lockyer 2003) |
| Q/B (year^{-1}) | 12.78 | 7 | | | (Yasui & Gaskin 1986, Santos & Pierce 2003) |
| UC | 0.075 | | | | (Lockyer 2007) |
| Catch | | 5 | | Bycatch | (Bjørge et al. 2013) |
| Diet (Pe. = 5) 1985-1990, Barents Sea coast, n = 21 st., Wp (Aarefjord & Bjørge 1995) Barents Sea included, review feeding (Bjørge 2003) | | | | | |

11 Killer whale

Killer whales are distributed in the western, southwestern and coastal areas of the Barents Sea (Jonsgård & Lyshoel 1969, Foote et al. 2007). According to (Christensen 1988), a minimum of 1500 killer whales were present in Norwegian waters when Norwegian spring-spawning herring were present during 1987-1992, and the Lofoten area was the only area with a year-round presence. Abundance in the Northeast Atlantic was estimated by sighting surveys, and an average of 15594 animals was estimated from surveys in 1987, 1989, 1995 and 2001 (Foote et al. 2007). Based on distribution maps (Christensen 1988, Foote et al. 2007), it was assumed that the abundance in the Barents Sea amounted to 10% of this value, giving a number of 1559 animals. This value was used in the models. In the Vestfjord area, a total of about 700 animals has been present during the period when the Norwegian Spring spawning herring were overwintering in the area (Kuningas et al. 2014). Killer whales have earlier been exploited (Jonsgård & Lyshoel 1969), and hunting ended in 1981 (Øien 1988). Body mass has been measured to 2350 kg (Christensen 1982).

P/B was calculated 0.029 year^{-1} from natural mark-resighting data in Vestfjorden (Kuningas et al. 2014), and Q/B was set to 8.53 year^{-1} (Sigurjonsson & Vikingsson 1997) (Table S2-11). Herring has been emphasised as the major prey for killer whales in the area (Jonsgård & Lyshoel 1969, Bjørge et al. 1981, Similä et al. 1996), but they also feed on mackerel (*Scomber scombrus*) (Nøttestad et al. 2014), saithe (*Pollachius virens*), eider ducks (*Somateria molissima*), little auk (*Alle alle*), northern fulmar (*Fulmaris glacialis*), harbour and grey seals (*Halichoerus grypus*) (Christensen 1982, Similä et al. 1996, Vongraven & Bisther 2014, Jourdain et al. 2017) and harbour porpoise (*Phoca vitulina*) (Cosentino 2015).

| Table S2-11 Killer whale | | | | | |
|--|-------------------|-----|-------------|--|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 1559 | 3 | 1987-2001 | Assumed 10% of total stock (n = 15594) is in the Barents Sea LME, used in 2000 model | (Foote et al. 2007) |
| | Ca 730 (500,1100) | 5 | 1986-2003 | Only in the Vestfjord area | (Kuningas et al. 2014) |
| Bm (kg ww) | 2350 | | | | (Christensen 1982) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year^{-1}) | 0.029 | 7 | 1986-2003 | Vestfjord, marking data | (Kuningas et al. 2014) |
| Q/B (year^{-1}) | 8.53 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.075 | 5 | | | (Lockyer 2007) |
| Catch (no. ind.) | | 6 | 1938-1968 | Distribution of catches | (Bjørge et al. 1981) (Jonsgård & Lyshoel 1969) |
| Diet (Pe. = 4) 1967, Norwegian Sea, n = 4 st, Wp (Jonsgård & Lyshoel 1969) 1979-1980, Lofoten, Norway, n = 87 st, Foc (Bjørge et al. 1981) 1988-2011, Norwegian Coast, visual observations (Vongraven & Bisther 2014) 1991-1993, Vestfjorden, Norway, visual observations (Similä et al. 1996) 2013-2016, Vesterålen-Troms, Norway, visual and photo obs. (Jourdain et al. 2017) 2006-2007, Norwegian Sea, diet inferred from predator-prey spatial overlap (Nøttestad et al. 2014) 2012, Andenes, Norway, visual obs. (Cosentino 2015) | | | | | |

12 Sperm whale

In the Barents Sea LME area, sperm whales have been distributed outside the shelf along Lofoten and Vesterålen and northwards to Svalbard with a few animals observed north of Svalbard (Øien 2009). The abundance estimates within the Barents Sea LME area were low (ca 300 animals) and with large uncertainty. Sperm whales have been hunted in the Norwegian Sea and the Barents Sea in the period 1880 – 1971 (Christensen et al. 1992b). Body mass was set to 34322 kg based on Icelandic data (Sigurjonsson & Vikingsson 1997).

P/B and Q/B were set to 0.014 and 4.76 year⁻¹, respectively (Table S2-12). Sperm whales are deep divers that can dive to more than 2000 m depth (Christensen et al. 1992b). In Norwegian waters, cephalopods, in particular *Gonatus*, were major prey, but lumpsucker and redfish were also recorded (Christensen et al. 1992b, Bjørke 2001). The model diet composition had 70% cephalopods (Pauly et al. 1998), and the rest was made up of redfish and lumpsucker.

| Table S2-12 Sperm whale | | | | | |
|---|-----------------|---------|-------------|---------------------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | Summer resident | (Kovacs et al. 2009) |
| Abundance | 344 (CV = 0.63) | 5*(123) | 1995 | Barents Sea, used in 2000 model | (Øien 2009) |
| | 156 (CV = 0.75) | 5 | 2002-2007 | Barents Sea | (Leonard & Øien 2020a) |
| | 480 (CV = 0.88) | 5 | 2008-2013 | Barents Sea | |
| | 443 (CV = 0.60) | 5 | 2014-2018 | Barents Sea | (Leonard & Øien 2020b) |
| Bm (kg ww) | 34322 | | | | (Sigurjonsson & Vikingsson 1997) |
| C/WW | 0.15 | | | Assumed | |
| P/B (year ⁻¹) | 0.014 | 4 | | Model | (Taylor et al. 2007) |
| Q/B (year ⁻¹) | 4.76 | 4 | | Method b | (Sigurjonsson & Vikingsson 1997) |
| UC | 0.075 | | | | (Lockyer 2007) |
| Catch | | 6 | | | (Christensen et al. 1992b) |
| Diet (Pe. = 4) | | | | | |
| Norwegian waters, feeding review (Christensen et al. 1992a) | | | | | |
| Review of studies outside the Barents Sea (Pauly et al. 1998) | | | | | |
| Norwegian waters, review of feeding studies (Bjørke 2001) | | | | | |

Seals

The arctic seals (harp seal, ringed seal, bearded seal and walrus) dominate in numbers and biomass, while the coastal seals (harbor seal and grey seal) have lower abundances. The Q/B-values for the seal groups were calculated using literature-derived C/WW-values that were relatively high due to high lipid content compared to other groups. Hence the carbon-based Q/B values were relatively low, but the consumption ($Q = B \cdot (Q/B)$) is the same as if lower predator C/WW-values have been used. Since seals are preyed on by Polar bear, Greenland

sharks and some other predators, the prey carbon production and carbon biomass is better represented using measured C/WW-values.

13 Harp seal

Harp seals seasonally migrate and use most of the Barents Sea as feeding grounds while the breeding is on the ice in the White Sea (Nordøy et al. 2008). Harp seal are the most abundant seal species in the Barents Sea, and the population number of age 1+ amounted to ca. 1.1 mill in 2013 (ICES 2019c). A modelled time-series of abundance is available (ICES 2019c). In addition, it was assumed that 20% of the west-ice population was inhabiting the Barents Sea area (Ulf Lindstrøm, IMR, pers comm). Harp seals from the Barents Sea population (Eastern Ice) have been exploited. Body mass for harp seals was set to 130 kg.

P/B was set to 0.13 year⁻¹ based on modelling of mortality rate (ICES 2016). Q/B has been calculated to 4.80 year⁻¹ from consumption and abundance estimates (Nilssen et al. 2000). Diet composition has been assessed by stomach analysis (Table S2-13), and model diet was comprised of capelin, polar cod, Northeast Arctic cod, haddock, Stichaidae, small bentivorous fishes, long rough dab, small herring, sandeel, *Thysanoessa*, pelagic amphipods, northern shrimps and crangonid and other shrimps.

| Table S2-13 Harp seal | | | | | |
|---|---------|-----|-------------|---------------------------------|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 1550000 | 6 | 1950 | | (ICES 2019c) |
| Abundance | 1120000 | 6 | 2000 | State-space mod. | (ICES 2019c) |
| Bm (kg ww) | 130 | | | | (Kovacs et al. 2009) |
| C/WW | 0.37 | | | | (Gales et al. 1994) |
| P/B (year ⁻¹) | 0.13 | 8 | | Model ICES, SD = 0.05 | (ICES 2019c) |
| Q/B (year ⁻¹) | 4.80 | 4 | | | (Nilssen et al. 2000) |
| UC | 0.115 | 8 | | Av. for capelin and krill | (Mårtensson et al. 1994, Nilssen et al. 2000) |
| Catch | 170373 | 6 | 1950 | Total landings, age 1+ and pups | (Johannesen et al. 2012a, ICES 2016) |
| | 44770 | 6 | 2000 | Total landings, age 1+ and pups | (Johannesen et al. 2012a, ICES 2016) |
| Diet (Pe. = 6) Food consumption estimates for harp seals were given by (Nilssen et al. 2000). The Ecopath diet compositions (for 2000) were based on the diet composition given by (Nilssen et al. 2000) which gives diet composition for states with depleted capelin stock and high abundance (used for 2000). Data from the studies listed below was used to allocate harp seal diet proportions for “Other crustaceans” and “Other fish” into Ecopath model groups that not were separate. 1987, Northern Barents Sea, August-September, (n = 56), Wp (Lydersen et al. 1991) 1990-1992, Northern Barents Sea, June, September, October, (n = 352), Foc, Wp (Nilssen et al. 1995b) 1989, 1992-1993, White Sea, Varangerfjord, Foc, Wp (Nilssen et al. 1995a) 1993 February (n = 76 st.) & 1995 October (n = 18 st.), Eastern and southern Barents Sea, N% (Lindstrøm et al. 1998) 1996-1997 & 2004-2006, Svalbard area, (n = 146 st., n = 33 faeces samples), combined feeding index (Lindstrøm et al. 2013) | | | | | |

14 Harbour seal

Harbour seal has a coastal distribution with one population on the western side of Svalbard and another on the Norwegian coast from Lofoten to the Murman coast in Russia. There is a total of about 3000 animals, ca. 1000 individuals at Svalbard and ca. 2000 individuals at the mainland (Kovacs et al. 2009). Harbour seals are exploited (Nilssen & Bjørge 2015).

Body mass is ca. 95 kg, P/B is 0.094 year⁻¹ and Q/B is 5.8 year⁻¹ (Table S2-14). They feed mainly on small fish with small saithe and Atlantic cod as important prey (Berg et al. 2002, Andersen et al. 2004), and the diet composition was calculated as the average of data from Vesterålen (mainland Norway) and Svalbard.

| Table S2-14 Harbour seal | | | | | |
|---|-------|-----|-------------|------------------------------------|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 3000 | 5 | c. 2010 | 1000 at Svalbard, 2000 at mainland | (Lydersen & Kovacs 2005, Kovacs et al. 2009, Nilssen et al. 2010, Nilssen & Bjørge 2015) |
| Bm (kg ww) | 95 | | | | (Kovacs et al. 2009) |
| C/WW | 0.35 | | | | (Bowen et al. 2001) |
| P/B (year ⁻¹) | 0.094 | 7 | | | (Härkönen & Heide-Jørgensen 1990) |
| Q/B (year ⁻¹) | 5.8 | 4 | | | (Perez et al. 1990) |
| UC | 0.115 | 6 | | Same as for harp seal | |
| Catch | | 5 | | 1997-2013 | (NAMMCO 2016) |
| Diet (Pe. = 5) | | | | | |
| Diet composition is average of data sets from Vesterålen and Svalbard | | | | | |
| 1990-1995, Vesterålen, samples of scats (n = 53) and stomachs (n = 37), Foc, Wp, (Berg et al. 2002) | | | | | |
| 1998, Svalbard, autumn, samples of scats (n = 117) and stomachs (n = 3), Wp, (Andersen et al. 2004) | | | | | |

15 Grey seal

Grey seals have a coastal distribution at the mainland (Ziryanov & Mishin 2007, Øigård et al. 2012). Abundance has been estimated to about 3500 individuals on the Murman coast in 1994. On the Norwegian coast, it was estimated that ca 1000 individuals in the year 2001-2003, ca 1500 individuals during 2006 – 2008, and ca 2000 individuals in 2010 were present (Øigård et al. 2012). Total abundance for the Barents Sea LME is the sum of abundance at the Murman and Norwegian coast. Grey seals are exploited (Nilssen & Bjørge 2015). Body mass was set to 134 kg. P/B was set to 0.12 year⁻¹ and Q/B to 5.9 year⁻¹. The diet composition was calculated as the average of data from Nordland and Finnmark (Nilssen et al. 2019). Grey seal feed mainly on demersal fishes with gadoids and wolffish (*Anarhichas* sp.) as important prey (Nilssen et al. 2019).

| Table S2-15 Grey seal | | | | | |
|---|----------------------|-------|--------------------------------|------------------------------------|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 4500 5000 5500 | 5(60) | 2001-2003 2006-2008 2010 | Assumed CV = 0.3 | (Haug et al. 1994, Ziryanov & Mishin 2007, Øigård et al. 2012, Nilssen & Bjørge 2015) |
| | 4500 | 5 | | Used in 2000 model | |
| Bm (kg ww) | 134 | | | 70% of max body mass | (Dommasnes et al. 2002) |
| C/WW | 0.43 | | | | (Bennett et al. 2007) |
| P/B (year ⁻¹) | 0.12 | 8 | | | (Øigård et al. 2012) |
| Q/B (year ⁻¹) | 5.9 | 4 | | | (Perez et al. 1990) |
| UC | 0.115 | 5 | | Same as for harp seal | |
| Catch | | 6 | 1980-2013 | Catch in Troms and Finnmark county | (Øigård et al. 2012, Nilssen & Bjørge 2015) |
| Diet (Pe. 4) 1999-2009, Vesterålen to Finnmark, samples of scats (n = 81) and stomachs (n = 90), Foc, Wp (Nilssen et al. 2019) | | | | | |

16 Ringed seal

Ringed seals are distributed in areas with sea ice, and they maintain breathing holes in ice (Kovacs et al. 2009). Abundance is uncertain, but probably close to 100 000 individuals in the Svalbard/Barents Sea (Kovacs et al. 2009). They are exploited to a very low degree. Body mass was set to 40 and 20 kg for age 1+ and age 0.

P/B was estimated from catch-curve methods to 0.091 year^{-1} (Table S2-16). Q/B was 7.9 year^{-1} . Polar cod was the dominant prey in all diet studies. Diet composition was calculated as the average of results from a study north and west of Svalbard (Labansen et al. 2007) and a study from the areas between Franz Josef Island and Novaja Zemlja (Wathne et al. 2000). The diets in both studies were dominated by polar cod. Other diet studies also show that decapods and amphipods may be important (Gjertz & Lydersen 1986, Lydersen et al. 1989).

| Table S2-16 Ringed seal | | | | | |
|--|-----------------------|-------|-------------|---------------------------------|--------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 100000 | 3 | | Used in 2000 model | (Kovacs et al. 2009) |
| Bm (kg ww) | 40 | | | 70% of av. adult weight | (Kovacs et al. 2009) |
| C/WW | 0.32 | | | | (Stirling & McEwan 1975) |
| P/B (year^{-1}) | 0.091 (0.07, 0.11) | 8(22) | | Catch –curve, Chapman-Robson | (Lydersen & Gjertz 1987) |
| Q/B (year^{-1}) | 7.9 | 4 | | For average female and male | (Lydersen 1998) |
| UC | 0.115 | 6 | | Same as for harp seal | |
| Catch (ind. year^{-1}) | 400 | 1 | | Assumed from “Some few hundred” | (Lydersen 1998) |
| Diet (Pe. 5) | | | | | |
| Diet composition was based on three studies | | | | | |
| 1985-1987, Southeast of Svalbard, n = 19, and Kongsfjorden, n = 115, Wp (Weslawski et al. 1994a) | | | | | |
| 1995, between Franz Josef Land and Novaja Zemlja, n = 27, Foc, N% (Wathne et al. 2000) | | | | | |
| 2002-2004, west and northwest of Svalbard, n = 267, Foc, Wp (Labansen et al. 2007) | | | | | |

17 Bearded seal

Bearded seals prefer drifting pack-ice over shallow water as habitat, and they breed throughout the northern Barents Sea (Kovacs et al. 2009). A value of 10000 individuals has been given for population size, but the value is uncertain (*op cit.*). They have been exploited but are presently exploited at a very low level. Body mass has been calculated to 191 kg.

P/B has been estimated to 0.14 year⁻¹ from catch-curve methodology based on age-frequency distributions (Benjaminsen 1973) (Table S2-17). Q/B was set to 4.9 year⁻¹. Bearded seals feed on polar cod, benthic fishes, and benthic invertebrates (Finley & Evans 1983, Hjelset et al. 1999).

| Table S2-17 Bearded seal | | | | | |
|--|-------------------------|--------|-------------|-----------------------------|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 10000 | 3 | | Used in 2000 model | (Kovacs et al. 2009) |
| Av weight (kg ww) | 191 | | | 70% of maximum weight | Calculated from (Kovacs et al. 2009) |
| C/WW | 0.37 | | | As for harp seal | |
| P/B (year ⁻¹) | 0.140 (0.104, 0.175) | 8 (25) | 1968-1970 | Catch-curve, Chapman-Robson | (Benjaminsen 1973) |
| Q/B (year ⁻¹) | 4.86 | 7 | | | (Perez et al. 1990) |
| UC | 0.115 | 6 | | Same as for harp seal | |
| Catch | 30 | 5 | 2017 | Svalbard | NPI (http://www.npolar.no/en/species/bearded-seal.html) |
| Diet (Pe. 4) 1978-1980, Canadian high Arctic waters, n = 34 st., Foc, Wp (Finley & Evans 1983) Diet composition for the model was calculated from the Hjelset et al. (1999) study from numerical frequency with assumed average prey weights (fish size is given in the paper) 1989-1996, Svalbard, n = 47 gastrointestinal tracts, Foc, numerical prey frequency (Hjelset et al. 1999) | | | | | |

18 Walrus

Walruses mainly inhabit the northern shallower part of the Barents Sea, east of Svalbard and the Pechora Sea, and breed on sea ice (Kovacs et al. 2009). Before the exploitation started around the year 1600, the population size around Svalbard may have been about 25 000 individuals (Weslawski et al. 2000a), and the total population size in the Barents and Kara Sea may have been 70000 to 80000 individuals (Born et al. 1995). Walruses were exploited to very low abundance in the Svalbard area when the walrus was protected in 1952 (Kovacs et al. 2014). Following protection, the abundance has increased, and in 1993 the abundance in the northern part of the Barents Sea was estimated to about 2000 animals (Gjertz & Wiig 1995), and the total abundance in 2011 for the whole Barents Sea, including the Pechora Sea, was calculated to ca. 7800 individuals. Body mass has been set to 1050 kg,

P/B was set to 0.05 year⁻¹, and Q/B to 5.8 year⁻¹ (Table S2-18). Walruses feed mainly on benthic invertebrates, mainly bivalves, but they may also prey on birds (eiders and fulmars) and seals (bearded, ringed and harp seals) (Gjertz 1990, Lydersen & Kovacs 2014). Diet composition was based on data from scat samples and the many literature sources given in (Gjertz & Wiig 1992).

| Table S2-18 Walrus | | | | | |
|---|----------------------|--------|-------------|--|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | |
| Abundance | 2629 (2318, 2998) | 6 (13) | 2006 | Svalbard | (Lydersen et al. 2008) |
| | 3886 (3553, 4262) | 6 (9) | 2012 | Svalbard, 48% increase since 2006 | (Kovacs et al. 2014) |
| | 3943 (3605, 4325) | 6 (9) | 2011 | Pechora Sea, total 7829 is sum of Svalbard and Pechora Sea | (Lydersen et al. 2012) |
| | 7829 | | | Total Svalbard & Pechora Sea, used in 2000 model | |
| Bm (kg ww) | 1050 | | | Adult weight: =0.7*(2000+1000)/2 | (Kovacs et al. 2009) |
| C/WW | 0.37 | | | Same as for harp seal | |
| P/B (year ⁻¹) | 0.05 | 7 | | Natural mortality rate, Greenland | (Witting & Born 2005) |
| Q/B (year ⁻¹) | 5.8 | 7 | | | (Born et al. 2003) |
| UC | 0.073 (0.041, 0.105) | | | | (Fisher et al. 1992) |
| Catch | | 6 | 1897-1955 | Franz Josef Land | (Gjertz et al. 1998) |
| Diet (Pe. 4) Diet composition is based on (Gjertz & Wiig 1992) Svalbard, Kalvøya, Svalbard, n =14 faeces samples, qualitative ranking of prey (Gjertz & Wiig 1992) Svalbard, review (Lydersen & Kovacs 2014) 2002-2004, Svalbard, n = 18 blubber samples, feeding inferred from fatty acid composition (Skoglund et al. 2010) | | | | | |

Bird groups

Estimates of the number of sea-birds are for most groups, mainly from the first half of the 1990s (Anker-Nilssen et al. 2000). These values have been used as input for the models for 2000 and also for 1950, if better estimates were not available for 1950.

Few of the seabird groups are now hunted, but exploitation was more common earlier. Seabirds are common bycatch in some fisheries (*e.g.* gill-net fisheries) (Bærum et al. 2019). However, precise bycatch statistics were not found for the Barents LME, and the bycatch of seabirds was not included as catch in the Ecopath models.

Most species of adult sea-birds have relatively low P/B-values and very high Q/B-values compared to other groups. Average assimilation efficiency in birds is about 75% (UC = 0.25) with slightly higher values for fish as prey (77.2%, UC = 0.23) than for invertebrates (73.9%, UC = 0.26) (Castro et al. 1989). Thus, in case of group-specific values were not available, an UC of 0.23 was used for predominantly piscivores, an UC of 0.25 was used for mixed fish and invertebrate feeders, and a UC of 0.26 was used for invertebrate feeders.

19 Northern Fulmar

Northern Fulmar is a pelagic surface-feeder and breed on Svalbard and Bear Island (Fauchald et al. 2015). The abundance was about 1.7 mill individuals in the 1990's (Table S2-19). Northern fulmars consume many types of food items, including cephalopods, fish, crustaceans, offal, discards and it is common to observe Northern fulmars close to fishing vessels (Anker-Nilssen & Barrett 1991).

| Table S2-19 Northern Fulmar | | | | | |
|---|----------|-----|-------------|------------------|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 12 | | | | (Barrett et al. 2002) |
| Abundance | 1700 000 | 5 | 1990's | | (Barrett et al. 2002) |
| Av weight (kg ww) | 0.82 | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.05 | 7 | | Orkney, Scotland | (Grosbois & Thompson 2005) |
| Q/B (year ⁻¹) | 77.6 | 8 | | Calculated from | (Barrett et al. 2002) |
| UC | 0.25 | | | | (Castro et al. 1989) |
| Diet (Pe. 4) | | | | | |
| Diet composition was averaged for all studies in (Anker-Nilssen et al. 2000) and the fish proportion was allocated to model groups also using data from (Erikstad 1989), (Mehlum & Gabrielsen 1993a) and (Cherel et al. 2001) | | | | | |
| Barents Sea, feeding review, semiquantitative (Anker-Nilssen et al. 2000) | | | | | |
| 1987, Barents sea, Central Bank, march, n = 30, N% (Erikstad 1989) | | | | | |
| 1982-1985, Svalbard, ice-covered waters, n = 50, Foc, N% (Mehlum & Gabrielsen 1993a) | | | | | |
| 1999, Bear Island, n = 58 regurgiated samples (Cherel et al. 2001) | | | | | |

20 Black-legged kittiwake

Black-legged kittiwake is a pelagic surface-feeder and breed along the coast in the south, at Bear Island and at Svalbard (Fauchald et al. 2015). Total abundance in the 1990s was ca. 3 mill individuals (Table S2-20). They feed on invertebrates, small fish and offal (Anker-Nilssen & Barrett 1991).

| Table S2-20 Black-legged kittiwake | | | | | |
|--|----------|--------|-------------|---|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 8 | | | | (Barrett et al. 2002) |
| Abundance | 3070 800 | 5 | 1990's | Total no ind. (853 000 breed. No), used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg. ww) | 0.409 | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.128 | 8 (20) | | Hornøya, Norway | (Sandvik et al. 2005) |
| Q/B (year ⁻¹) | 137 | 8 | | Calc. from consumption and biomass | (Barrett et al. 2002) |
| UC | 0.25 | | | | (Brekke & Gabrielsen 1994) |
| Diet (Pe. 6) Diet composition was calculated from the diet in all studies in (Anker-Nilssen et al. 2000), (Barrett 2007) and (Weslawski et al. 1994b), weighted by the number of individuals in each region from Anker-Nilssen et al. (2000) 1948-1994 Barents Sea, review (Anker-Nilssen et al. 2000) 1980-2006, Hornøya & Syltefjord, Norw. Coast, n = 1285 regurgiations, Wp (Barrett 2007) 1991-1993, Franz Jozef Land, n = 5 (Weslawski et al. 1994b) | | | | | |

21 Other gulls and surface feeders

The groups comprise a number of surface-feeding species including; Glaceous gull (*Larus hyperboreus*), Herring Gull (*Larus argentatus*), Great Black-backed Gull (*Larus marinus*), Lesser Black-backed Gull (*Larus fuscus*), Common Gull (*Larus canus*), Arctic tern (*Sterna paradisaea*), Ivory gull (*Pagophila eburnea*). The biomass of the group was based on the numbers and body masses of the various species and the duration of their presence in the Barents Sea areas. Total abundance was about 800 000 individuals in the 1990s (Table S2-21). Diet was calculated by weighting biomass and consumption of *L. argentatus* and *L. marinus*.

| Table S2-21 Other gulls and surface feeders | | | | | |
|---|------------------|-------|-------------|------------------------------------|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | | | | Depending on species | |
| Abundance | 770 350 | 5 | 1990's | Used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg ww) | 0.745 | | | Weighted by no. of each species | |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.127 (CV ~0.04) | 7 (8) | | From Herring gull, coast of France | (Pons & Migot 1995) |
| Q/B (year ⁻¹) | 77.5 | 8 | | Calc from consump and biomass | (Barrett et al. 2002) |
| UC | 0.25 | | | | (Castro et al. 1989) |
| Diet (Pe. 5) Diet is based on studies of <i>L. marinus</i> & <i>L. argentatus</i> which make up ca. 80% of the biomass in the group. Diet composition is weighted by proportion consumption from each gull species and by numbers in each sub-area given. 1948-1994 Barents Sea, review (Anker-Nilssen et al. 2000) | | | | | |

22 Little auk

Little auk is a small alcid which breed in all the high-Arctic archipelago in the Barents Sea LME but not on the mainland (Anker-Nilssen & Barrett 1991). Total abundance was about 4.4 mill individuals in the 1990s (Table S2-22). Little auk is diving and feed on zooplankton, predominantly *Calanus glacialis* and *Calanus finmarchicus* (Anker-Nilssen et al. 2000), but crab larvae, krill (*Thysanoessa*), amphipods, and *C. hyperboreus* may also be consumed (Boehnke et al. 2015, Jakubas et al. 2016).

| Table S2-22 Little auk | | | | | |
|---|----------|-----|-------------|--------------------------------|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 6 | | | | (Barrett et al. 2002) |
| Abundance | 4420 000 | 5 | 1990's | Used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg ww) | 0.160 | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.139 | 8 | 2006-2013 | Bear Island, West Spitzbergen | (Hovinen et al. 2014) |
| Q/B (year ⁻¹) | 160.4 | 8 | | Calc. from consump and biomass | (Barrett et al. 2002) |
| UC | 0.26 | | | | (Castro et al. 1989) |
| Diet (Pe. 6) | | | | | |
| Diet composition was based on (Anker-Nilssen et al. 2000) supplemented by the two studies shown below | | | | | |
| 1948-1994, Barents Sea, review (Anker-Nilssen et al. 2000) | | | | | |
| 2013, around Bear Island, n = 40 samples, Wp (Jakubas et al. 2016) | | | | | |
| 2007-2009, Svalbard, n = 343 samples, Wp (Boehnke et al. 2015) | | | | | |

23 Brunnich guillemot

Brunnich guillemot is a high-Arctic species that breed at Svalbard, Bear Island, and some colonies on the mainland (Anker-Nilssen & Barrett 1991). Brunnich guillemot is a pelagic diver has been the seabird species with the highest food consumption in the Barents sea (Barrett et al. 2002). Total abundance was ca 6 mill individuals in the 1990s (Table S2-23).

They are single-prey loaders feeding their chicken with one prey per foraging trip. According to (Barrett et al. 2002), their diet is composed of 60% fish, and 40% invertebrates and these proportions have been allocated to model groups based on diet information from the review by (Anker-Nilssen & Barrett 1991) and from other investigations. They feed on many prey groups; small gadoids, herring, capelin, polar cod, euphausiids, pelagic and symphagis amphipods and pandalid shrimps.

| Table S2-23 Brunnich guillemot | | | | | |
|---|----------|--------|-------------|--------------------------------|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 10 | | | | (Barrett et al. 2002) |
| Abundance | 6120 000 | 5 | 1990's | Used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg ww) | 0.998 | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.085 | 8 (10) | 1989-2002 | Hornøya, northern Norway | (Sandvik et al. 2005) |
| Q/B (year ⁻¹) | 99.4 | 8 | | Calc. from consump and biomass | (Barrett et al. 2002) |
| UC | 0.25 | | | | (Brekke & Gabrielsen 1994) |
| Diet (Pe.) 5) Assumed diet was composed of 60% fish and 40% invertebrates, allocation to model group based on studies below. Data from open water/ice were weighted by 33% of the total. 1896-1994, Barents Sea, review (Anker-Nilssen et al. 2000) 1982-1993, near Svalbard, n = 276, Foc, N% (Mehlum & Gabrielsen 1993b) 1983-1994, Barents sea, 4 locations, n = 1068 prey fish, additional feeding review (Barrett et al. 1997) 1996, near Bear Island, July, n = 38, Foc, N% (Mehlum 2001) | | | | | |

24 Common guillemot and razorbill

Common guillemot (*Uria aalge*) is a pelagic diver with a boreo-low arctic distribution and breeds mainly at the mainland and at Bear Island with some smaller colonies at Svalbard (Fauchald et al. 2015). In 1986-87 there was a large decline in the number of common guillemot in the Barents Sea, but the numbers have increased afterward (Anker-Nilssen et al. 2000). Razorbill (*Alca torda*) breed mainly on the mainland with some colonies at Bear Island and Svalbard (Anker-Nilssen et al. 2000). Common guillemot has a much higher population number than razorbill (Table S2-24).

Guillemots are single-prey loaders feeding their chicken with one prey per foraging trip (Mehlum 2001). Most earlier diet data are from fish brought to chickens by adults (Anker-Nilssen et al. 2000). However, the diet of adults may differ from that of chicken, and adults at Hornøya at the Norwegian coast fed on smaller and larger gadoids than the planktivore fish, usually provided to the chicken (Bugge et al. 2011). In the Bear Island area, adults fed on small krill (*Thysanoessa inermis*) (Mehlum 2001).

| Table S2-24 Common guillemot and razorbill | | | | | |
|---|--|-------|-------------|--|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 10 | | | for C. guillemot | |
| Abundance | 120 000 (C. guillemot) 20 000 (Razorbill) | 5 | 1990's | C. guillemot comprise 92% of C biomass. Used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg ww) | 1.028 (C. guillemot) 0.711 (Razorbill) | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.088 | 8 (5) | 1989-2002 | For C. guillemot, Hornøya | (Sandvik et al. 2005) |
| Q/B (year ⁻¹) | 104.32 | 8 | | | (Barrett et al. 2002) |
| UC | 0.23 | | | | (Castro et al. 1989) |
| Diet (Pe. = 5) Diet composition was derived by combining data from Anker-Nilssen mainly for chickens (weighting ca. 60%) and for adults from (Mehlum 2001) and Bugge et al. (weighting ca. 40%) 1947-1995, Barents Sea, feeding review (Anker-Nilssen et al. 2000) 1996, Bear Island area, n = 26, N% (Mehlum 2001) 2008, Barents Sea, Hornøya, samples from chicken and adult prey (n = 59 samples), Foc (Bugge et al. 2011) | | | | | |

25 Atlantic puffin

Atlantic puffin is a pelagic diver mainly distributed in the southern part of the Barents Sea close to the Norwegian coast and most breeds in colonies along the Norwegian coast (Anker-Nilssen et al. 2000). The abundance in the Barents Sea LME was about three mill individuals in the 1990s (Table S2-25).

Diet composition was calculated from (Anker-Nilssen et al. 2000), and herring and sandeel were dominant prey. Diet data from 2002 and 2003 at Hornøya show that puffins also feed on sandeel and small juvenile gadoids while capelin was the dominant prey in 1980-1982 (Eilertsen et al. 2008).

| Table S2-25 Atlantic puffin | | | | | |
|--|-----------|--------|-------------|--------------------------------------|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 8 | | | | (Barrett et al. 2002) |
| Abundance | 3 060 000 | 6 | 1990's | Used in 2000 model | (Barrett et al. 2002) |
| Av weight (kg ww) | 0.480 | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.083 | 8 (13) | 1990-2003 | Average for Hornøya and Røst, Norway | (Sandvik et al. 2005) |
| Q/B (year ⁻¹) | 134.9 | 8 | | Barents Sea | (Barrett et al. 2002) |
| UC | 0.23 | | | | (Castro et al. 1989) |
| Diet (Pe. = 5) | | | | | |
| 1935-1998, Barents Sea, feeding review (Anker-Nilssen et al. 2000) | | | | | |

26 Benthic piscivore birds

This group comprises the two cormorant species; the Great cormorant (*Phalacrocorax carbo*), the European shag (*Phalacrocorax aristotelis*), and the black guillemot (*Cepphus grylle*). The species are coastal divers. The cormorant species are mainly distributed at shallow water along the southern coast, while the black guillemot also is distributed along the coast of Spitsbergen, Franz Josef land, and Novaja Zemlja (Anker-Nilssen et al. 2000). There were about 180 000 black guillemots and about 40 000 cormorants in the 1990s (Table S2-26). There has been very limited hunting on cormorants within the Barents Sea LME (Pedersen et al. 2016a).

The cormorant species are predominantly feeding on fish, and the black guillemot also feed on some benthic invertebrates (Anker-Nilssen et al. 2000).

| Table S2-26 Benthic piscivore birds | | | | | |
|---|---|-----|-------------|---|-----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Months present | 8 (<i>P. carbo</i>) 8 (<i>P. aristotelis</i>) 12 (<i>C. grylle</i>) | | | | (Anker-Nilssen et al. 2000) |
| Abundance | 18 000 (<i>P. carbo</i>) 21 600 (<i>P. aristotelis</i>) 180 000 (<i>C. grylle</i>) | 5 | 1990's | Used in 2000 model | (Anker-Nilssen et al. 2000) |
| Bm weight (kg ww) | 3.250 (<i>P. carbo</i>) 1.836 (<i>P. aristotelis</i>) 0.410 (<i>C. grylle</i>) | | | | (Anker-Nilssen et al. 2000) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.21 | 8 | | <i>P. carbo</i> , Norway | (Fiske & Røv 1997) |
| Q/B (year ⁻¹) | 105.2 | 8 | | | (Barrett et al. 2002) |
| UC | 0.23 | | | | (Castro et al. 1989) |
| Catch (ind.) | 500 | 6 | | For Finnmark, Troms and half of Nordland County for 2005-2009 | (Pedersen et al. 2016a) |
| Diet (Pe. 6) The diet composition was weighted by proportion population size in each region and by C consumption for each species. 1935-1998, Barents Sea, feeding review (Anker-Nilssen et al. 2000) 1996-1997, <i>P. carbo</i> , Sørfjord, Norw. Coast (Johansen et al. 1999b) 1983-1989, <i>C. grylle</i> , Hornøya, Norw coast (Barrett & Furness 1990) | | | | | |

27 Benthic invertebrate feeding birds

The group comprises the common eider (*Somateria mollissima*), the king eider (*Somateria spectabilis*) and the Steller's eider (*Polystycta stelleri*). The birds dive at relatively shallow water along the coasts (Anker-Nilssen et al. 2000). King eider breed along the coast of Spitsbergen, Novaja Zemlj, and the Russian coast of the Barents Sea. Stellers eider overwinter in the Barents Sea and breed at the Russian coast east of the Barents Sea. Common eider breeds both at the southern coast, the Spitsbergen coast and the Russian coasts. The total abundance of the three eider species was about 400 000 individuals in the 1990s (Table S2-27). The eider species mainly feed on benthic invertebrates (Anker-Nilssen et al. 2000).

| Table S2-27 Benthic invertebrate feeding birds | | | | | |
|--|--|--------|-------------|---------------------------|--------------------------|
| Input | Value | Pe. | Time period | Comments | Reference |
| Months present | | | | | |
| Abundance | 360 000 Eiders 40 000 Steller's Eider 20 000 Kings Eider | 5 | 1990's | Used in 2000 model | (Barrett et al. 2002) |
| Bm (kg ww) | 1.630 Eiders 1.500 Steller's eider 1.630 Kings Eider | | | | (Barrett et al. 2002) |
| C/WW | 0.132 | | | | (Sakshaug et al. 1994) |
| P/B (year ⁻¹) | 0.163 (0.105, 0.261) | 8*(48) | | Grindøya, Norwegian coast | (Yoccoz et al. 2002) |
| Q/B (year ⁻¹) | 77.2 | 8 | | | (Barrett et al. 2002) |
| UC | 0.28 | | | Common eider | (Richman & Lovvorn 2003) |
| Diet (Pe. = 5) Diet composition is weighted with numbers per region and numbers per species. 86% of the C biomass is comprised by Eiders. 1934-1935, Tromsø area (Soot-Ryen 1941) 1935-1998, Barents Sea, feeding review (Anker-Nilssen et al. 2000) 1984, September-October, Hornsund, Svalbard, Eider, n = 20, Foc (Lydersen et al. 1989) 1986-1987, Eider (n = 82) and King eider (n = 44), Troms, Norway, April-May, Wp (Bustnes & Erikstad 1988) 1991-1992, Eider (n = 638 dives) and King eider (n = 8 st.), Wp (Bustnes & Lønne 1994) | | | | | |

Fish groups

Diet information may be quantitative, based on weight proportions (Wp) of prey from stomachs or semiquantitative, based on number proportions (Np) or frequency of occurrence (Foc) or qualitative, based on just single observations of occurrences of prey. When calculating the diet composition of multistanza age 0-2 groups, diet of 0-group have been weighted by 25 of the total.

Biomass accumulation (change in biomass during a year) was calculated and is input to Ecopath (Table S2-28-61). For multistanza groups, a single value for biomass accumulation had to be calculated as separate values for each stanza could not be entered.

Table S2-28-61. Overview of biomass accumulation rates (BA, year⁻¹) for various groups. For multi-stanza group, only one value for biomass accumulation can be entered in the multi-stanza routine. BA-values were based on time-series for biomasses (Supplementary Appendix S4 & S5). The biomass accumulation is calculated as the proportion change in biomass from the model year and the following year for the total biomass of all stanza-groups. Only groups with BA-values differing from zero are shown.

| Gr. No. | Group | Biomass accumulation rates (year ⁻¹) | |
|---------|----------------------|--|-------|
| | | 1950 | 2000 |
| 13 | Harp seal | -0.0003 | 0.0 |
| 29-30 | Northeast arctic cod | 0.065 | 0.11 |
| 31-32 | Coastal cod | 0.04 | 0.055 |
| 35-36 | Haddock | 0.39 | 0.31 |
| 49 | Small herring | 0.0 | -0.60 |
| 50-51 | Capelin | 0.12 | 0.12 |

28 Greenland shark

Greenland shark is widely distributed within the Barents Sea both in Atlantic and Arctic waters (Fisk et al. 2012, Rusyaev & Orlov 2013, Lydersen et al. 2016). Density was calculated by swept-area methodology from catch records from research bottom-trawl surveys (Wienerroither et al. 2011). It was assuming that the caught fish had a mean total length of 276 cm and an average body mass of 218 kg based on the total length-weight relationship of (MacNeil et al. 2012). Greenland shark is a slow-growing and very long-lived species (Nielsen et al. 2016). Greenland shark has earlier been exploited, and there was fishery in the 1950s, but it was not possible to allocate catches to various catching areas (Carlson 1958). In recent years there has been some bycatch of Greenland shark in trawl fisheries. (Rusyaev & Orlov 2013) estimated that during 1968-2010 on average, ca 140-150 t were caught in Russian trawl fisheries.

From length at age estimates (Nielsen et al. 2016), a von Bertalanffy growth equation has been estimated with $L_{\infty} = 478$ cm, $K = 0.0084$ year⁻¹. The natural mortality rate was calculated to $M = 0.014$ year⁻¹ from an empirical relationship with temperature (assumed temperature of 3 °C), curvature (K) of the von Bertalanffy's growth equation and body size as predictors (Pauly 1980).

Two alternative approaches for calculating Q/B were explored. In the first, Q/B was calculated from bioenergetic budgets for the large sharks Lemon shark (*Negaprion brevirostri*) and Bull shark (*Carcharinus leucas*), estimating that production was ca. 8 % of

the consumption ($P/Q = 0.08$) (Sundström & Gruber 1998). When assuming that fishing mortality rate has been very low after 1980 and setting P/B equal to $M = 0.014 \text{ year}^{-1}$, Q/B became 0.17 year^{-1} . Alternatively, Q/B was calculated from respiration and expected growth (adjusted for body mass and temperature) assumed to be equal to measurements for spurdog (*Squalias acanthias*) (Lowe & Goldman 2001). The average ambient temperature for Greenland shark was set to $3 \text{ }^{\circ}\text{C}$ based on tagging measurements around Svalbard (Fisk et al. 2012). An average of the Q/B -values from the two approaches was used in the models (Table S2-28)

The diet of Greenland shark contains fish, mammals (mainly seals) and some invertebrates. Diet investigations from Iceland showed fish, mainly redfish and cod, and also seals and small toothed whales (porpoises or dolphins) in the diet (McMeans et al.). The model diet was based on stomach sampling at Svalbard (Leclerc et al. 2012), showing a diet with 18.2 %W seals (mainly ringed seals), and mainly fish (49 %W cod, 20 %W wolffish). Another study from the Barents Sea showed a fish-dominated diet (Dolgov 2016). Since ringed seals has a high local density in the diet study area of Leclerc *et al.* (2012)(Svalbard), the proportion of ringed seals in the model diet was reduced from 18 to 4%.

| Table S2-28 Greenland shark | | | | | |
|--|-----------------------------|-----|-------------|--|-----------------------------|
| Input | Value | Pe. | Time period | Comment | Reference |
| Density (ind.*km ⁻²) | 0.15 | | 2004 - 2009 | Calculated as swept area estimates from bottom trawl surveys, used in 2000 model | (Wienerroither et al. 2011) |
| Av.ind. weight (kg WW) | 218 | | | Based on mean length of 276 cm and length-weight relationship | (MacNeil et al. 2012) |
| B (t ww km ⁻²) | 0.0327 | | 2004 - 2009 | Assuming av. weight of 218 kg WW | |
| B (g C m ⁻²) | 0.00412 | 4 | | Used in models | |
| C/WW | 0.126 | | | Av. for hammerhead and lemon shark | (Wetherbee & Cortes 2004) |
| P/B (year ⁻¹) | 0.014 | 4 | | M est. by indirect method, P/B set equal to M | (Pauly 1980) |
| P/Q | 0.08 | | | For Lemon shark and bull shark | (Sundström & Gruber 1998) |
| Q/B (year ⁻¹) | 0.17 0.22 0.19 | 5 | | Calculated from $P/Q = 0.08$ and P/B Calc. from respiration and bioenergetics Average of values used in model | (Wetherbee & Cortes 2004) |
| UC | 0.20 | | | For Lemon shark | (Wetherbee & Gruber 1993) |
| Catch (g C m ⁻²) | $1.88 \cdot 10^{-5}$ | | | Assumed that total catch was double of Russian trawl bycatches | (Rusyaev & Orlov 2013) |
| Diet (Pe. 5) 1959-2009, Barents Sea, n = 30, Wp (Dolgov 2016) 2008-2009, Svalbard, Kongsfjorden, n = 45, Wp (Leclerc et al. 2012) 2001-2005, Icelandic waters, n = 22, Wp (McMeans et al. 2010) | | | | | |

29-30 Northeast Arctic cod

Northeast Arctic cod (NEAC) has a wide distribution in the Barents Sea (Wienerroither et al. 2011). NEAC is a major predator and also the main fishing target in the Barents Sea (Nakken 1998, Bogstad et al. 2015). Stock biomass is estimated using a State-space Assessment Model (SAM-model) and several research surveys and catch information are included as data sources for the assessment (ICES 2019a) (Table S-29). Mortality rates were estimated by the assessment model.

Total mortality rate for the age 3+ group was calculated as $Z = F + M$ where F was calculated as catch/biomass and M was set 0.20 year^{-1} as is used in the assessment. These F -values are lower than the F -measure used in the assessment (F_{bar} 5-10), which is the average instantaneous fishing mortality for age 5-10 years, but they work when fishing mortalities are applied as time-series in Ecosim. A Norwegian-Russian stomach sampling programme for cod has been run since 1984, and consumption of various prey groups has been estimated (Bogstad et al. 2015). P/B of the age 0-2 group was set to 1.2 year^{-1} based on a measured average cannibalism in the year 2000 for age 1 and 2 of ca. 0.8 year^{-1} (Bogstad et al. 2016), and an assumed predation mortality rate from other predators of 0.4 year^{-1} . Cannibalism mortality of young cod varies between years and is dependent on the capelin stock size and number of older potentially cannibalistic cod (age 3+) (Bogstad et al. 2016).

Northeast Arctic cod was represented as a multi-stanza group with age group 0-2 and three years and older (age 3+) as linked groups. The age3+ group was the leading group in the multi-stanza.

| Table S2-29 Northeast Arctic cod age 3+ | | | | | |
|---|---------|-----|-------------|---|--------------------------|
| Input | Value | Pe. | Time period | Comment | References |
| B (t ww) | 2780989 | 6 | 1950 | Estimated by SAM-model | (ICES 2019a) |
| | 1185278 | 6 | 2000 | | |
| B (g C m ⁻²) | 0.140 | 6 | 1950 | Estimated by SAM-model | (ICES 2019a) |
| | 0.0596 | 6 | 2000 | | |
| Catch (t ww) | 731982 | 6 | 1950 | Landings | (ICES 2019a) |
| | 414868 | 6 | 2000 | | |
| Catch (g C m ⁻² year ⁻¹) | 0.0368 | 6 | 1950 | Calc. from data above | |
| | 0.0209 | 6 | 2000 | | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 0.46 | 8 | 1950 | Calculated as (Catch/Biomass) + 0.20 year^{-1} | |
| | 0.55 | 8 | 2000 | | |
| Q/B (year ⁻¹) | 2.71 | 5 | 1950 | Same as for 2000 | (ICES 2019a) |
| | 2.71 | 8 | 2000 | Average for age 5-6 years, assumed C/WW = 0.12 for prey | |
| UC | 0.20 | | | General carnivore | (Brett & Groves 1979) |
| Diet (Pe. = 6) Based on quantitative annually sampled stomach data from Russian-Norwegian investigations (Bogstad et al. 2015) Bogstad pers. Comm. To allocate the “Other “ to specific groups, diet information from Zenkevitch (1963) and Dolgov (2016) were used. | | | | | |

| Table S2-30 Northeast Arctic cod age 0-2 | | | | | |
|--|-------|-----|-------------|--|--|
| Input | Value | Pe. | Time period | Comment | Ref |
| B (g C m ⁻²) | | 4 | 2000 | Multistanza | |
| Catch (t ww) | | 6 | | Found no data on catch of these young | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.2 | 7 | 1950 | Assumed equal to year 2000 | |
| | 1.2 | 8 | 2000 | Calculated as average cannibalism mortality from older cod of ca. 0.8 year ⁻¹ + assumed other predation mortality of 0.3 year ⁻¹ | Cannibalism mortality: (Bogstad et al. 2016) |
| Q/B (year ⁻¹) | 6.6 | 8 | | Multistanza | |
| Unass. | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. 6) Based on quantitative annually sampled stomach data from Russian-Norwegian investigations (Bogstad et al. 2015), B. Bogstad IMR, Norway, pers. Comm. In addition, data for 0-group cod was included: 2002-2003, Barents Sea, n = 1360, N% (Hallfredsson & Pedersen 2007) 2003, Barents Sea, n = 69, N% (Pedersen & Fossheim 2007) 2005-2006, Barents sea, n = 77, Wp (partial fullness index) (Dalpadado et al. 2009) | | | | | |

31-32 Coastal cod

This cod stock is divided into an age 2+ and an age 0-1 multistanza group. Coastal cod inhabits fjords and have short migrations (Jakobsen 1987, Nøstvik & Pedersen 1999) (Skreslet et al. 1999). Coastal cod uses spawning areas in the fjords along the coast (Jakobsen 1987), and in addition some Coastal cod occur at some of the same spawning grounds as Northeast Arctic cod on the outer coast (Hysten 1964). The 0 and 1-group of NCC inhabit shallow water both in fjords and coastal areas and are hardly found in deeper trawling areas until reaching about 25 cm (Berg & Pedersen 2001). NCC become mature at age 4–6 years and migrates towards spawning grounds in early winter. Estimated landings for year 2000 include commercial, recreational and tourist fishery. Uncertainty is high regarding values for commercial catch, recreational and tourist fishing. The main fishery for coastal cod takes place in the first half of the year by coastal vessels using traditional fishing gears (ICES 2019a). Due to uncertain estimation of numbers caught at age, estimation of stock biomass has a large uncertainty, but estimates from a Virtual Population Analysis (VPA) have been used to provide biomass estimates for the age2+ group in the Ecopath model (ICES 2019a).

Coastal cod age 2+ predate on several commercial species. Haddock, herring and saithe were frequent prey in the northern areas, while Norway pout and northern shrimp were frequent in southern areas (Mortensen 2007). The diet also consists of fish (small cod, saithe, haddock and other gadoids, capelin, herring), small krill, other pandalid shrimps, crabs and other crustaceans, polychaetes and echinoderms (Kanopathipillai et al. 1994)

Total mortality rate (Z) of age 0-1 coastal cod was set to 1.5 year⁻¹ based on model studies quantifying cannibalism and other predation (Pedersen & Pope 2003a, b, Pedersen et al. 2020). Important predators on young coastal cod are larger cod, saithe, cottids and cormorants (Johansen 1998, Johansen et al. 1999a, Pedersen & Pope 2003a, b, Aas 2007, Pedersen et al. 2020). The diet of age 0-1 coastal cod consists of both pelagic (calanoid and cyclopoid copepods, cladocera, meroplankton, krill) and benthic invertebrates (pandalid shrimp,

gastropods, isopods, amphipods, harpacticoid copepods), fish and some insects (Sandneseng 2006, Heggland 2013).

| Table S2-31 Coastal cod (2+) | | | | | |
|---|--------|-----|-------------|--|--------------------------|
| Input | Value | Pe. | Time period | Comment | Reference |
| B (t ww) | | | 1950 | | |
| | 140572 | | 2000 | From SVPA | (ICES 2019a) |
| B (g C m ⁻²) | | 5 | 1950 | Used equal value as for year 2000 as initial value | |
| | 0.0071 | 5 | 2000 | Calc. from data above | |
| Catch (t WW) | | | 1950 | Calculated from B and F | |
| | 48415 | 5 | 2000 | Include recreational, tourist fishery and commercial | (ICES 2019a) |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | | 6 | 1950 | Assumed equal Z as in year 2000 | |
| | 0.54 | 6 | 2000 | Calculated as $Z = C/B + M$ (Assumes $M = 0.20 \text{ year}^{-1}$), biomass from SVPA | (ICES 2019a) |
| Q/B (year ⁻¹) | 3.00 | 7 | | | (Pedersen et al. 2016b) |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. 5) 2005, coast of Northern Norway north of 68°N, average Wp of three subareas, n = 2017 st. (Mortensen 2007) | | | | | |

| Table S2-32 Coastal cod (0-1) | | | | | |
|---|-------|-----|-------------|------------------------|--------------------------|
| Input | Value | Pe. | Time period | Comment | Reference |
| B (g C m ⁻²) | | 4 | | Multistanza proc. | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.5 | 7 | | Used in models | (Pedersen & Pope 2003a) |
| Q/B (year ⁻¹) | | 4 | | In multistanza proc. | |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. = 5) Diet is the average of two datasets. 2005, Kvaløya, Ullsfjord and Sørfjord, Northern Norway, average of samples of bottom settled juveniles from August to November, n = 172 st., Wp (Sandneseng 2006) 2012, Porsangerfjord and Balsfjord, Northern Norway, average of samples of pelagic and bottom settled juveniles from August, n = 103 st., Wp (Heggland 2013) | | | | | |

33-34 Saithe

This species is divided into an age 3+ and an age 0-2 multistanza group. Northeast Arctic saithe is mainly distributed along the coast of Norway from the Kola Peninsula in northeast and south to 62°N (Bergstad et al. 1987). A part of the stock is distributed south of the Barents Sea LME area and the proportion of saithe that is inside the area of Barents Sea LME was calculated to an average of 0.61 based on a time-series for acoustically surveys for the period 1997-2018 (ICES 2019a). The 0- group drifts from the spawning grounds to inshore waters which is the main nursery area. Saithe of age 2-4 gradually moves to deeper waters, but are found in coastal waters. Older saithe are found at the coastal banks. Saithe starts to mature at age 5-7 and in early winter a migration towards the spawning grounds further out

and south starts. A State-space model (SAM) (Nielsen & Berg 2014) is used in the assessment and uncertainty estimates are available (Table S2-33).

Young saithe feed mainly on plankton (copepods, krill), and the diet gradually changes towards fish in larger saithe (Lie 1961, Hallfredsson 1998).

| Table S2-33 Saithe (3+) | | | | | |
|---|-------------------------------|--------|-------------|---|--------------------------|
| Input | Value | Pe. | Time period | Comment | Ref |
| B (t ww) | 828281 (701242, 978334) | 6 (17) | 2000 | Estimated total stock biomass (Age 3+). SAM. Table 5.11 p. 319 | (ICES 2019a) |
| B (g C m ⁻²) | | 5 | 1950 | Assumed same initial value as value for 2000 | |
| | 0.0254 | 6 (17) | 2000 | From above | |
| Catch (t ww) | 101825 | 6 | 1950 | Used value for 1951 | (ICES 2019a) |
| | 135928 | 6 | 2000 | | (ICES 2019a) |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 0.39 | | 1950 | Assuming F equal to 0.19 as in 1960 and M = 0.20 year ⁻¹ | |
| | 0.36 | 27 (8) | 2000 | Z = Y/B + M, assuming M = 0.20 year ⁻¹ | (ICES 2019a) |
| Q/B (year ⁻¹) | 5.0 | 5 | | | (Dommasnes et al. 2002) |
| UC | 0.20 | | | General carnivore fish | |
| Diet (Pe. = 6) | | | | | |
| Average of three datasets | | | | | |
| 1995, February and June, coastal banks of Northern Norway (> 69°N), n = 320 st., Wp (Hallfredsson 1998) | | | | | |
| 1995-2010, Barents Sea, n = 6881 st., Wp (Dolgov 2016) | | | | | |
| 1998-2003, coast of Northern Norway (> 69°30'N), n = 2638 st., Wp (Mehl 2005) | | | | | |

| Table S2-34 Saithe age 0-2 | | | | | |
|--|-------|----|-------------|-------------------------|--------------------------|
| | Value | Pe | Time period | Comment | References |
| B (g C m ⁻²) | | 4 | | Multistanza proc. | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.5 | 5 | | Same as for coastal cod | (Pedersen & Pope 2003a) |
| Q/B (year ⁻¹) | | 4 | | Multistanza proc. | |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. 5) | | | | | |
| For age 1, the diet was an average of three data sets | | | | | |
| 1998-2003, coastal banks of Northern Norway, n = 801, Wp (Mehl 2005) | | | | | |
| 2005, June-August, shallow water at the coast of Northern Norway, n = 616, Wp (Aas 2007) | | | | | |
| 2010, Ullsfjord, Northern Norway, n = 33 st., Wp (Pedersen et al. 2016b) | | | | | |
| For 0-group saithe, Lie (1961) estimated that ca. 50% of the volume of the diet from October-November was copepods, while there was relatively more copepods in the diet from June-August. | | | | | |
| 1956, coast of Northern Norway, October-November, 3 locations, n = 141 st., N% (Lie 1961) | | | | | |
| 1999, near Tromsø, Norway, May-August, settled juveniles at 4 locations, n = 303 st., Wp, van der Kooij (unpubl.) | | | | | |

35-36 Haddock

This species is divided into an age 3+ and an age 0-2 multistanza group. Haddock has a wide distribution in the southern warm part of the Barents Sea (Wienerroither et al. 2011). Stock biomass is estimated using a State-space Assessment Model (SAM-model) and several research surveys and catch information are included as data sources for the assessment (ICES 2019a) (Table S2-35).

Z was calculated using formula $Z = Y/B + 0.20$ assuming $M = 0.25 \text{ year}^{-1}$. M was set to 0.25 year^{-1} because M estimated by SAM is considerably higher than 0.20 year^{-1} for age 3-5 (ICES 2019a). Q/B was set to 2.80 year^{-1} (Dommasnes et al. 2002). Haddock feed on a variety of prey, both pelagic and benthic invertebrates and some fish.

| Table S2-35 Haddock (3+) | | | | | |
|--|----------------------------|--------|-------------|--|--------------------------|
| Variable | Value | Pe. | Time period | Comment | Ref |
| B (t ww) | 382994 (32807, 452999) | 6(14) | 1950 | Estimated by SAM | (ICES 2019a) |
| B (t ww) | 231993 (201606, 266961) | 6 (13) | 2000 | Estimated by SAM | (ICES 2019a) |
| B (g C m ⁻²) | 0.0192 | | 1950 | Initial value | (ICES 2019a) |
| | 0.0117 | 6 | 2000 | Calculated from above | |
| Catch (t ww) | 68 944 | 6 | 2000 | | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | | | 1950 | Same initial value as for year 2000 | |
| | 0.55 | 8 | 2000 | $Z = \text{Catch/Biomass} + M$ (assume $M = 0.25 \text{ year}^{-1}$) | (ICES 2019a) |
| Q/B (year ⁻¹) | 2.80 | 5 | 1950 | Same as for year 2000 | |
| | 2.80 | 5 | 2000 | | (Dommasnes et al. 2002) |
| UC | 0.20 | | | General carnivore | (Brett & Groves 1979) |
| Diet (Pe. = 6) Diet based on two studies 1984-1986, Barents Sea, n = 80884, Wp (Dolgov 2016) 1984-1991, Barents Sea, n = 3536, Wp (Jiang 1992, Jiang & Jørgensen 1996) | | | | | |

| Table S2-36 Haddock age 0-2 | | | | | |
|---|-------|-----|-------------|-------------------------|--------------------------|
| Variable | Value | Pe. | Time period | Ref | Comment |
| B (g C m ⁻²) | | 4 | | Multistanza proc. | |
| C/WW | 0.101 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.5 | 5 | | Same as for NCC age 1-2 | |
| Q/B (year ⁻¹) | 7.0 | 4 | | Multistanza proc. | |
| UC | 0.20 | | | General carnivore | |
| Diet (Pe. = 6) Diet based on 5 studies Diet of age 1 & 2: 1984-1991, Barents Sea, n = 5888, Wp (Jiang 1992, Jiang & Jørgensen 1996) The diet of 0-group haddock was calculated as the average of data from Wiborg (1960) and the two data sets for haddock < 10 cm length and > 10 cm length from (Dalpadado et al. 2009). 1957, July-August, Barents Sea, 4 stations, n = 72 st., Foc (Wiborg 1960) 2005-2006, Barents Sea, 24 stations, n = 288 st., Wp (Dalpadado et al. 2009) | | | | | |

37 Other small gadoids

Silvery pout (*Gadiculus argenteus*), Norway pout (*Trisopterus esmarkii*) and whiting (*Merlangius merlangus*) comprise this group. These species are distributed in the relatively warm southwestern part of the Barents Sea. Biomass estimates are based on survey data from August to October and are available for the period 2004-2014 (Krivosheya & Bogstad 2015). We calculated an average biomass for Norway pout from the period 2004-2014 of 63727 tons. However, this is likely to be an underestimate because of the selection pattern of the trawl underestimating small fish. The biomass was estimated by the model. There has been very little targeted fishery on this group, but they were caught together with other small fish as bycatch by shrimp trawlers before sorting grid was implemented in the shrimp fishery in 1993 (Torstein Pedersen UiT, unpubl. obs.)(Isaksen et al. 1992).

P/B was set to the same value as for “Other small bentivorous fishes” (1.0 year⁻¹) and Q/B calculated assuming a P/Q of 0.2 (Table S2-37). The “Other small gadoids” group is feeding mostly on pelagic invertebrates (e.g. krill), but withing also prey on fish.

| Table S2-37 Other small gadoids | | | | | |
|--|-------|-----|-------------|--|--------------------------|
| Variable | Value | Pe. | Time period | Comment | References |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.138 | | | | (Pedersen & Hislop 2001) |
| P/B (year ⁻¹) | 1.00 | 5 | | Same as for “Other small bentivorous fishes” | |
| P/Q | 0.20 | | | Assumed | |
| Q/B (year ⁻¹) | 5.00 | 5 | | From P/B and P/Q | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 5) 2009-2010, Ullsfjord, Norway pout (n = 63 st.), Silvery pout (n = 9), Whiting (n = 48 st.) (Pedersen et al. 2016b) and (Kolsum 2011), weighted (bottom trawl biomass CPUE) average of diet (weight prop.) from Silvery pout, Norway pout and Whiting. 1999-2009, Barents Sea, Norway pout, n = 568 (Dolgov 2016) 1999-2009, Barents Sea, Whiting, n = 70 (Dolgov 2016) | | | | | |

38-39 Greenland halibut

Greenland halibut was divided into two multistanza groups, large (≥ 45 cm length) and small (< 45 cm length). Greenland halibut is a long-lived slow-growing flatfish, and the large Greenland halibut is distributed in the western slope of the Barents Sea and in the deeper wester areas (Wienerroither et al. 2013, Albert 2016). Small Greenland halibut is distributed around Svalbard which is considered as a nursery area (Albert & Vollen 2014). Biomass is estimated from GADGET which is a length based model (ICES 2015), with time series back to 1992 (ICES 2019a) (Table S2-38). Catch data is from ICES (2019) AFWG report (ICES 2019a).

Z for Greenland halibut (≥ 45 cm length) was calculated for 2000 by using a value for $F = Y/B = 0.029 \text{ year}^{-1}$ and assuming natural mortality of 0.10 year^{-1} . Q/B for large Greenland halibut was set 2.30 year^{-1} . Z for small Greenland halibut was set to 0.50 year^{-1} based on the consideration that they occupy cold and relatively deep water and may have a relatively low natural mortality rate. Greenland halibut females mature at age 7 and males at age 5, and at 55 cm (F) and 40 cm (M) length, respectively (Wienerroither et al. 2013).

Large Greenland halibut feed mostly on fish and cephalopods. Diet of small Greenland halibut (< 45 in length) around Svalbard was dominated by polar cod, but also contained other fish and deep-water shrimp (Vollen et al. 2004).

| Table S2-38 Large Greenland halibut (length ≥ 45 cm) | | | | | |
|--|--------|-----|-------------|---|----------------------------------|
| Variable | Value | Pe. | Time period | Comment | References |
| B (t ww) | 560000 | 6 | 2000 | Gadget model | (ICES 2019a) |
| B (g C m ⁻²) | 0.0499 | 6 | 2000 | Used in 2000 model, calculated from above | |
| Catch (t ww) | 2074 | 6 | 1950 | | (ICES 2019a) |
| | 14297 | 6 | 2000 | | |
| C/WW | 0.179 | | | | (Chumakov & Podrazhanskaya 1986) |
| Z (year ⁻¹) | | | 1950 | Used value for year 2000 as initial value | |
| | 0.129 | 5 | 2000 | Calculated as $Z = Y/B + M$, with an M of 0.10 year^{-1} | (ICES 2019a) |
| Q/B (year ⁻¹) | 2.30 | 7 | | Canada, consumpt. 0.63 % body weight day ⁻¹ for 11 year old fish | (Chumakov & Podrazhanskaya 1986) |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 5) Diet was average of three sets of data 1996-1998 Continental slope, Hopen Deep, Bear Island Channel, n = 386, Wp, (Hovde et al. 2002) 1992-1994, Barents Sea, Continental slope, October and June, n = 4204, Wp, (Michalsen et al. 1998) 1990-2010, Barents Sea, n = 40281, (Dolgov 2016) | | | | | |

| Table S2-39 Small Greenland halibut (< 45 cm length) | | | | | |
|--|-------|-----|-------------|-------------------|----------------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m ⁻²) | | 4 | | Multistanza proc. | |
| C/WW | 0.179 | | | | (Chumakov & Podrazhanskaya 1986) |
| Z (year ⁻¹) | 0.50 | 2 | | Assumed | |
| Q/B (year ⁻¹) | 9.0 | 4 | | Multistanza proc. | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 5) | | | | | |
| Average of two data sets | | | | | |
| 1995-1996, west and north of Svalbard, December-January, juvenile GLH, n = 353 stomachs, Wp (Vollen et al. 2004) | | | | | |
| 1990-2010, Barents Sea, diet from fish less than c. 35 cm in length (Dolgov 2016) | | | | | |

40 Other piscivorous fish

This group comprises Atlantic halibut (*Hippoglossus hippoglossus*), anglerfish (*Lophius piscatorius*), ling (*Molva molva*) and Spurdog/spiny dogfish (*Squalus acanthias*). No quantitative assessment of Atlantic halibut and Anglerfish is available. Biomass data is not available for these species and biomass is therefore calculated from catch and assumed fishing mortality. Atlantic halibut is probably the dominating species in the group and the Norwegian catch in the year 2000 was ca. 380 t WW (Bakketeig et al. 2015). If it is assumed that the total catches in the Barents Sea LME in the year 2000 was 500 t and that the fishing mortality rate was assumed to be 0.20 year⁻¹, this gives biomass of the commercial stock of $B = (\text{catch}/F) = 2500$ t WW which was used in the model (Table S2-40). According to ICES catch statistics, the annual catches in the 1950s ranged between 78 to 1954 tons per year (<https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx>). Catches increased to a maximum of 5137 tons in 1965 followed by a decrease to very low values (< 20 t) in the 1970'ies (*ibid.*). After the year 2000, annual Atlantic halibut catches in Norwegian waters has increased to a level of ca. 2000 t, indicating an increase in the populations size (Bakketeig et al. 2015).

A P/B-value of $P/B = F + M = 0.35$ year⁻¹ was used with a M of 0.15 year⁻¹ as used in anglerfish assessment for other stocks (Thangstad et al. 2002) (Table S2-40). Diet data is only available for Atlantic halibut, which feeds on many of the fish groups and northern shrimp. A similar diet is expected for anglerfish who feed on many fish species in other areas (Ofstad 2013).

| Table S2-40 Other piscivorous fish | | | | | |
|--|---------|-----|-------------|---|-------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t ww) | | | 1950 | Assumed equal to year 2000 | |
| | 2500 | 4 | 2000 | Calculated from catch and assumed fishing mortality | See text above |
| B (g C m ⁻²) | 0.00126 | | 1950 | Set equal to year 2000 | |
| | 0.00126 | | 2000 | | |
| Catch (t ww) | | | 1950 | Assumed equal to year 2000 | |
| | Ca. 500 | 5 | 2000 | | (Bakketeig et al. 2015) |
| C/WW | 0.101 | | | Assumed equal to value for cod | |
| P/B (year ⁻¹) | 0.35 | 4 | | Assumed, M = 0.15 and F = 0.20 year ⁻¹ | |
| P/Q | 0.15 | | | Assumed | |
| Q/B (year ⁻¹) | 2.00 | 5 | | Calculated from P/B and P/Q | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. 4) Diet composition is the weighted average by stomach numbers of the three data sets for Atlantic halibut: 2009-2010, Porsangerfjord and Ullsfjord, Norway, Wp, n = 30 and 3 st., respectively (unpubl. Data. Torstein Pedersen, UiT). 1990-2010, Barents Sea, n = 85, Wp (Dolgov 2016) | | | | | |

41 Wolffishes

This group comprises Atlantic wolffish (*Anarhichas lupus*), the spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*). The group has a wide distribution in the Barents Sea (Wienerroither et al. 2011). There is no separate stock assessment for the species or the group but there are swept-area estimates from bottom trawl surveys. Biomass was estimated by the model (Table S2-41).

P/B was assumed to be equal to total mortality rate Z estimated by catch-curve method (Chapman-Robson) to data on age distributions of male and female spotted wolffish from Nordbanken, Hjelmsøybanken and Bear Island from 1953 and 1954 (Østvedt 1963). The Z averaged for sex and area was 0.54 year⁻¹ (Table S2-41).

The diet is based on a study of Atlantic wolffish and consist mainly of sea urchins, bivalves, crustaceans and gastropods and some other benthic invertebrates and fish (Falk-Petersen et al. 2010). This is supported by information for Atlantic and spotted wolffish given by Zenkevitch (1963), who mention that wolffish may also feed on cod and long rough dab.

| Table S2-41 Wolffishes | | | | | |
|--|-----------------------|--------|-------------|--|-------------------------|
| Variable | Value | Pe. | Time period | Comment | Ref |
| B (g C m ⁻²) | M | | | Estimated by model | |
| Catch (t ww) | 14000 | | 1950 | | (Bakketeig et al. 2015) |
| | 31700 | 5 | 2000 | | (Bakketeig et al. 2015) |
| C/WW | | | 0.101 | Same as for cod | |
| P/B (year ⁻¹) | 0.536 (0.43, 0.64) | 8 (20) | 1953-1954 | Chapman-Robson method, P/B = Z, spotted wolffish | (Østvedt 1963) |
| P/Q | 0.20 | | | Assumed | |
| Q/B (year ⁻¹) | 2.68 | 6 | | Calculated from assumed P/Q and P/B | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 5) Diet composition is the average of four data sets for three species 1989-1993, Atlantic wolffish (<i>A. lupus</i>), coast of Northern Norway, n = 2008, Wp (Falk-Petersen et al. 2010). 1996-2010, Barents Sea, (<i>A. minor</i>), n = 995, Wp (Dolgov 2016) 1990-2010, Barents Sea, (<i>A. minor</i>), n = 1917, Wp (Dolgov 2016) 1990-2010, Barents Sea, (<i>A. denticulatus</i>), n = 725, Wp (Dolgov 2016) | | | | | |

42 Stichaeidae

This group consists of fish species of in the family Stichaeidae (*Anisarchus medius*, *Leptoclinus maculatus*, *Lumpenus fabricii* and *Lumpenus lampretaeformis*. The group has a wide distribution in the Barents Sea (Wienerroither et al. 2011). They have pelagic larvae. Biomass is estimated by the model.

P/B was assumed to be equal to $Z = 0.59 \text{ year}^{-1}$ estimated by the Chapman-Robson method based on a pooled age-distribution of females and males of *Leptoclinus maculatus* from the western part of Svalbard given by (Ottesen et al. 2014)(Table S2-43). The diet is based on a study of *Leptoclinus maculatus* and *Lumpenus lampretaeformis*, and consists of benthic invertebrates, polychaetes, crustaceans (mainly gammarids), echinoderms and others (Dolgov 1994). The group is preyed upon by many fish and bird groups.

| Table S2-43 Stichaeidae | | | | | |
|---|---------------------|--------|-------------|---------------------------------------|-----------------------|
| Variable | Value | Pe. | Time period | Comment | Reference |
| B (g WW m ⁻²) | M | 1 | | Estimated by model | |
| C/WW | 0.129 | | | | (Lawson et al. 1998) |
| P/B (year ⁻¹) | 0.59 (0.45,0.74) | 8 (25) | 2006-2008 | Chapman-Robson method. Used in models | (Ottesen et al. 2014) |
| P/Q | 0.20 | | | Assumed | |
| Q/B (year ⁻¹) | 2.95 | 5 | | From P/B and P/Q | |
| UC | 0.20 | | | General predatory fish | (Brett & Groves 1979) |
| Diet (Pe. = 5) | | | | | |
| 1990-2002, Barents Sea, <i>Lumpenus lampretaeformis</i> , n = 106, Wp (Dolgov 2016) | | | | | |
| 1990-2010, Barents Sea, <i>Leptoclinus maculatus</i> , n = 130, Wp (Dolgov 2016) | | | | | |

43 Other small bentivorous fishes

This group comprises many small-bodied species from several families (see Table S1-1). Many of them have demersal eggs and most species have their main distribution in the cold northern part of the Barents Sea (Wienerroither et al. 2011). These species are frequent in predator stomachs and the model estimates biomass.

P/B was assumed to be equal to $Z = 1.00 \text{ year}^{-1}$ estimated by the Chapman-Robson method from the average pooled age-distribution of females and males of six species (Table S2-43). Diet was calculated as the average for 24 species. The diet mainly consists of invertebrates, but some fish are consumed.

| Table S2-43 Other small bentivorous fishes | | | | | |
|---|---|------------------------------------|-------------|---|--|
| Variable | Value | Pe. | Time period | Comment | References |
| B (g C m ⁻²) | M | 1 | | Estimated by model | |
| C/WW | | | 0.129 | Same as for Stichaeidae | |
| Z or P/B (year ⁻¹) | 1.34 0.84 0.96 0.42 1.39 1.06 1.00 (0.63-1.38) | 5 5 (38) | 1998-1999 | <i>Liparis gibbus</i> <i>Careproctus reinhardii</i> <i>Leptagonus decagonus</i> <i>Triglops murrayi</i> <i>Triglops nybelini</i> <i>Myoxocephalus scorpius</i> Average for group | (Falk-Petersen et al. 1988) (Falk-Petersen et al. 1988) (Heggland et al. 2015) (Ottesen et al. 2014) (Ottesen et al. 2014) (Luksenburg & Pedersen 2002) |
| P/Q | 0.20 | | | Assumed | |
| Q/B (year ⁻¹) | 5.00 | 5 | | Calculated from P/B and P/Q | |
| UC | 0.20 | | | General predatory fish | (Brett & Groves 1979) |
| Diet (Pe. = 5) Diet data came from Dolgov (2016) based on data from 1990-2010. Diet composition was calculated as an average for all species weighted by stomach numbers (n). <i>Lycodes vahlii</i> , n = 597 <i>Lycodes seminudus</i> , n = 186 <i>Lycodes polaris</i> , n = 27 <i>Lycodes pallidus</i> , n = 112 <i>Lycodes eudipleurostichus</i> , n = 91 <i>Lycodes esmarkii</i> , n = 315, <i>Lycodes reticulatus</i> , n = 426 <i>Lycodes rossi</i> , n = 100 <i>Eumicrotremus spinosus</i> , n = 240 <i>Eumicrotremus derjugini</i> , n = 21 <i>Cottunculus microps</i> , n = 367 <i>Cottunculus sadko</i> , n = 145 <i>Triglops murrayi</i> , n = 552 <i>Triglops nybelini</i> , n = 773 <i>Triglops pingelii</i> , n = 92 <i>Gymnacanthus tricuspis</i> , n = 307 <i>Icelus bicornis</i> , n = 48 <i>Icelus spatula</i> , n = 25 <i>Myoxocephalus scorpius</i> , n = 196 <i>Artediellus atlanticus</i> , n = 710 <i>Leptagonus decagonus</i> , n = 667 <i>Liparis gibbus</i> , n = 248 <i>Liparis fabricii</i> , n = 385 <i>Careproctus reinhardi</i> , n = 632 | | | | | |

44 Other large benthic invertebrate feeding fishes

This group contain the following species; Roughead grenadier (*Macrourus berglax*), tusk (*Brosme brosme*), Arctic skate (*Amblyraja hyperborea*), Round skate (*Rajella fyllae*), Blue skate (*Dipturus batis*), Spinytail skate (*Bathyrāja spinicauda*), Sail ray (*Dipturus linteus*), *Chimaera monstrosa* and Velvet Belly (*Etmopterus spinax*). Catches in the period of 1950-2015 have been less than 1000 t and have been dominated by tusk (ICES database). Biomass was estimated by the model.

No information was found on mortality- and consumption rates for these species, so values were set equal to those for thorny skate (Table S2-44). Diet information for Roughead grenadier was used to represent the group and this species feed on northern shrimp (*Pandalus borealis*), other benthic invertebrates and some fish (Eliassen & Jobling 1985, Dolgov 2016).

| Table S2-44 Other large benthic invertebrate feeding fish | | | | | |
|--|-------|-----|-------------|----------------------------------|-----------------------|
| Variable | Value | Pe. | Time period | Comment | References |
| B (g C m ⁻²) | | 1 | 2000 | Estimated by model | |
| Catch (t WW) | 364 | 4 | 1950 | | ICES database |
| | 749 | 4 | 2000 | | IECS database |
| C/WW | 0.101 | | | Same as for Northeast Arctic cod | |
| P/B (year ⁻¹) | 0.27 | 5 | | Same as for thorny skate | |
| Q/B (year ⁻¹) | 2.9 | 5 | | Same as for Thorny skate | |
| UC | 0.20 | | | Predatory fish | (Brett & Groves 1979) |
| Diet (Pe. = 4) Diet composition for roughhead grenadier was used to represent the group, and data from two studies were averaged 1981-1984 Continental slope (500-900 m depth) of Northern Norway (69° N), n = 362 st. Dominance index (Eliassen & Jobling 1985) 1998-2007 Barents Sea, n = 444 st, Wp% (Dolgov 2016) | | | | | |

45 Thorny skate

Thorny skate is distributed in most of the Barents Sea except for the northeast high-arctic part (Dolgov et al. 2005a). Thorny skate is the most abundant skate in the Barents Sea and comprise ca. 92% of the biomass of skates according to (Dolgov et al. 2005a). The biomass of thorny skate in the Barents Sea was estimated based on numerical abundance and length data in 5 cm intervals from PINRO surveys from October to December (Dolgov et al. 2005a). The estimated average biomass (95495 tons WW) for the period of 1998-2001 is applied for 2000 (Dolgov et al. 2005a). Catch of thorny skate correspond to 90-95% of all bycatch of skates in the Barents Sea (Dolgov et al. 2005b).

P/B was calculated using an indirect method for natural mortality rate and adding estimated fishing mortality of 0.05 year⁻¹ (Frisk et al. 2005, Drevetnyak et al. 2010) (Table S2-45). Thorny skate feeds on many preys, both benthic invertebrates and diverse fish species, including cod, haddock and capelin (Dolgov 2016).

| Table S2-45 Thorny skate | | | | | |
|---|---------|-----|-------------|--|---|
| Variable | Value | Pe. | Time period | Comment | Ref |
| B (t WW) | 95495 | 5 | 1998-2001 | Av. for period (1998-2001) | (Dolgov et al. 2005a) |
| B (g C m ⁻²) | 0.00599 | 5 | 2000 | From above | |
| Catch (ton WW) | 3078 | 5 | 2000 | Assumed that total catch is twice the Russian catch of 1539 t WW | (Dolgov et al. 2005b) |
| C/WW | 0.126 | | | As for Greenland shark | |
| P/B (year ⁻¹) | 0.27 | 3 | | Based on life-hist. model: M = 0.22 year ⁻¹ and F = 0.05 year ⁻¹ | (Frisk et al. 2005) (Drevetnyak et al. 2010) |
| Q/B (year ⁻¹) | 2.9 | 5 | | Cited in (Dolgov 2005) | (Berestovsky 1989) |
| UC | 0.20 | | | As for Greenland shark | |
| Diet (Pe. 6) 1987-2010, Barents Sea, n = 4819, Wp% (Dolgov 2016) | | | | | |

46 Long rough dab

Long rough dab is distributed over most of the Barents Sea with the highest abundance in the central area with intermediate temperatures (Albert et al. 1994, Walsh 1996, Wienerroither et al. 2011). It has been caught as bycatch in the fishery for cod, but Albert et al. (1994) considered that less than 3000 tons were caught annually amounting to probably less than 0.2% of the standing biomass in the early 1990s. Mean Russian bycatch in the time period from 1946-2005 was approximately 5000 tonnes per year (Wienerroither et al. 2013). We added an assumed Norwegian catch of 5000 t in the year 2000, giving an annual total of 10 000 tons catch these years, which is reasonable according to increasing stock biomass. Despite that, this species is numerous, and no analytical assessment has been conducted (McBride et al. 2016). Dolgov (2009) reported the mean stock biomass in the time period from 1946-2005 to be 100 000 tons. Biomass has been estimated for the time period 2004-2013 based on the Barents Sea Ecosystem survey with an average of 408 167 tons ranging from 280 000 to 584 000 tons (Krivosheya & Bogstad 2015). For the year 2000, we used the average estimate for 2004-2006; 323 000 tons (Table S2-46). In 2013, the biomass estimate had increased to 565 000 tons (Krivosheya & Bogstad 2015). The biomass estimates for this species are likely a minimum estimate of the stock abundance (McBride et al. 2016).

Age-distributions show that long rough dab is a long-lived species in the Barents Sea and females have higher survival and become older than males (Albert et al. 1994, Albert et al. 1998, Fossen et al. 1999, Berestovsky & Matishov 2001). It is common that fish between 15 and 20 years old are present in the samples (*op cit.*). Average total mortality rate (Z) for males and females has been calculated to 0.34 year⁻¹ (CI: 0.28-0.41) from age-frequency distributions (Albert et al. 1998).

It was attempted to use data for American Plaice from Canada to estimate annual Q/B from estimates of daily rations (Macdonald et al. 1982, Zamarro 1992). However, the estimated Q/B of 1.17 year⁻¹ based on (Zamarro 1992) implied a P/Q of 0.29, which seem to be a very high P/Q for a long-lived slow growing species. Macdonald et al. (1982) estimated a daily consumption of 1.28% body weight per day corresponding to a Q/B of 4.67 year⁻¹ for juvenile American plaic with lengths of 14-31 cm at 5.5-6.1 °C. Adjusting this to an assumed ambient

temperature of 1 °C in the Barents Sea and a Q_{10} of 2.0 gives a Q/B of 3.29 year⁻¹. The average of 1.17 and 3.20 year⁻¹ was used in the Barents Sea model (Table S2-46).

Long rough dab feed mainly on benthic invertebrates and fish (Simacheva & Glukhov 1985, Dolgov 2000). In the period 1992-1997, cod made up much of the diet of long rough dab according to Dolgov (2000), but capelin and some polar cod are frequently consumed (*op cit.*). Echinoderms (mainly ophiurids) is a major prey group, but small molluscs, polychaetes and pandalid shrimp are also found in the diet.

| Table S2-46 Long rough dab | | | | | |
|---|------------------|----------|-------------|---|---|
| Variable | Value | Pe. | Time period | Comment | References |
| B (ton WW) | | | 1950 | Assumed equal to value for year 2000 | |
| | 323 000 | 4 | 2000 | Av. for period (2004-2006) | (Krivosheya & Bogstad 2015) |
| B (g C m ⁻²) | | 1 | 2000 | Estimated by model, biomass value above is likely underestimate | |
| Catch (ton ww) | 10 000 | 5 | 2000 | From Russian annual catches, with added assumed Norwegian catch equal to Russian catches of 5 000 tons. | (Albert et al. 1994, Wienerroither et al. 2011) |
| C/WW | 0.094 | | | | (Lawson et al. 1998) |
| P/B (year ⁻¹) | 0.34 (0.28-0.41) | 8 (19) | 1992-1995 | Coast of Northern Norway and Kola | (Albert et al. 1998) |
| Q/B (year ⁻¹) | 3.29 | | | For American plaice, adjusted to ambient temperature of 1 °C | (Macdonald et al. 1982) |
| | 1.31 | | | Assuming P/Q = 0.26 | |
| | 2.30 | 5 | | Average used in model | |
| P/Q | 0.26 | | | Somatic gross growth efficiency | (MacKinnon 1972) |
| UC | 0.20 | | | General carnivore | (Brett & Groves 1979) |
| Diet (Pe. = 5) 1991-2010, Barents Sea, n = 23699, Wp (Dolgov 2016) | | | | | |

47 Other benthivore flatfish

This group comprises several species; witch (*Glyptocephalus cynoglossus*), plaice (*Pleuronectes platessa*), dab (*Limanda limanda*), lemon sole (*Microstomus kitt*), European flounder (*Platichys flesus*) and Arctic flounder (*Liopsetta glacialis*) (Table S1-1), the species has different distributions, but are mainly distributed in the southern warmer part of the Barents Sea (Wienerroither et al. 2011). Biomass data were not available for this group, and biomass was estimated by the model. Catch data (3033 t WW in 2000) from ICES database were used as input (Table S2-47).

For witch, an estimate of total mortality rate (Z) are available for the Malangen fjord, Northern Norway (average $Z = 0.53 \text{ year}^{-1}$) (Nilsen et al. 1991). From age-distributions for the outer Norwegian coast (Albert et al. 1998), a total mortality rate Z of 0.56 year^{-1} was calculated using the Chapman-Robson catch-curve method and this value was used in the model (Table S2-47). The group feed mainly on benthic invertebrates; polychaetes, small bivalves, echinoderms, sandeel and krill (Dolgov 2016).

| Table S2-47 Other benthivore flatfish | | | | | |
|---|-------------------|--------|-------------|-------------------------------------|-----------------------|
| Variable | Value | Pe. | Time period | Comment | References |
| B (g WW m ⁻²) | M | 1 | | Estimated by model | |
| Catch t WW | 5954 | | 1950 | | ICES database |
| | 3033 | | 2000 | | ICES database |
| C/WW | 0.094 | | | Same as for long rough dab | |
| P/B (year ⁻¹) | 0.56 (0.43, 0.69) | 8 (23) | | For witch, coast of Northern Norway | (Albert et al. 1998) |
| Q/B (year ⁻¹) | 2.30 | 6 | | Same as for long rough dab | |
| UC | 0.20 | | | General carnivore | (Brett & Groves 1979) |
| Diet (Pe. = 5) Diet is the average for three species 2009-2010, Witch, Ullsfjord, Northern Norway, n = 98, Wp, Pedersen unpubl. mat. 2002-2010, Barents Sea, Dab, n = 263, Wp (Dolgov 2016) 2002-2010, Barents Sea, European Plaice, n = 4298, Wp (Dolgov 2016) | | | | | |

48 Large herring (> 25 cm length)

Atlantic herring is split into two groups that are not linked in the multistanza procedure. This is because the large, mainly mature herring has its main distribution outside the Barents Sea LME while the small juvenile herring has its main distribution within the Barents Sea. Large (> 25 cm length) Norwegian Spring spawning herring are mainly distributed in the Norwegian Sea, but during parts of the year (spawning season in winter, feeding season in summer, and overwintering in autumn), a part of the stock is distributed in the Barents Sea LME area as defined here. Most of the catch is taken at the overwintering areas which since 1965 has been partly within the Barents Sea LME and from 1997 mainly has been at and outside the coast of the Troms area, Northern Norway (Huse et al. 2010). Biomass and mortality values for 1950 are from (Toresen & Østvedt 2000) and for the period year 2000 from (ICES 2019b). It was assumed that on average, 15% of the large herring was within the BS LME.

P/B was calculated as catch/biomass + natural mortality rate resulting in $P/B = 0.22 \text{ year}^{-1}$ for 1950 and 0.40 year^{-1} for year 2000 assuming a M of 0.15 year^{-1} (ICES 2019e) (Table S2-48). Two studies report diet data from within the area. The herring was mainly feeding on *C. finmarhicus*, appendicularians and pelagic amphipods (Prokopchuk & Sentyabov 2006, Langøy et al. 2012).

| Table S2-48 Large herring | | | | | |
|---|-------|-----|-------------|--|--------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m ⁻²) | 0.314 | | 1950 | Assumed that 15% of the total biomass was within the Barents Sea | (Toresen & Østvedt 2000) |
| | 0.109 | 3 | 2000 | | (ICES 2019e) |
| C/WW | 0.226 | | | | (Mårtensson et al. 1996) |
| P/B (year ⁻¹) | 0.22 | 8 | 1950 | Based on | (Toresen & Østvedt 2000) |
| | 0.40 | 8 | 2000 | | (ICES 2019e) |
| Q/B (year ⁻¹) | 2.83 | 7 | | | (Bachiller et al. 2018) |
| UC | 0.16 | | | | (Bachiller et al. 2018) |
| Diet (Pe. = 5) The diet composition is average of two data sets 2001 and 2005, Barents sea, 8 stations, n = 416, Wp (Prokopchuk 2009) 2006, Eastern Norwegian Sea & Western Barents Sea, July-August, Wp (Langøy et al. 2012) | | | | | |

49 Small herring (< 25 cm length)

Norwegian spring spawning herring uses the Barents Sea as a nursery area, and herring from age 0 to up to age three years and ca 25 cm in length is abundant in years with strong year classes (Huse 1994). Small juvenile herring were caught during the period 1950-1971, but later only large herring has been exploited. Biomass values in the Barents Sea have large interannual variability (Table S2-49).

A P/B of 0.9 year⁻¹ is used in the assessment (ICES 2019e) and was used in the Ecopath model (Table S2-49). The diet of immature herring is dominated by *C. finmarchicus* (medium sized copepods) and euphausiids, and smaller amounts of pteropods, appendicularians, small copepods and other large zooplankton (Jørgensen 1992, Huse & Toresen 1996, Godiksen et al. 2006, Prokopchuk 2009). Herring larvae fed mainly on copepods while small juvenile herring (> 35 mm in length) also fed on euphausiids (Pedersen & Fossheim 2007). Larger 0-group feed mainly on copepods, krill and appendicularians (Prokopchuk 2009). Herring is an important prey group for mammals, birds and fish.

| Table S2-49 Small herring | | | | | |
|--|----------|-----|-------------|---------------------|--------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | 882 000 | 5 | 1950 | Assessment | (Toresen & Østvedt 2000) |
| | 2136 000 | 5 | 2000 | | (ICES 2019e) |
| B (g C m ⁻²) | 0.066 | 5 | 1950 | From above | |
| | 0.160 | 5 | 2000 | | |
| C/WW | 0.151 | | | | (Mårtensson et al. 1996) |
| P/B (year ⁻¹) | 0.9 | 4 | | Same as in 2000 | |
| | 0.9 | 4 | 2000 | | (ICES 2019e) |
| Q/B (year ⁻¹) | 4.7 | 6 | | Same as for capelin | |
| UC | 0.16 | | | | (Bachiller et al. 2018) |
| Diet (Pe. = 5) Diet composition was calculated as an average of five data sets for 1-2 year old herring 1989-1991, Coast of Northern Norway, 10 stations, April-September, n = 536, Wp (Jørgensen 1992) 1992-1993, Southwestern Barents Sea, May-June, n = 686, Wp (Huse & Toresen 1996) 2001 and 2005, Barents sea, 8 stations, n = 205, Wp (Prokopchuk 2009) 2003, Barents Sea, 3 stations, n = 240, Wp (Godiksen et al. 2006). 1984-2010, Barents Sea, n = 5278, Wp (Dolgov 2016) For 0-group herring, the diet composition was averaged over the years within data sets and then for the two data sets 2001-2003, Barents Sea, n = 57, % numbers (Pedersen & Fossheim 2007) 2002-2004, Barents sea, 8 stations, n = 410, Wp (Prokopchuk 2009) | | | | | |

50-51 Capelin

Capelin is divided into two multistanza groups, age 3+ and age 0-2 groups. Capelin spawns along the coast of Norway from ca. 69° N and east to the Kola coast (Gjøsæter 1998). The capelin die after spawning. Larvae and 1-group have a wide distribution in the central part of the Barents Sea and older capelin has feeding area in the central and northern part of the Barents Sea (*op cit.*). From 1972 onwards, the abundance and biomass have been estimated by an acoustic and pelagic trawl survey in the autumn (ICES 2019e). Prior to 1972, a biomass proxy based on frequency of occurrence of capelin in cod stomachs (Gjøsæter 1998), has been used to calculate biomass values.

Mortality rates (Z) have been estimated from numbers at age 1 and 2 and from the survey data and we used the average Z (= P/B) for the periode for 2000 - 2004 (Prozorkevich & Sunnanå 2017). For capelin age 3+ the P/B was set to 1.6 year⁻¹ to reflect the very high mortality after spawning. Q/B was set to 4.7 year⁻¹ based on an indirect method (Blanchard et al. 2002).

Capelin is a plankton feeder, although they may feed on fish larvae and also capelin eggs (Slotte et al. 2006). Diet composition data for capelin longer than 12 cm in length was used for the age 3+ group, while data for fish < 12 cm length was used for the age 1-2 group. Capelin larvae have a small mouth relative to their body size. (Pedersen & Fossheim 2007) found that capelin larvae guts contained much bivalvia and other meroplankton (resistant to digestion) and stages of small copepods. Capelin larvae also feed on protozoans (Pedersen & Fossheim 2007). Bjørke (1976) found that capelin larvae in 1971 fed on stages of *C. finmarchicus* and had a higher preference for eggs than for nauplii of *C. finmarchicus*. Capelin is important an important food source for many, mammal, bird, and some invertebrate groups.

| Table S2-50 Capelin age 3+ | | | | | |
|---|---------|-----|-------------|--|--------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | 1879000 | 4 | 1950 | From proxy | (Gjøsæter 1998) |
| | 2098000 | 5 | 2000 | | (ICES 2019e) |
| B (g C m ⁻²) | 0.128 | | 1950 | Initial value from above | |
| | 0.070 | | 2000 | Multistanza, with Capelin age 0-2 as leading stanza | |
| Catch (t WW) | 0 | | 1950 | | (Gjøsæter 1998) |
| | 410000 | 6 | 2000 | | (ICES 2019a) |
| C/WW | 0.137 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.6 | 2 | 1950 | Initial value equal to year 2000-value | |
| | 1.6 | 2 | 2000 | Assumed, set to high value because of mortality after spawning | |
| Q/B (year ⁻¹) | 4.7 | 3 | | Indirect method | (Blanchard et al. 2002) |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 6) | | | | | |
| The diet composition was averaged for all four sets of data | | | | | |
| 1989, August, Goose Bank, Barents Sea, n = 250, Wp (Ajiad & Pushchaeva 1992) | | | | | |
| 1992, Southwestern Barents Sea, May-June, n = 238 st., Wp (Huse & Toresen 1996) | | | | | |
| 2004-2005, Barents Sea, 5 and 7 areas sampled in the two years, n = 306 Wp (Orlova et al. 2009) | | | | | |
| 2005-2008, Barents Sea, wide area, August-September, n = 819, Wp (Dalpadado & Mowbray 2013) | | | | | |

| Table S2-51 Capelin age 0-2 | | | | | |
|---|---------|-----|-------------|---|-------------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | 2435000 | | 1950 | | (Gjøsæter 1998) |
| | 3290000 | 5* | 2000 | | (ICES 2019e) |
| B (g C m ⁻²) | 0.166 | | 1950 | Initial value from above | |
| | 0.224 | | 2000 | Multistanza, with Capelin age 0-2 as leading stanza | |
| C/WW | 0.137 | | | | (Mårtensson et al. 1996) |
| Z (year ⁻¹) | 1.07 | 5* | 1950 | Equal to value in 2000 | |
| | 1.07 | 5* | 2000 | | (Prozorkevich & Sunnanå 2017) |
| Q/B (year ⁻¹) | | 3 | | Multistanza | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 6) The diet composition was averaged for data sets described below 1989, Barents Sea, August, Goose Bank, n = 432, Wp (Ajiad & Pushchaeva 1992) 2005-2008, Barents Sea, wide area, August-September, n = 398, Wp (Dalpadado & Mowbray 2013) For 0-group capelin, the diet composition of the two data sets was averaged 1971, Barents Sea, April-June, n = 1149 st., % numbers (Bjørke 1976) 2001-2003, Barents Sea, summer, n = 931 st, % numbers (Pedersen & Fossheim 2007) | | | | | |

52-53 Polar cod

Polar cod is divided into two multistanza groups, age 2+ and age 0-1 groups. The species is a relatively short-lived gadoid distributed in cold water in the northern part of the Barents Sea and partly within the ice-covered areas (Wienerroither et al. 2011). Acoustical surveys have estimated biomass, and the first year with biomass data was 1986. The acoustic survey coverage may be low in some years since the survey was targeting capelin distribution of polar cod extend into ice-covered areas so that the survey estimate should be regarded as indicative (Gjøsæter 1995). The fishery on polar cod started in 1966, but catches peaked in 1971 with 332 000 t ww caught, and after that, catches have been lower and variable between years (Ajiad et al. 2011).

P/B was set equal to “survey mortalities” estimated from survey collected data to an average of 1.02 year⁻¹ for the period 1999-2015 based on numbers at age in survey data for age 1-2 and 2-3 (Table S2-52 & S2-53) (Prozorkevich & Sunnanå 2016). A very high value of gross growth efficiency (P/Q = 0.5) has been measured experimentally for polar cod fed *Calanus* to satiation, but P/Q was lower for fish fed capelin or *Themisto* (Hop et al. 1997). Thus, P/Q will likely be lower than 0.50 in the sea for fish feeding a mixture of prey, and a P/Q of 0.30 was assumed when calculating Q/B in the model. Polar cod is mainly a plankton feeder, feeding on copepods, pelagic and symphagic amphipods and krill (Hop & Gjøsæter 2013). Polar cod

is an important prey for demersal fish, including cod, seals and birds in the northern part of the Barents Sea (Hop & Gjøsæter 2013).

| Table S2-52 Polar cod age 2+ | | | | | |
|---|---------|-----|-------------|--------------------------------------|---|
| Variable | Value | Pe. | Time period | Comment | References |
| B (t WW) | | | 1950 | Set initial value to same as in 2000 | |
| | 1078000 | 5 | 2000 | | (Prozorkevich & Sunnanå 2016) |
| B (g C m ⁻²) | | | 1950 | Set initial value to same as in 2000 | |
| | 0.078 | 5 | 2000 | From above | |
| Catch (t WW) | 0 | 6 | 1950 | | |
| | 40730 | 6 | 2000 | ICES marine data | (http://ices.dk/marine-data) |
| C/WW | 0.146 | | | Midpoint of range given | (Nilssen et al. 2000) |
| Z (year ⁻¹) | | | 1950 | Initial value as in 2000 | |
| | 1.02 | 8 | 2000 | Survey mortalities | (Prozorkevich & Sunnanå 2016) |
| P/Q | 0.30 | | | Reduced from 0.5 in exp. conditions | (Hop et al. 1997) |
| Q/B (year ⁻¹) | 3.40 | 8* | | From P/B and P/Q | |
| UC | 0.20 | | | Energy budget | (Hop et al. 1997) |
| Diet (Pe. = 5) Diet composition was averaged for the four sets of data. 1986-1987, Barents Sea, drift-ice north of Svalbard and in western B. Sea, n = 114 st., Wp (Ajiad & Gjøsæter 1990) 2004-2005, Barents Sea, August-September, 5 and 7 areas sampled in the two years, n = 306, data for lengths > 10.5 cm used (Bogstad et al. 2011) 1986-2010, Barents Sea, n = 11097, Wp (Dolgov 2016) | | | | | |

| Table S2-53 Polar cod age 0-1 | | | | | |
|--|--------|-----|-------------|---|-------------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | 269400 | 4 | 2000 | Multistanza | (Prozorkevich & Sunnanå 2016) |
| B (g C m ⁻²) | 0.02 | | | Initial value | |
| C/WW | 0.146 | | 2000 | | (Nilssen et al. 2000) |
| Z (year ⁻¹) | | | 1950 | Initial value set to same as in 2000 | |
| | 1.0 | 5 | 2000 | Set equal to other small bentivorous fish | |
| Q/B (year ⁻¹) | | 4 | | Multistanza | |
| UC | 0.20 | | | As for polar cod age 1+ | |
| Diet (Pe. = 5) Diet was based on diet composition given above for larger polar cod, but proportions of medium copepods were adjusted upwards and proportion of pelagic amphipods and krill were adjusted downwards to become approximately equal to values given by (Orlova et al. 2009) for polar cod in the length interval 7-10.5 cm in length | | | | | |

54 Blue whiting

Blue whiting has their main distribution in the Norwegian Sea and further south but after year 2000, the abundance in the Barents Sea has increased (Dolgov et al. 2010). Blue whiting is a mesopelagic species with pronounced diurnal vertical migrations (Belikov et al. 2011).

Biomass of Blue whiting has been estimated since year 2004 and biomass has varied below a level of ca. 300 000 t WW (ICES 2020b). Blue whiting is exploited outside the Barents Sea. Biomass for the year 2000 models was estimated within the model.

P/B for year 2000 is set equal to 0.68 year^{-1} which is the Z estimated by the assessment for the whole stock (ICES 2019e) (Table S2-54). Q/B has been estimated to 5.77 year^{-1} for the Norwegian Sea (Bachiller et al. 2018) and this value was used in the model. Blue whiting feed on euphausiids (both large and *Thysanoessa*), copepods, and small fishes. Blue whiting is also prey for many predatory groups, e.g. Northeast Arctic cod and saithe.

| Table S2-54 Blue whiting | | | | | |
|--|-------|-----|-------------|----------------------------------|-------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | M | 1 | 1950 | Estimated by model | |
| | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.092 | | | Based on | (Bachiller et al. 2018) |
| P/B (year^{-1}) | | | 1950 | Initial value is same as in 2000 | |
| P/B (year^{-1}) | 0.68 | 8 | 2000 | | (ICES 2020b) |
| Q/B (year^{-1}) | 5.77 | 7 | | | (Bachiller et al. 2018) |
| UC | 0.17 | | | | (Bachiller et al. 2018) |
| Diet (Pe. = 6) | | | | | |
| 1998-2006, Barents sea, all quarters, n = 2281 st, Wp (Dolgov et al. 2010) | | | | | |

55 Sandeel

Sandeel (mainly *Ammodytes marinus*) is mainly distributed in the shallower coastal areas in the south and southeast of the Barents Sea (Eriksen et al. 2011). Sandeel may rest in sandy bottom substrate and biomass is difficult to assess quantitatively using trawl surveys or acoustic surveys (Høines & Bergstad 2001). Biomass was estimated by the model.

P/B and Q/B-values were set equal to those of capelin age 0-2 (Table S2-55). Sandeel is a plankton feeder and there is only one known feeding study (Godiksen et al. 2006). The diet composition of sandeel contains about 20% fewer euphausiids and 20 % more copepods than in juvenile herring. Sandeel is an important prey for seabirds, seals, whales and fish (*e.g.* salmon) in relatively shallow coastal waters (Barrett et al. 1997, Svenning et al. 2005a, Svenning et al. 2005b, Eriksen et al. 2011).

| Table S2- 55 Sandeel | | | | | |
|---|-------|-----|-------------|-----------------------------|--------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g WW m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.131 | | | | (Mårtensson et al. 1996) |
| P/B (year ⁻¹) | 1.07 | 5 | | Same as for capelin age 0-2 | |
| Q/B (year ⁻¹) | 4.7 | 5 | | Same as for capelin | |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. = 5) Data from diet in 2003, Barents Sea, one station, n = 80 st., Wp (Godiksen et al. 2006), showed a very similar diet as for herring in the same area and diet composition for small herring was used, but with less krill and more medium sized copepods | | | | | |

56 Other pelagic planktivorous fish

The group comprises the small mesopelagic fishes (*Benthosema glaciale* and *Maurolicus muelleri*), the larger *Arctozenus risso* (family Paralepididae) and *Argentina silus*. *Benthosema glaciale* and *Maurolicus muelleri* are plankton feeders and mainly feed on calanoid copepods and are relatively short-lived with high mortality rates (T. Pedersen unpubl. obs, Kristoffersen & Salvanes 1998). Biomass was estimated by the model.

Z has been estimated to 2.30 and 0.71 year⁻¹ for *M. muelleri* and *B. glaciale*, respectively and a P/B equal to the average Z has been used for the group (Table S2-56). No direct diet data is available but lipid data suggest that calanoid copepods are the main prey (Falk-Petersen et al. 1986). Diet composition was assumed to be similar to small herring, but with less krill.

| Table S2-56 Other pelagic planktivorous fishes | | | | | |
|---|-----------------------------|-----|-------------|---|--|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.144 | | | Av. for <i>M. muelleri</i> <i>B. glaciale</i> | (Pedersen & Hislop 2001, Spitz et al. 2010) |
| P/B (year ⁻¹) | 2.30 0.74 1.51 | 6 | | <i>M. muelleri</i> <i>B. glaciale</i> average used in mod. | (Kristoffersen & Salvanes 1998) (Gjøsæter 1973) |
| P/Q | 0.20 | | | Assumed | |
| Q/B (year ⁻¹) | 7.55 | 5 | | From P/B and P/Q | |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. = 3) | | | | | |
| Diet composition was assumed to be similar to small herring, but with less krill (T. Pedersen, UiT, unpubl. obs.) | | | | | |

57 Lumpfish

Lumpfish spawn at the coast in shallow water and the juveniles leave the coastal areas and feed pelagically in the Norwegian and Barents Sea. In the Barents Sea, pelagic lumpfish has a wide distribution (Eriksen et al. 2014). There are biomass estimates of the pelagic part of the population-based on swept-area methods using pelagic trawl for the period 1990-2014 (Eriksen et al. 2014). Catch time-series is available for the period 1970-2010 (Eriksen et al. 2014) <https://heima.hafro.is/~jim/project/populations/>.

P/B was calculated using indirect methods Pauly (1980) and Q/B calculated from P/B and P/Q (Table S2-57). Diet studies show that ctenophores are major prey in the Barents Sea (Dolgov 2016).

| Table S2-57 Lumpfish | | | | | |
|--|-------------------------|--------|-------------|---|-----------------------|
| Variable | Value | Pe. | Time period | Comment | Ref |
| B (t WW) | 72898 (53000, 84000) | 6 (21) | 2000 | Swept area from pelagic trawl survey | (Eriksen et al. 2014) |
| B (g C m ⁻²) | | | 1950 | Set to value for year 2000 | (Eriksen et al. 2014) |
| | 0.00363 | | 2000 | | |
| Catch (t WW) | 2373 | | 2000 | (http://ices.dk/marine-data) | ICES marine data |
| C/WW | 0.10 | | | Assumed | |
| M (year ⁻¹) | 0.44 | | | K = 0.42 year ⁻¹ , t = 6 °C, Loo = 45.7 cm | Pauly (1980) |
| P/B (year ⁻¹) | 0.47 | 4 | 2000 | | Pauly (1980) |
| P/Q | 0.29 | | | General carnivore fish | (Brett & Groves 1979) |
| Q/B (year ⁻¹) | 1.62 | 5 | 2000 | From P/B and P/Q | |
| UC | 0.20 | | | General carnivore fish | (Brett & Groves 1979) |
| Diet (Pe. = 3) | | | | | |
| Diet was a weighted average from three data sets | | | | | |
| Coast of Northern Norway (Myrseth 1971) | | | | | |
| 2001-2003, Barents Sea, T. Pedersen, UiT, unpubl. Observations | | | | | |
| 2004-2010, Barents Sea, n = 121, Wp (Dolgov 2016) | | | | | |

58 Mackerel

Mackerel is a widely distributed stock that spawn west of the British Isles and Ireland and have its main distribution south of the Barents Sea. No biomass estimates were available in the Barents Sea LME-area. Catch data for year 2000 show that ca. 100 t WW was landed in the Barents Sea LME area in year 2000 (Table S2-58).

P/B was set to the Z-value (0.49 year^{-1}) used in the assessment for year 2000 (ICES 2019e) (Eriksen et al. 2014). Mackerel caught at Svalbard in 2013 had fed on small juvenile herring (Berge et al. 2015), but except for this, no quantitative diet data were available from the Barents Sea area and the diet was calculated from samples from the Arctic part of the Norwegian Sea (Langøy et al. 2012). Predation from mackerel on herring larvae was observed around Lofoten in the southern part of the model area (Skaret et al. 2015).

| Table S2-58 Mackerel | | | | | |
|--|-------|-----|-------------|--|--------------------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | M | 1 | 2000 | Estimated by model | |
| Catch (t WW) | 0 | | 1950 | Assumed to be zero | |
| | 99 | 6 | 2000 | https://www.fiskeridir.no/Yrkesfiske/Tall-og-analyse/Fangst-og-kvoter/Fangst/Fangst-fordelt-paa-landingssted (half of catch in Nordland, and all in Troms and Finnmark) | Statistics, Directorate of Fisheries |
| C/WW | 0.22 | | | Based on | (Bachiller et al. 2018) |
| P/B (year^{-1}) | 0.49 | 5 | | Assessment: $Z = F + M = (0.336 + 0.15) \text{ year}^{-1}$ | (ICES 2019e) |
| Q/B (year^{-1}) | 2.35 | 7 | | | (Bachiller et al. 2018) |
| UC | 0.16 | | | | (Bachiller et al. 2018) |
| Diet (Pe. = 5) Diet composition based on data from Langøy et al. (2012) with the addition of a small proportion (0.005) of small herring in the diet to indicate these trophic links. 2004 and 2006, Norwegian Sea, arctic part, 3 stations, n = 30 st., Wp (Langøy et al. 2012) 2013, June, around Lofoten, Wp (Skaret et al. 2015) 2013, September, Svalbard, n = 10, Wp (Berge et al. 2015) | | | | | |

59-60 Redfish

Redfish is divided into two multistanza-groups, “Large Redfish” and “Small redfish”. The groups consist of two species, beaked redfish (*Sebastes mentella*) and golden redfish (*Sebastes norvegicus*, earlier *Sebastes marinus*). Both species are slow-growing, late maturing and long-lived species (Planque et al. 2013). The beaked redfish has a more pelagic distribution extending into the Norwegian Sea than has golden redfish. In predator stomachs analysis, it is very seldom that the two species are differentiated and we therefore treat them as one group. The large redfish group has low natural mortality rate and is rare in predator stomachs but is exposed to fishery exploitation. The small redfish group that occur in predator stomachs and has higher natural mortality rate and are prone to a predation mortality in the Ecopath model. Parts of the two redfish stocks are distributed outside the Barents Sea LME. We used the spawning stock size as a measure for biomass for “Large Redfish” in the Barents Sea since part of the stock is outside the Barents Sea. The catches from the two species are

pooled in the analysis, and total catches of the two redfish species peaked in 1976 with 342 000 t WW (ICES 2019a) (Table S2-59).

Sebastes mentella is assessed using a Statistical catch at age model for the period after 1992 and natural mortality rate (M) was set 0.05 year⁻¹ (ICES 2019a). *S. norvegicus* is assessed using the model GADGET and *S. norvegicus* has a higher fishing mortality than *S. mentella* (ICES 2019a). Fishing mortality for year 2000 for the large redfish group has been calculated from the pooled biomass and catch values ($F = \text{catch/biomass} = 0.025 \text{ year}^{-1}$). P/B was set to 0.10 year⁻¹ for the “Large redfish” group (Table S2-59). Small redfish are frequently occurring in predator stomachs and the P/B was set to the same value as for “Other small benthivorous fishes” (1.0 year⁻¹) in the Ecopath model (Table S2-43).

| Table S2-59 Large Redfish | | | | | |
|--|--------|-----|-------------|---|----------------------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (t WW) | | | 1950 | Initial value set to same as in 2000 | |
| | 602000 | 5 | 2000 | Sum of spawning stock biomass for <i>S. mentella</i> and <i>S. norvegicus</i> | (ICES 2019a) |
| B (g C m ⁻²) | | | 1950 | Initial value set to same as in 2000 | |
| | 0.034 | | 2000 | From above | |
| Catch (t WW) | 25500 | 6 | 1950 | Catch of <i>S. norvegicus</i> | (ICES 2019a) |
| | 24536 | 6 | 2000 | Catch of <i>S. norvegicus</i> and <i>S. mentella</i> | (ICES 2019a) |
| C/WW | 0.118 | | | | (Lawson et al. 1998) |
| Z (year ⁻¹) | 0.10 | 8 | | Av. for beaked and golden redfish | (ICES 2019a) |
| Q/B (year ⁻¹) | 1.3 | 6* | | For <i>S. mentella</i> | (Dolgov & Drevetnyak 1990) |
| UC | 0.30 | | | Assumed | (Dolgov & Drevetnyak 1990) |
| Diet (Pe. = 6) Diet composition was calculated as a weighted average for the two species assuming that <i>S. mentella</i> consumed 70% of the total consumption 1991-2010, Barents Sea, wide area, n = 15836 <i>S. mentella</i> & n = 1491 <i>S. marinus</i> , Wp, (Dolgov 2016) | | | | | |

| Table S2-60 Small Redfish | | | | | |
|--|-------|-----|------|---------------------------------------|-----------------------|
| | Value | Pe. | Year | Comments | References |
| B (t WW) | M | 4 | | Estimated by the model, multistanza | |
| C/WW | 0.118 | | | | (Lawson et al. 1998) |
| Z (year ⁻¹) | 1.0 | 5 | | Same as for Small benthivorous fishes | |
| Q/B (year ⁻¹) | M | 4 | | Multistanza | |
| UC | 0.20 | | | | (Brett & Groves 1979) |
| Diet (Pe. = 5) The diet composition was similar to diet of large redfish, but with less capelin, Northern shrimp and cephalopods and more small krill and medium sized copepods (Dolgov 2016) | | | | | |

61 Atlantic salmon

Salmon spawning in rivers in Northern Norway and in Russia along the Barents Sea and use the Barents Sea as a feeding area (Ozerov et al. 2017). Biomass and P/B-value were taken from another Ecopath model (Skaret & Pitcher 2016). The proportion of the salmon caught in the sea has decreased in Norway in recent years and in year 2000, 53% of the catch was taken in the sea. Based on distribution of catches of salmon within districts in Norway, It was assumed that 28% of the total catch of salmon in Norway and Russia was taken in the Barents Sea LME. The biomass value used in our model was set equal to half the biomass density calculated for the Norwegian and Barents Sea Ecopath model (Skaret & Pitcher 2016)(Table S2-61).

P/B was set to 0.60 year^{-1} and Q/B was calculated to 2.07 year^{-1} assuming a P/Q of 0.29 (Table S2-61). The diet composition in the model was derived based on data from the north of Andøya (69-70°N) (Hansen & Pethon 1985) and the Barents Sea coastal area (Rasmussen 2012, (Aykanat et al. 2020). Salmon feed mainly on pelagic invertebrates (krill and amphipods), herring, capelin, sandeel and small haddock (Hansen & Pethon 1985, Rasmussen 2012).

| Table S2-61 Salmon | | | | | |
|--|---------|-----|-------------|---|-------------------------|
| Vatiable | Value | Pe. | Time period | Comment | References |
| B (g C m^{-2}) | 0.00043 | 4 | 2000 | | (Skaret & Pitcher 2016) |
| Catch ($\text{g C m}^{-2} \text{ year}^{-1}$) | 0.00004 | | 2000 | Assumed 28 of Norwegian catch and all Russian catch | (ICES 2020a) |
| C/WW | 0.178 | | | Prespawning fish | (Jonsson et al. 1997) |
| P/B (year^{-1}) | 0.60 | 4 | | | (Skaret & Pitcher 2016) |
| P/Q | 0.29 | | | General carnivore fish | (Brett & Groves 1979) |
| Q/B (year^{-1}) | 2.07 | 5 | | Based on P/B and P/Q = 0.29 | |
| UC | 0.20 | | | General predatory fish | (Brett & Groves 1979) |
| Diet (Pe. = 5) | | | | | |
| Diet composition was averaged from two studies | | | | | |
| 1969-1972, North of Andøya, n = 468, Foc (Hansen & Pethon 1985) | | | | | |
| 2008, May-July, coast of Troms and Finnmark, Norway, n = 2247, Wp (Rasmussen 2012, Aykanat et al. 2020). | | | | | |

Pelagic invertebrate plankton and nekton

62 Cephalopods

According to Golikov et al. (2016), the two most abundant cephalopod species are *Rossia palpebrosa* and *Gonatus fabricii*. *Gonatus* has the highest biomass of the two species. *Gonatus* is distributed in the deep western parts, and *Rossia* is mainly distributed in the colder northeastern parts (Sennikov et al. 1989). *Gonatus fabricii* in the Norwegian Sea has a two year life cycle and has high biomass in the Norwegian Sea (Bjørke 2001, Dommasnes et al. 2002). It is likely that *Gonatus fabricii* juveniles are transported to western part of the Barents Sea from the Norwegian Sea. The biomass of cephalopods in the Barents sea was estimated from sampling by bottom and pelagic trawl to an average of 36 000 t for the period 2007-2012 (Golikov et al. 2016) (Table S2-62). Cephalopods are common in predator stomachs and the biomass was estimated by the model.

A P/B-value of 2.44 year⁻¹ was used (Dommasnes et al. 2002) (Table S2-62). Q/B was set to 12.0 year⁻¹ based on (Dommasnes et al. 2002). Diet composition was calculated from stomach samples of *Gonatus* from (Wiborg 1980, 1982) and from (Sennikov et al. 1989), who sampled the eastern part of the Norwegian Sea and the western part of the Barents Sea. They mainly feed on pelagic amphipods, large calanoid copepods and krill (Sennikov et al. 1989, (Wiborg 1980, 1982).

| Table S2-62 Cephalopods | | | | | |
|---|-------|-----|-------------|--|-------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (t WW) | 36000 | 5 | 2007-2012 | | (Golikov et al. 2016) |
| B (g C m ⁻²) | M | 1 | 2000 | Biomass estimated by model | |
| C/WW | 0.151 | | | <i>Gonatus fabricii</i> | (Lawson et al. 1998) |
| P/B (year ⁻¹) | 2.44 | 7 | | Calculated from production estimates and biomass | (Dommasnes et al. 2002) |
| Q/B (year ⁻¹) | 12.0 | 7 | | | (Dommasnes et al. 2002) |
| UC | 0.20 | | | <i>Sepia officinalis</i> | (Domingues et al. 2008) |
| Diet (Pe. 4) | | | | | |
| Frequency of occurrence of <i>Gonatus</i> was scaled to a sum of 1.0 and the average of the two data sets were taken as diet composition. | | | | | |
| 1979- June-September, Barents Sea, n = 218, Foc (Wiborg 1980, 1982), sample from Jan Mayen was omitted | | | | | |
| 1986-1988, summer and autumn, Barents Sea, n = 497, Foc (Sennikov et al. 1989) | | | | | |

63 Scyphomedusae

The two species *Cyanea capillata* and *Aurelia aurita* occur in the Barents Sea (Eriksen et al. 2012) and they are distributed in the western and central part. The total biomass of scyphozoans was estimated from sampling with pelagic trawl (swept area method) in the autumn for the period 1980-2010 (Eriksen et al. 2012). The mean biomass for the area surveyed and the period 1980-2010 was 0.78 g WW m⁻² (Eriksen et al. 2012).

P/B was set to 3.0 based on Pauly et al. (1996) and this value was also used by (Dommasnes et al. 2002) (Table S2-63). Q/B was calculated to 30.0 year⁻¹ based on a P/Q of 0.10. Diet composition was based on Martinussen and Båmstedt (1995) and Båmstedt et al. (1994) which showed that they mainly fed on zooplankton, including fish eggs and fish larvae. *Cyanea capillata* may predate on *Aurelia aurita* (Båmstedt et al. 1994) and may also predate on ctenophores (Hosia & Titelman 2010).

| Table S2-63 Scyphomedusae | | | | | |
|--|---------|-----|-------------|--|--------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (t WW km ⁻²) | 0.78 | 5 | 1980-2010 | Mean for period | (Eriksen et al. 2012) |
| B (g C m ⁻²) | 0.00265 | 5 | 1950 | Equal to value for year 2000 | |
| | 0.00265 | 5 | 2000 | Calculated from wet mass biomass value above | (Eriksen et al. 2012) |
| C/WW | 0.0034 | | | Av. values for <i>A. aurita</i> and <i>C. capillata</i> of the DW/WW ratio (0.040) and the C/DW ratio of 0.086 | (Larson 1986) |
| P/B (year ⁻¹) | 3.0 | 5 | | Also used by (Dommasnes et al. 2002) | (Pauly et al. 1996) |
| P/Q | 0.10 | | | Calculated for <i>A. aurita</i> | (Møller & Riisgård 2007) |
| Q/B (year ⁻¹) | 30.0 | 5 | | From P/B and P/Q | |
| UC | 0.65 | | | For <i>Aurelia aurita</i> | (Møller & Riisgård 2007) |
| Diet (Pe. = 3) Diet composition was based on two sets of data 1992-1993, Raunefjorden, Western Norway, <i>A. aurita</i> (n = 73), <i>C. capillata</i> (n = 189), gut analysis (Martinussen & Båmstedt 1995) Laboratory experiments, <i>A. aurita</i> and <i>C. capillata</i> (Båmstedt et al. 1994) | | | | | |

64 Chaetognaths

Chaetognaths are widely distributed, carnivorous, and are very common in plankton samples in the Barents Sea. Local biomass in the Barents Sea may be up to ca. 0.5 g C m⁻² based on plankton net samples (Hassel et al. 1991, Dvoretsky & Dvoretsky 2009). Two species, *Parasagitta elegans* and *Eukrohnia hamata*, are present. However, no abundance or biomass estimate for the whole Barents Sea are available, and the biomass was estimated by the model.

Grigor et al. (2014) suggested that *P. elegans* had a three-year life-cycle at Svalbard. P/B in the model was set to 3.8 year⁻¹ based on data from *Parasagitta elegans* from a subarctic fjord 70°N in Northern Norway (Pedersen et al. 2008) (Table S2-64). Q/B was calculated to 12.5 year⁻¹ from feeding rates calculated from sampled from the Barents Sea (Falkenhaus 1991). Chaetognaths prey on zooplankton in the Barents Sea (Falkenhaus 1991, Hirche & Kosobokova 2011), and their diet in the model were dominated by the copepod groups. They may also feed on appendicularians, juvenile euphausiids and cannibalism do occur (Solov'ev & Kosobokova 2003). Chaetognaths are common prey for planktivorous fishes in the Barents Sea (Orlova et al. 2009).

| Table S2-64 Chaetognaths | | | | | |
|---|--------|-----|-------------|--|-------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (t C km ⁻²) | M | 1 | | Estimated by model | |
| C/WW | 0.0408 | | | | (Ikeda & Skjoldal 1989) |
| P/B (year ⁻¹) | 3.8 | 7 | | | (Pedersen et al. 2008) |
| Q/B (year ⁻¹) | 12.5 | 8 | | Calculated from specific daily feeding rates | (Falkenhaus 1991) |
| UC | 0.28 | | | for <i>Sagitta elegans</i> | (Sameoto 1972) |
| Diet (Pe. 6) | | | | | |
| 1983, Barents Sea, May-June, 7 stations, <i>S. elegans</i> , n = 3014, Wp (Falkenhaus 1991) | | | | | |
| 1999-2000, White Sea, <i>S. elegans</i> , n = 877, Wp (Solov'ev & Kosobokova 2003) | | | | | |

65 *Thysanoessa*

The species in the group (*Thysanoessa inermis*, *T. raschii* and *T. longicaudata*) are predominantly herbivorous. Life-lengths of 3-4 years were indicated for *T. inermis* and three years for *T. longicaudata* in the mixed ice zone (Dalpadado & Skjoldal 1996, Dalpadado et al. 2008a). Life-lengths of two years or slightly more were found for the species further south in the Barents Sea (Dalpadado & Skjoldal 1991). Biomass of krill, including large krill (*M. norvegica*) was estimated from 1980-2009 by pelagic trawl and swept –volume method in the autumn (Eriksen & Dalpadado 2011). A Russian time-series with krill abundance indices exist from 1952 onwards based on a plankton net connected to the headline of the bottom trawl (Drobysheva 1994, Johannesen et al. 2012a, Orlova et al. 2015, Eriksen et al. 2016). Both time-series show considerable yearly fluctuations. Biomass was estimated by the model.

P/B was set to 2.5 year⁻¹ for the group (Table S2-65). This value is equal to the values used for the krill group by (Dommasnes et al. 2002) for the Norwegian Sea and the Barents Sea and for *Thysanoessa* in a sub-arctic fjord (Pedersen et al. 2008), and very close to P/B = 2.43 year⁻¹ computed by Christensen (1995) based on data from *Thysanoessa* (Lindley 1980). Q/B was set to 16.7 year⁻¹, implying a P/Q of 0.15 (Christensen 1995).

T. inermis is predominantly herbivorous feeding mostly on diatoms and dinoflagellates, while *T. longicaudata* feed on phytoplankton and some calanoid copepods and tintinnids

(Dalpadado et al. 2008b). *Thysanoessa* are preyed upon by many other groups, including invertebrates, fishes, mammals and birds (Eriksen & Dalpadado 2011).

| Table S2-65 <i>Thysanoessa</i> | | | | | |
|---|-------|-----|-------------|---|-------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by the model | |
| C/WW | 0.152 | | | Average of groups with body weight < and > 10 mg DW | (Ikeda & Skjoldal 1989) |
| P/B (year ⁻¹) | 2.5 | 3 | | | (Dommasnes et al. 2002) |
| Q/B (year ⁻¹) | 16.7 | 3 | | | (Pedersen et al. 2008) |
| UC | 0.30 | | | | (Slagstad et al. 1999) |
| Diet (Pe. = 4) 2004 -2005, North and east of Svalbard, May and July, <i>T. inermis</i> and <i>T. longicaudata</i> , n = 46 st., qualitative (Dalpadado et al. 2008b) | | | | | |

66 Large krill (*Meganctiphanes norvegica*)

Life-length of *M. norvegica* was ca. 2.5 years in Balsfjord, northern Norway (Falk-Petersen & Hopkins 1981). *M. norvegica* is advected into the Barents Sea from the Norwegian Sea and is mainly found in the warmer southwestern part of the Barents Sea (Dalpadado & Skjoldal 1991, Eriksen et al. 2016). *M. norvegica* is lumped with the other krill species with regard to estimation of biomass indices (see “*Thysanoessa*”) from surveys. Biomass was estimated by the model.

P/B was set to 2.5 year⁻¹ (Table S2-66). This value was used for the krill group by (Dommasnes et al. 2002) for the Norwegian and the Barents Seas. For Antarctic krill *Euphausia superba*, a food consumption of 5% day⁻¹ has been suggested and this gave a Q/B of 18.3 year⁻¹ which was used in the model. *M. norvegica* is an omnivore feeding on both phytoplankton and copepods and also on microzooplankton (e.g., tintinnids) (Dalpadado et al. 2008b). The species is prey for many fish and mammal species.

| Table S2-66 Large krill | | | | | |
|--|-----------------------------|-----|-------------|---|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | | Estimated by the model | |
| C/WW | 0.12 | | | From Balsfjord, northern Norway | (Falk-Petersen 1981) |
| P/B (year ⁻¹) | 2.5 | 5 | | | (Dommasnes et al. 2002) |
| Q/B (year ⁻¹) | 18.25 | 5 | | From consumption of 5% body weight day ⁻¹ | (Clarke & Morris 1983) |
| UC | 0.20 0.35 0.28 | | | <i>Meganctiphanes norvegica</i> Average used in the model | (Tarling et al. 2000) (Conover 1966) |
| Diet (Pe. = 4) 2004 -2005, North and east of Svalbard, May and July, n = 22 st., qualitative (Dalpadado et al. 2008b) | | | | | |

67 Ctenophora

Mertensia ovum and *Beroe cucumis* are common in the northern and central Barents Sea (Swanberg & Bamstedt 1991, Lundberg et al. 2006). *M. ovum* has a life length of about two years (Lundberg et al. 2006). *Bolinopsis infundibulum* has been observed in the southern part of the Barents Sea in warm years (Zenkevitch 1963). There are few studies of ctenophore biomass, but biomass of *M. ovum* was calculated to an average of 0.091 g C m⁻² based on five studies, and this value was used in the model. Although ctenophores are found in predator stomachs, there is no quantitative estimates of predator consumption. Hence, the biomass was not estimated by the model was but based on the field measurements (Table S-67).

P/B was calculated to 2.4 year⁻¹ based on the data for *M. ovum* from Svalbard (Lundberg et al. 2006) (Table S2-67). Published values for assimilation efficiency in ctenophores were relatively low (ca. 22%, UC = 0.78) and gross growth efficiency (P/Q) is also low (P/Q = 0.08)(Welch 1968, Møller et al. 2010). Q/B was calculated to 30.0 year⁻¹ based on the P/B and a P/Q of 0.08.

Calanus, especially *C. glacialis* is likely the most important prey of *M. ovum* and *M. ovum* is the main prey of *Beroe* (Falk-Petersen et al. 2002). *M. ovum* also feed on chaetognaths, *Thysanoessa* (krill), appendicularians, and the amphipod *Themisto* has been identified (Majaneva et al. 2013). Ctenophores are consumed by cod and other fishes (Falk-Petersen et al. 2002, Eriksen et al. 2018).

| Table S2-67 Ctenophora | | | | | |
|---|----------------------|-----------|-------------|--|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.091 (CV = 0.58) | 5 (90) | | Average from 5 studies | (Swanberg & Bamstedt 1991, Søreide et al. 2003, Lundberg et al. 2006, Majaneva et al. 2013) |
| C/WW | 0.010 | | | Arctic Canada | (Percy & Fife 1981) |
| P/B (year ⁻¹) | 2.4 | 7 | | Calculated from data in (Lundberg et al. 2006) | |
| P/Q | 0.08 | | | For <i>Pleurobrachia pileus</i> | (Møller et al. 2010) |
| Q/B (year ⁻¹) | 30.0 | 5 | | From P/B and P/Q | |
| UC | 0.78 | | | | (Møller et al. 2010) |
| Diet (Pe. = 4) 1997, Svalbard, <i>M. ovum</i> (n = 10), <i>B. cucumis</i> (n = 18), diet inferred from lipid analysis (Falk-Petersen et al. 2002) 2010, Svalbard, September, <i>M. ovum</i> , n = 78, N% (Majaneva et al. 2013) | | | | | |

68 Pelagic amphipods

Themisto abyssorum and *Themisto libellula* are the two dominant species and the larger *T. libellula* are distributed in colder water than the smaller *T. abyssorum* (Dalpadado et al. 2001). Dalpadado et al. (2001) give abundance (ind. m⁻²) time-series for the period 1984-1996, and show a time-series to 2010. Life-length of *T. libellula* which dominate the biomass has been indicated to be two to three years by (Koszteln et al. 1995, Dalpadado 2002, Dale et al. 2006). Dalpadado et al. (2008a) indicated more cohorts with a life length up to 4 years in the marginal ice zone.

There is no P/B-value available based on field data, so a value (P/B = 2.20 year⁻¹) was calculated from average growth rate from embryo to adult and a life-length of 2.5 years was used (Table S2-68). From Auel and Werner (2003), a Q/B of 6.9 year⁻¹ for large individuals (ca. 25 mm long) and ca 10 year⁻¹ for 10 mm long ind. can be calculated. In the Ecopath model, a Q/B of 7.1 year⁻¹ based on a P/Q of 0.31 was used.

Lipid content of *T. libellula* increase during late summer (Dale et al. 2006). The *Themisto*-species are predominantly raptorial feeders feeding on zooplankton, mainly copepods and some phytoplankton (Dalpadado et al. 2008b, Noyon et al. 2009, Kraft et al. 2013). *Themisto libellula* may also feed on ice-algae (Scott et al. 1999). *T. abyssorum* fed on some appendicularians and both *Themisto*-species fed on tintinnids (Dalpadado et al. 2008b). *T. libellula* is an important prey for harp seals in the northern Barents Sea (Nilssen et al. 1995b, Dalpadado et al. 2001). *Themisto* is also important prey for polar cod and Atlantic cod, especially in years with low capelin abundance (Dalpadado et al. 2001). A number of other groups also feed on *Themisto*.

| Table S2-68 Pelagic amphipods | | | | | |
|--|--------------------------------|-----|-------------|--|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.35 | 5 | 2000 | Average biomass calculated from abundance 1984-1996 | (Dalpadado et al. 2001, Dalpadado et al. 2002) (Dalpadado et al. 2012) |
| C/WW | 0.092 0.067 0.080 | | | Canadian Arctic (<i>T. lib.</i>) Barents Sea (<i>T. lib.</i>) Average used in model | (Percy & Fife 1981) (Ikeda & Skjoldal 1989) |
| P/B (year ⁻¹) | 2.20 | 4 | | Calculated from average specific growth rate from 4 mm (embryo) to 25 mm length (adult) | (Percy 1993, Dalpadado et al. 2002) |
| P/Q | 0.31 | | | For four amphipod species | (Yamada & Ikeda 2006) |
| Q/B (year ⁻¹) | 7.1 | 5 | | Calc. from P/B and P/Q | |
| UC | 0.15 | | | | (Welch et al. 1992) |
| Diet (Pe. = 4) | | | | | |
| Diet composition was calculated from data sets below | | | | | |
| 1995, Barents Sea, June, <i>P. libellula</i> , diet inferred from fatty acids (Scott et al. 1999) | | | | | |
| 2004 -2005, North and east of Svalbard, May and July, <i>T. abyssorum</i> (n = 26), <i>T. libellula</i> (n = 30), qualitative (Dalpadado et al. 2008b) | | | | | |
| 2006-2007, Svalbard, Kongsfjorden, June, <i>T. libellula</i> , experimental feeding incubations (Noyon et al. 2009) | | | | | |
| 2012, Svalbard, January, <i>T. abyssorum</i> (n = 44), <i>T. libellula</i> (n = 17), qualitative (Kraft et al. 2013) | | | | | |

69 Symphagic amphipods

Symphagic amphipods are ice-associated and the main species are *Gammarus wilkitzkii*, *Apherusa glacialis*, *Onismus nanseni* and *Onismus glacialis* (Hop et al. 2000, Poltermann 2001). There was an annual import during the period 2003-2005 into the Barents Sea of the biomass of ice- and ice-associated amphipods amounting to about 23000 t C (Hop & Pavlova 2008). Biomass-values for different types of ice have been estimated (Hop et al. 2000), but since inter-annual variability in ice coverage is very variable in the Barents Sea, biomass for the group was estimated by the Ecopath model from the consumption by various predator groups.

A total P/B-value (0.384 year^{-1}) for the group was calculated from taking the weighted (by biomass) values of the two dominant species (*G. wilkitzkii* and *A. glacialis*) (Table S2-69). *G. wilkitzkii* has the highest biomass, is long-lived and has a relatively low P/B; 0.398 year^{-1} (Poltermann 2000), 0.255 year^{-1} (Beuchel & Lønne 2002). *A. glacialis* has a shorter life-length and higher P/B-value of 1.98 year^{-1} (Beuchel & Lønne 2002). A biomass-weighted mean value ($P/B = 0.384 \text{ year}^{-1}$) was used in the model. Q/B was set to 1.6 year^{-1} based on a P/Q of 0.24 (Table S2-69). Symphagic amphipods feed on ice-algae, detritus and some crustaceans (Poltermann 2001). The group is prey for birds, mammals and fish.

| Table S2-69 Symphagic amphipods | | | | | |
|--|-------|-----|-------------|---------------------------------|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (t WW km ⁻²) | M | 1 | 1996 | Estimated by model | (Hop et al. 2000) |
| C/WW | 0.120 | | | Weighted by habitat and species | (Hop & Pavlova 2008) |
| P/B (year ⁻¹) | 0.384 | 8 | | Biomass weighted average | (Poltermann 2000, Beuchel & Lønne 2002) |
| P/Q | 0.24 | | | | (Welch et al. 1992) |
| Q/B (year ⁻¹) | 1.6 | 5 | | From P/B and P/Q | |
| UC | 0.30 | | | | (Welch et al. 1992) |
| Diet (Pe. = 4) | | | | | |
| 1993-1994, Fram Strait and northern Barents Sea, March and August-September, four amphipod species, stomach analysis (Poltermann 2001) | | | | | |
| 1995, Barents Sea, June, three "ice amphipod" species, diet inferred from fatty acids (Scott et al. 1999) | | | | | |

70 Pteropods

Two species are dominating with highest abundance in arctic waters, the omnivorous *Limacina helicina* and the carnivorous *Clione limacina* (Böer et al. 2005). Life-length of *L. helicina* is one year at Svalbard (Gannefors et al. 2005), and life-length of *C. limacina* is at least two years (Böer et al. 2005). *L. helicina* has very high egg production (ca. 4000 ind⁻¹) compared to copepods (ca. 400 ind⁻¹) (Pasternak et al. 2017). *L. helicina* has on average much large biomass-values than *C. limacina* (Walkusz et al. 2009). Total biomass-estimates for the whole Barents Sea from surveys with good coverage are not available, but typical “local” biomass values of pteropods in the arctic part of the Barents Sea (including fjords in Svalbard) range from 0.5 – 1.5 g C m⁻² calculated from various plankton investigations (Falk-Petersen et al. 1999, Blachowiak-Samolyk et al. 2008, Dvoretzky & Dvoretzky 2009, Walkusz et al. 2009, Basedow et al. 2014, Flint et al. 2015). Much higher local biomasses in fjords at Svalbard and north of Svalbard have been observed (Weslawski et al. 2000b, Daase & Eiane 2007). Since only local biomass values were available, the biomass of pteropods was estimated by the model.

No P/B-value was found for the arctic *L. helicina*. The Antarctic *L. helicina antarctica* has a two-year life-cycle and a P/B of 3.83 year⁻¹ (Bednaršek et al. 2012). A value for *L. helicina* of P/B = 8.9 year⁻¹ was calculated based on one-year life length and the estimated growth rate from veliger (0.2 mm in diameter) to weight of adult animals (11.2 mg DW). Q/B was set to 29.5 year⁻¹ based on a P/Q of 0.30. For *C. limacina* with a longer generation length, P/B and Q/B was assumed to be half the values for *L. helicina*, and biomass weighted values (P/B = 7.99 year⁻¹ and Q/B = 26.6 year⁻¹) were calculated for the pteropod group (Table S2-70).

L. helicina feed on a wide range of prey sizes, ranging from 2 – 300 µm (Pasternak et al. 2017). The food includes phytoplankton (both flagellates and diatoms), microzooplankton (ciliates and dinoflagellates) and copepods (Gilmer & Harbison 1991, Pasternak et al. 2017). They are also cannibalistic (Gilmer & Harbison 1991). *C. limacina* feed exclusively on *L. limacina* (Böer et al. 2005). The model diet composition was averaged from (Gilmer & Harbison 1991) and (Pasternak et al. 2017) and a proportion cannibalism of 0.109 was calculated. Pteropods are also common prey in the diet of planktivorous fishes.

| Table S2-70 Pteropods | | | | | |
|--|-------|-----|-------------|---|-------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.082 | | | <i>L. helicina</i> , from the Barents sea | (Ikeda & Skjoldal 1989) |
| P/B (year ⁻¹) | 7.99 | 4 | | Calc. from growth rates | |
| P/Q | 0.30 | | | Assumed | |
| Q/B (year ⁻¹) | 26.6 | 2 | | From P/B and P/Q | |
| UC | 0.30 | | | Assumed | |
| Diet (Pe. = 4) | | | | | |
| 1985 & 1988, Greenland Sea, Barents Sea, August, <i>L. helicina</i> , gut (n = 28) and pellet (n = 20) analysis (Gilmer & Harbison 1991) | | | | | |
| 2011-2015, Kara and Laptev Seas, August-October, n = 20 pellets (Pasternak et al. 2017) | | | | | |

71-73 Copepod groups

The copepod groups (no. 71 “Medium sized copepods”, no. 72 “Large calanoids and no. 73. “Small copepods”) comprise most of the mesozooplankton biomass in the Barents Sea, and the *Calanus* species make up about 80% of the mesozooplankton biomass in the Barents Sea (Aarflot et al. 2017).

The “Medium sized copepod” group is dominated by *C. finmarchicus* which mainly is distributed in relatively warm water of Atlantic origin (Aarflot et al. 2017). Other species in this group are *Metridia* spp. Advection of *C. finmarchicus* from the Norwegian Sea into the Barents Sea has been estimated to ca. 8 mill t WW year⁻¹ for the period 1997-2010 (Dalpadado et al. 2012), and this corresponding to a supply of c. 0.6 g C m⁻² year⁻¹ averaged over the whole Barents Sea area. Import of medium sized copepods in the Ecopath model was set to 0.6 g C m⁻² year⁻¹. *C. finmarchicus* over-winter as adult and spawn in the spring and summer in the Barents Sea (Tande et al. 1985).

“Large calanoids” are composed mainly of *Calanus glacialis* and *Calanus hyperboreus* and have their main distribution in cold Arctic water (Aarflot et al. 2017). These species have large body size than *C. finmarchicus*. *C. glacialis* have a life-cycle of mainly two year in the Barents Sea (Tande et al. 1985), and is mainly distributed on the shelf while the larger *C. hyperboreus* have a life-cycle of 2-5 years with their main distribution in deep water off the shelf (Falk-Petersen et al. 2007). *C. glacialis* has higher average biomass than *C. finmarchicus* in water colder than ca. 0 °C (Aarflot et al. 2017).

Species in the “Small copepod group” have adult body length (prosoma lengths) mainly less than 1 mm. The most abundant species in this group are *Pseudocalanus* spp., *Oithona* spp. and *Microcalanus* spp. (Arashkevich et al. 2002b).

Based on Aarflot et al. (2017), the average annual biomass of *C. finmarchicus* for the whole Barents Sea for the time-period 1995-2016 was calculated to be in the range ca. 0.83 – 1.52 g C m⁻² (Table S2-71-73). For large calanoids, the average biomass for the period 1995-2016 was ca. 1.09 g C m⁻² (Table S2-71-73). The sum of biomass for medium and large copepod groups (ca. 1.92 – 2.61 g C m⁻²) is comparable to the value for *Calanus* of about 2 g C m⁻² given by (Sakshaug et al. 1994). These values are also similar to the biomass value of 2.7 g C m⁻² calculated from the value for total mesozooplankton biomass in autumn 1998-2011 (6.7 g DW m⁻²) for the whole Barents Sea (Dalpadado et al. 2012). There are few separate estimates for the biomass of small copepods, but Arashkevich et al. (2002a) found that small copepods usually made up 2-4% of the mesozooplankton biomass in the Barents Sea. A biomass value (B = 0.06 g C m⁻²) for small copepods equal to 3% of 2 g C m⁻² was used as initial value in the model. In the year 2000 model, the biomass for “Medium sized copepods” were set to 0.83 g C m⁻² while the biomasses of “Large calanoids” and “Small copepods” were estimated by the model.

For medium sized copepods, a P/B-value of 6.5 year⁻¹ was used in the model. This is somewhat lower than P/B = 7.3 year⁻¹ computed from (Aksnes & Blindheim 1996) for *C. finmarchicus* in the Norwegian Sea, and equal to the value used by (Hopkins et al. 1989) for copepods in the cold Balsfjord, northern Norway. Sakshaug et al. (1994) calculated a P/B-value for *Calanus* (including *C. finmarchicus* and the larger *Calanus* species) to 4.0 year⁻¹. For “Large calanoids” which have a longer life-cycle, half the value used for “Medium sized copepods” (P/B = 3.25 year⁻¹) was used in the model. Q/B was set to 26.0 year⁻¹ for “Medium

sized copepods” and “Small copepods” and to 13.0 year⁻¹ for “Large calanoids” based on an assumed P/Q of 0.25 (Table S2-71-73).

The copepod groups are mainly herbivorous, feeding on phytoplankton, both diatoms and flagellates but also feed on microzooplankton (ciliates and heterotrophic dinoflagellates) (Båmstedt et al. 1991, Nejstgaard et al. 2007). They may feed on copepod eggs and nauplii (Basedow & Tande 2006). *Calanus glacialis* in the large copepod groups feed on ice-algae early in the spring and on phytoplankton when the ice breaks up in summer (Leu et al. 2011).

The copepod groups are major prey for planktivore fish and invertebrates and some bird and mammal groups. A time-series for total mesozooplankton biomass for the Barents Sea based on plankton net samples are available since 1984, and since 1987 the biomass has been allocated to the size categories; 180 – 1000 µm, 1000-2000 µm and > 2000 µm (Johannesen et al. 2012b).

Table S2-71-73 Overview of input values for the copepod groups. A C/DW- ratio of 0.4 has been used to convert from dry mass to carbon

| Variable | 71 Medium sized copepods | 72 Large calanoids | 73 Small copepods | Pe. | Comments | References |
|--|--------------------------|--------------------|-------------------|-----|---|--|
| Biomass (g DW m ⁻²) | 5.2 | | | | For June-August 1995-2004, western part | (Aarflot et al. 2017) |
| Biomass (g C m ⁻²)* | 0.83 ^a | | | 5 | Annual average for whole B. Sea | |
| Biomass (g DW m ⁻²) | 9.5 | | | | For June-August 2005-2016, western part | (Aarflot et al. 2017) |
| Biomass (g C m ⁻²)* | 1.52 ^a | | | 5 | Annual average for whole B. Sea | |
| Biomass (g DW m ⁻²) | | 3.6 ^b | | | June-August 1995-2016, central and northern part, <i>C. glacialis</i> | (Aarflot et al. 2017) |
| Biomass (g DW m ⁻²) | | 0.5 ^c | | | Annual average for all areas, <i>C. hyperboreus</i> | |
| Biomass (g C m ⁻²) | | 0.92 ^d | | 5 | Calculated annual average for whole Barents Sea | |
| Biomass (g C m ⁻²) | | | 0.06 | 4 | Equal to 3% of 2 g C m ⁻² | (Arashkevich et al. 2002a) |
| Import (g C m ⁻² year ⁻¹) | 0.6 | | | | Adevection into the Barents Sea from the Norwegian Sea | (Dalpadado et al. 2012) |
| P/B (year ⁻¹) | 6.5 | 3.2 | 6.5 | 6 | | |
| P/Q | 0.25 | 0.25 | 0.25 | | | (Pedersen et al. 2008) |
| Q/B (year ⁻¹) | 26.0 | 13.0 | 26.0 | 5 | Assumed P/Q = 0.25 | (Pedersen et al. 2008) |
| Production (g C m ⁻² year ⁻²) | 5.4 9.9 | 3.5 | | | 1995-2004 2005-2016 Average for time period 1995-2016 | |
| Total production (g C m ⁻² year ⁻¹) | 8.9 13.4 | | | | 1995-2004 2005-2016 | |
| Total production (mill t WW) | 120 180 | | | | 1995-2004 2005-2016 | |
| C/WW | 0.147 | 0.176 | 0.060 | | | (Ikeda & Skjoldal 1989) (McClatchie 1985) |
| UC | 0.40 | 0.40 | 0.40 | | | (Conover 1966) |

Diet (Pe. 3)

Diet compositions of the three copepod groups were based on literature (Conover 1966), (Båmstedt et al. 1991, Basedow & Tande 2006, Nejstgaard et al. 2007, Leu et al. 2011, Cleary et al. 2017)

a) assumed that annual average is half the value from June-August and that the western and central part make up 40% of the total Barents Sea, b) *C. glacialis*, assumed that the annual average is half the value for June-August and that the northern and central part make up 60% of the Barents Sea, c) *C. hyperboreus*, calculated from an average annual biomass value for all areas, d) Biomass equal to half the value for June –August for *C. glacialis* plus the biomass of *C. hyperboreus*: $B = (3.7/2 + 0.5) \cdot 0.40$, where 0.40 is the C/DW-ratio.

74 Other large zooplankton

This group is comprised of holoplankton taxa such as Cladocera, pelagic foraminifera, pelagic polychaetes and meroplankton comprising larval pelagic stages of benthic invertebrates. Biomass of the group is estimated by the model. P/B and Q/B were set equal to the values of “Medium sized copepods” (Table S2-74).

The diet of the group is composed of phytoplankton and microzooplankton groups (ciliates and heterotrophic dinoflagellates).

| Table S2-74 Other large zooplankton | | | | | |
|--|-------|-----|-------------|-----------------------------|------------|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.12 | | | Assumed | |
| Z or P/B (year ⁻¹) | 6.5 | 6 | | Same as for medium copepods | |
| Q/B (year ⁻¹) | 26.0 | 6 | | Same as for medium copepods | |
| UC | 0.20 | | | Assumed | |
| Diet (Pe. 1) | | | | | |
| Assumed same diet as for medium sized copepods | | | | | |

75 Appendicularians

Appendicularians are suspension feeders that feed using mucopolysaccharide filters named “house” (Deibel 1986). House production is very large compared to somatic production, and daily house production may nearly amount to standing biomass of *Oikopleura vanhoeffeni* (Choe & Deibel 2011). Houses are relatively large particles with high sinking rate and sediment rapidly out of the euphotic zone. Appendicularians are common both in boreal and arctic waters and in the Barents Sea. The relatively large *O. vanhoeffeni* is common in arctic waters, while *Fritillaria borealis* also is common in Atlantic water (Arashkevich et al. 2002a, Blachowiak-Samolyk et al. 2008, Dvoretzky & Dvoretzky 2010). No biomass estimates for the whole Barents Sea are available, however (Blachowiak-Samolyk et al. 2008) gives a biomass of 0.23 g DW m⁻² for the area north of Svalbard for May and August 1983. Biomass was estimated by the model.

In Canadian waters at cold but fluctuating temperatures (ca. 1-15 °C), somatic P/B for *O. vanhoeffeni* was on average measured to 9.75 year⁻¹ (Choe & Deibel 2011), and this value was used in the model (Table S2-75). A Q/B value of 375.5 year⁻¹ was used taking into account the large consumption needed for house production (Choe & Deibel 2011). Diet composition was based on studies from Canadian and Arctic areas, and appendicularians feed on detritus, bacteria, phytoplankton, flagellates, dinoflagellates and ciliates (Deibel 1986, Acuña et al. 2002, Sampei et al. 2009).

Appendicularians are common in the diet of planktivorous fish and invertebrates in the Barents Sea (Huse & Toresen 1996, Dalpadado et al. 2008b, Renaud et al. 2012).

| Table S2-75 Appendicularians | | | | | |
|---|-------|-----|-------------|------------------------------------|--------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.069 | | | From the Pacific | (Davis et al. 1998) |
| P/B (year ⁻¹) | 9.75 | 5 | | For <i>O. vanhoeffeni</i> , Canada | (Choe & Deibel 2011) |
| Q/B (year ⁻¹) | 375.5 | 5 | | | |
| UC | 0.33 | | | For <i>O. vanhoeffeni</i> | (Bochdanský et al. 1999) |
| Diet (Pe. 3) | | | | | |
| March 1985 - February 1986, Newfoundland, <i>O. vanhoeffeni</i> , field and lab. observations (Deibel 1986) | | | | | |
| 1998, June-July, Baffin Bay, Canada, <i>O. vanhoeffeni</i> , field observations (Acuña et al. 2002) | | | | | |
| October 2003 – September 2004, Beaufort Sea, food pellet observations (Sampei et al. 2009) | | | | | |

76-78 Ciliates, Heterotrophic dinoflagellates and Heterotrophic nanoflagellates (HNAN)

These groups are important components of the microbial food web and are groups with small body sizes and high P/B, Q/B-values and P/Q-values. It is challenging to calculate annual averages of the model input parameters of these groups since most studies are of relative low duration and on a small geographic scale during the spring bloom or in summer. Some ciliates and dinoflagellates are mixotrophic and contain chloroplast (Seuthe et al. 2011), but here only heterotrophic protozoans are considered. Several studies show that microzooplankton (i.e. ciliates and heterotrophic dinoflagellates) may graze a large proportion of the particulate primary production (Verity et al. 2002). In May 1993, depending on location within the Barents Sea, from 25 to 100 % of the daily primary production was grazed by microzooplankton (Hansen et al. 1996, Hansen et al. 1997). Based on data from June-July in 1999 in the Barents Sea, from 64-97% of the Chl a production was grazed by microzooplankton (Verity et al. 2002). Based on a data from March to December in 2006 Kongsfjorden, Svalbard (Seuthe et al. 2011), it was calculated that 87% of the primary production was grazed by microzooplankton. In Disko Bay, Greenland which had a primary production of 27 g C m⁻² year⁻¹, about 50% of the primary production was grazed by microzooplankton (Levinsen et al. 1999). This show that a high but variable proportion of the primary production in the Barents Sea and similar ecosystems is grazed by the microzooplankton groups.

Model input biomass values were based on a study in Kongsfjorden, Svalbard (Seuthe et al. 2011), where it was possibly to calculate annual averages. P/B values for the groups were calculated from estimates of production and biomass and Q/B's were calculated assuming a P/Q of 0.33 (Hansen et al. 1997) (Table S2-76-78).

Ciliates feed on heterotrophic and autotrophic flagellates and bacteria (Våge et al. 2018) and typically feed on prey that are much smaller (i.e. 10%) than themselves (Sherr & Sherr 2007). Heterotrophic dinoflagellates also feed on diatoms in addition to other prey and may consume prey that are equal to or larger than their own size (Sherr & Sherr 2007). Heterotrophic nanoflagellates prey efficiently on their main prey bacteria (Vaqué et al. 2008).

Ciliates and heterotrophic dinoflagellates are important prey for copepods and other zooplankton groups.

| Table S2-76-78 Input parameters to the model for the groups “Ciliates”, “Heterotrophic nanoflagellates” and “Heterotrophic nanoflagellates” | | | | | | |
|---|-------------|----------------------------------|----------------------------------|-----|---|--|
| Variable | Group | | | Pe. | Comments | References |
| | 76 Ciliates | 77 Heterotrophic dinoflagellates | 78 Heterotrophic nanoflagellates | | | |
| Biomass (B, g C m ⁻²) | 0.101 | 0.089 | 0.120 | 5 | Annual averages | (Seuthe et al. 2011) |
| C/WW | 0.11 | 0.10 | 0.10 | | | (Hansen et al. 1997) |
| P/B (year ⁻¹) | 89.2 | 86.8 | 36.5 | 6 | Calculated from P and B Calculated from | (Seuthe et al. 2011) (Archer et al. 2000) |
| P/Q | 0.33 | 0.33 | 0.33 | | | (Hansen et al. 1997) |
| Q/B (year ⁻¹) | 270.3 | 263.0 | 110.6 | 5 | Model input, calc. assuming P/Q = 0.33 | |
| Production (P, g C m ⁻² year ⁻¹) | 18.6 24 | | | | Calculated from Calculated for the Barents Sea | (Seuthe et al. 2011) (Franzè & Lavrentyev 2017) |
| UC | 0.10 | 0.10 | 0.10 | | Assumed | |
| Diet Ciliates (Pe. 3) Feed on heterotrophic and autotrophic flagellates and bacteria (Våge et al. 2018) and typically feed on prey that are much smaller (i.e. 10%) than themselves (Sherr & Sherr 2007) Heterotrophic dinoflagellates (Pe. 3) May also feed on diatoms in addition to other prey such as bacteria and may consume prey that are equal to or larger than their own size (Sherr & Sherr 2007, Jeong et al. 2010) Heterotrophic nanoflagellates (Pe. 3) Feed efficiently on their main prey bacteria (Vaqué et al. 2008). | | | | | | |

79 Northern shrimp

The northern shrimp (*Pandalus borealis*) is an important commercially exploited species in the Barents Sea. Northern shrimp is a protandrous hermaphrodite and matured to females at an age of 4-6 year in the east of the Barents Sea (Teigsmark 1983) and from 6-8 years at Svalbard (Hansen & Aschan 2000). A stock biomass index has been estimated since 1970 based on bottom trawl hauls taken in August-September (Hvingel & Thangstad 2010, Johannesen et al. 2012a). Biomass was estimated by the model. A time-series on the catch landings is available since 1970 (Hvingel & Thangstad 2010, Johannesen et al. 2012b).

An average total mortality rate (Z) was estimated to 0.68 year^{-1} based on a study in the Barents Sea in 1978-79 (Teigsmark 1983), and this value was used as input for P/B to the model (Table S2-79). Q/B was calculated to 3.78 year^{-1} assuming a P/Q of 0.18 as estimated for *Penaeus monodon* and *Metapenaeus monoceros* (Qasim & Easterson 1974, Ye et al. 2009). In Balsfjord, northern Norway, northern shrimp feed on *Thysanoessa*, copepods and were scavenging on discarded capelin. The importance of polychaetes and detritus increased with increasing body size (Hopkins et al. 1989). Further north in the Barents Sea, *P. borealis* feed mainly on small krill (*Thysanoessa*), copepods, polychaetes, bivalves, ophiurids, foraminifera, and they are cannibalistic (Berenboim 1981). The model diet was based on the results from Berenboim. Deep-water shrimps are prey of many predators, mainly fish and mammals, and the predation by cod on northern shrimp has been quantified and compared to stock biomass development (Bogstad et al. 2000).

| Table S2-79 Northern shrimp | | | | | |
|--|-------|-----|-------------|---|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | M | 1 | 2000 | Estimated by model | |
| Catch (t WW) | 3000 | 6 | 1950 | Assumed landings | |
| | 80700 | 6 | 2000 | Landings | (Hvingel & Thangstad 2010, Johannesen et al. 2012a) |
| C/WW | 0.116 | | | <i>P. borealis</i> | (Clarke 1987) |
| P/B (year^{-1}) | 0.68 | 8 | 1978 | Barents Sea | (Teigsmark 1983) |
| P/Q | 0.18 | | | <i>P. monodon</i> & <i>M. monoceros</i> | (Qasim & Easterson 1974, Ye et al. 2009) |
| Q/B | 3.78 | 5 | | from P/B and P/Q | |
| UC | 0.14 | | | For <i>Penaeus monodon</i> | (Ye et al. 2009) |
| Diet (Pe. 4) | | | | | |
| 1978-1979, Barents Sea, December and June, $n = 483$, Foc (Berenboim 1981) | | | | | |
| 1979-1980, Balsfjord, Northern Norway, spring and summer, qualitative observations (Hopkins et al. 1989) | | | | | |

Epibenthic predatory invertebrates

80 Crangonid and other shrimps

The group consists of a number of mostly benthic species (see table S1-1) and have a wide distribution in the Barents Sea. *Sclerocrangon boreas* dominated the biomass of crangonid shrimps in Isfjorden at Svalbard year 2001 where the biomass of *S. boreas* was estimated to 0.023 g C m⁻² (Birkely & Gulliksen 2003a). The biomass of the group was estimated by the Ecopath model. There is no commercial fishing targeting this group, but there is some unknown bycatch in the northern shrimp fishery.

The average total mortality rate (Z) for males and females (*Sclerocrangon boreas*) at Svalbard was estimated to 0.30 year⁻¹ (Birkely & Gulliksen 2003b), and this value was used as input to P/B (Table S2-80). Q/B was set to 1.58 year⁻¹ assuming a P/Q of 0.19 (Pihl & Rosenberg 1984). The diet of *S. boreas* was dominated by polychaetes, amphipods and bivalves (Birkely & Gulliksen 2003a). Birkely and Gulliksen (2003a) investigated the contents of 197 stomachs and found that the sculptured shrimp at Svalbard was a carnivore that fed on both epi- and infauna. The diet was dominated by polychaetes, amphipods, molluscs, and with lesser amounts of hydrozoans, sediment and other content. Crangonid shrimps are common in the diet of bearded seals and several other predators (Birkely & Gulliksen 2003a).

| Table S2-80 Crangonid and other shrimps | | | | | |
|---|-------|-----|-------------|----------------------------|---|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | 2000 | Estimated by model | |
| C/WW | 0.089 | | | | (Rumohr et al. 1987, Birkely & Gulliksen 2003b) |
| P/B (year ⁻¹) | 0.30 | 7 | | | (Birkely & Gulliksen 2003b) |
| P/Q | 0.19 | | | For <i>Crangon crangon</i> | (Pihl & Rosenberg 1984) |
| Q/B (year ⁻¹) | 1.58 | 5 | | from P/B and P/Q | |
| UC | 0.18 | | | For <i>Penaeus monodon</i> | (Ye et al. 2009) |
| Diet (Pe. 4) | | | | | |
| 2001 Svalbard, <i>Sclerocrangon boreas</i> , (n = 197), Foc, N% (Birkely & Gulliksen 2003a) | | | | | |

81 Other large crustaceans

The group is comprised of Anomurans and Brachyurans other than red king crab and snow crab (e.g. *Lithodes maja*, *Hyas araneus*, *Hyas coarctatus*, *Munida sarsi*, *Pagurus pubescens*, *P. bernhardus*). The group is widely distributed in the Barents Sea (Balazy et al. 2015, Zimina et al. 2015), but no biomass estimate is available for the whole Barents Sea. The group is prey for many species of fish, mammals and birds, and biomass is estimated by the model.

P/B value was set equal to 0.5 year⁻¹ for *Hyas* estimated for Sør fjord, northern Norway (Pedersen et al. 2008) (Table S2-81). Q/B was set to 2.08 year⁻¹, assuming that P/Q is 0.24 as estimated for Tanner crab (*Chionecetes bairdi*) (Paul & Fuji 1989). The species in the group are omnivore feeders and predators on benthic invertebrates, but they also feed on detritus and pelagic prey (Gerlach et al. 1976, Hudson & Wigham 2003, Markowska et al. 2008). The dietary composition used in the model was dominated by detritivorous polychaetes, detritus, small molluscs, detritivorous echinoderms and small benthic crustaceans.

| Table S2-81 Other large crustaceans | | | | | |
|--|-------|-----|-------------|---|------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | M | 1 | | Estimated by model | |
| C/WW | 0.097 | | | Avg. for <i>Hyas coarctatus</i> , <i>Pagurus bernhardus</i> | (Rumohr et al. 1987) |
| P/B (year ⁻¹) | 0.50 | 7 | | Estimated for <i>Hyas</i> in Sør fjord | (Pedersen et al. 2008) |
| P/Q | 0.24 | | | For Tanner crab | (Paul & Fuji 1989) |
| Q/B | 2.08 | 5 | | Assuming P/Q = 0.24 | |
| UC | 0.11 | | | Estimated for Tanner crab | (Paul & Fuji 1989) |
| Diet (Pe. 3) | | | | | |
| Based on Gerlach et al. (1976), Hudson and Wigham (2003), Markowska et al. (2008) and sources in Pedersen et al. (2016b), Pedersen et al. (2018) | | | | | |

82 Crinoids

Crinoids are common in the northern part of the Barents Sea, and the most common species is *Heliometra glacialis* (Jørgensen et al. 2015a), but *Poliometra proluxa* and *Bathycrinus carpenteri* is also present (Piepenburg et al. 1996). *H. glacialis* is common as by-catch in bottom trawl and estimates of biomass is likely to be underestimated as they become fragmentized during trawling (Jørgensen et al. 2015b). Biomass was estimated by the swept-area method from research bottom trawl catches (Lis L. Jørgensen, unpub. data) (Table S2-86).

P/B- values for crinoids were not available and a P/B-value of 0.07 year⁻¹ estimated for the echinoid *Strongylocentrotus pallidus* in the Barents Sea was used (Bluhm et al. 1998) (Table S2-86). Q/B was set to 0.7 year⁻¹ assuming a P/Q of 0.10 that was estimated for *Strongylocentrotus intermedius* (Fuji 1967). *Heliometra glacialis* is considered to be a plankton feeder potentially feeding on copepods and euphausiids (Kharlamenko et al. 2013, Jørgensen et al. 2015a).

| Table S2-82 Crinoids | | | | | |
|---|---------|-----|-------------|---|--------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g WW m ⁻²) | 0.0165 | 5 | 2000 | From bottom trawl survey | L. L. Jørgensen (unpubl. Data) |
| B (g C m ⁻²) | 0.00072 | 5 | 2000 | From value above and C/WW | |
| C/WW | 0.0435 | | | For the ophiuroid <i>Ophiotrix fragilis</i> | (Davoult et al. 1992) |
| P/B (year ⁻¹) | 0.07 | 5 | | For <i>Strongylocentrotus pallidus</i> | (Bluhm et al. 1998) |
| P/Q | 0.10 | | | For <i>Strongylocentrotus intermedius</i> | (Fuji 1967) |
| Q/B (year ⁻¹) | 0.70 | 5 | | From P/B and P/Q | |
| UC | 0.20 | | | Assumed | |
| Diet (Pe. = 3) | | | | | |
| 2010, Japan Sea, August, n = 3, diet inferred from fatty acid and stable isotope analysis (Kharlamenko et al. 2013) | | | | | |

Benthic invertebrates sampled by beam trawl and grab

These groups may be sampled using epifauna beamtrawl and/or grab and include epi- and infauna, both macrofauna and megafauna. Megafauna is organisms larger than 10 mm (Schoening et al. 2012). Since the model uses P/B-values, it was not considered possible to use size-categories (e.g. macrofauna, megafauna) as groups since the species with large adult size (megafauna as adults) would grow through the macrofauna category.

Biomass values were calculated based on the average value of 104 g WW m⁻² of the biomasses (147.0 g WW m⁻²) estimated for 1924-1932 and (59.5 g WW m⁻²) for 1968-1970 from large scale surveys in the Barents Sea for where grab was the main sampling gear (Denisenko 2001, Denisenko & Titov 2003, Denisenko 2004, Anisimova et al. 2010). Sampling was also performed by grab and benthos trawl for the period 2003-2008, but few results from that period are available except for some areas in the southeastern Barents Sea (Anisimova et al. 2010). The carbon biomasses for the groups were calculated from the total wet biomass value of 104 g WW m⁻², the overview of proportion of carbon weight biomass for various taxa and feeding modes given by Denisenko (2004). The total biomass of all groups was calculated to 5.2 g C m⁻². The same biomass values were used in the year 2000 and the 1950-models.

Benthic megafauna has also been sampled by bottom trawl (Campelen otter trawl) in the period after 2006 and P/B and production was estimated for the period 2008-2009 (Anisimova et al. 2010, Degen et al. 2016). For each Ecopath model-group, the biomass estimate from either Campelen bottom trawl (2008-2009) or the earlier grab surveys that had the highest value was used in the model.

The biomass (t WW m⁻²) of benthic invertebrates was highest in the shallow areas in the southeastern part of the Barents sea (including the Pechora Sea) and around the Svalbard Bank (Denisenko et al. 2003, Kędra et al. 2013). In these areas, the biomasses of bivalves and barnacles (suspension feeders) were high (Denisenko et al. 2003). In the deeper areas between the banks, the biomass was lower, but polychaetes were more important (Carroll et al. 2008b). According to Denisenko (2004), 7-8 species made up 50% of the biomass (3 bivalves, one sipunculid (*Golfingia margaritacea*), sea-urchins, the barnacle (*Balanus balanus*) and one asteroid (*Ctenodiscus crispatus*).

Very little information is available regarding P/B-values for benthic invertebrates from the Barents Sea. Zenkevitch (1963) gives a value of community P/B for benthic invertebrates of 0.20-0.25 year⁻¹ for the Barents Sea. In contrast, Dommasnes et al. (2002) used a P/B value of 1.5 year⁻¹ in an Ecopath model of the Norwegian and Barents Sea, based on a value from the North Sea reduced by 25%. In their models for the Norwegian and the Barents Sea, both Skaret and Pitcher (2016) and Bentley et al. (2017) used the same value (P/B = 1.5 year⁻¹) for “Other macrobenthos” and “Benthos”, respectively. In their Ecopath model for the Barents Sea, Blanchard et al. (2002) used values adopted from a model for the Bering Sea which were in the range of 1.37-2.50 year⁻¹ for the benthic invertebrate groups. In contrast to these high P/B-values used in previous Ecopath models, community P/B-estimates for macrobenthos based on grab-sampling from North-Norwegian fjords within the Barents Sea LME with similar temperature conditions as the central Barents Sea were much lower, with a P/B of 0.29 year⁻¹ for Sør fjord (Nilsen et al. 2006) and an average P/B of 1.02 year⁻¹ for Porsangerfjord (Fuhrmann et al. 2015).

For many of the benthic invertebrate groups in our Ecopath model for the Barents Sea, P/B-estimates from the inner part of Porsangerfjorden (average of values for subareas 4E and 4W,

70°7' N, 25°11'E), Northern Norway (Pedersen et al. 2018), were used. This area has similar species composition and temperature conditions as the Barents Sea. It was checked if these values were reasonable by comparing average individual body weights from samples from the Barents Sea and Porsangerfjorden. Individual weight is the most important input parameter for estimating P/B using the Brey model.

83 Predatory asteroids

The biomass of this group was highest in the shallow areas with the highest biomass of bivalves and echinoderms which are potential prey (Anisimova et al. 2010). The biomass value was derived from (Denisenko 2004) and was calculated as the total biomass of asteroids minus the biomass of the detritivorous asteroid *Ctenodiscus crispatus* (Table S2-87). The P/B-value (0.066 year^{-1}) used was estimated for the inner Porsangerfjord (Pedersen et al. 2018). Q/B was calculated assuming a P/Q of 0.28, and UC was set to 0.28.

Specific diet composition data from the Barents Sea were not found for the group and the diet was based on literature (see Pedersen et al. 2018). The group predares on bivalves and echinoderms and the diet composition in the Barents Sea Ecopath model was very similar to the diet in the Porsangerfjord models (Pedersen et al. 2018).

| Table S2-83 Predatory asteroids | | | | | |
|---|--------|-----|-------------|---------------------------------------|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 0.0052 | 5 | | Total asteroids – <i>C. crispatus</i> | (Denisenko 2004) |
| C/WW | 0.058 | | | | (Ricciardi & Bourget 1998) |
| P/B (year^{-1}) | 0.066 | 5 | | Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.28 | | | Average for two species | (Shirley & Stickle 1982, Forcucci & Lawrence 1986) |
| Q/B (year^{-1}) | 0.24 | 5 | | From P/B and P/Q | |
| UC | 0.28 | | | Average for two species | (Shirley & Stickle 1982, Forcucci & Lawrence 1986) |
| Diet (Pe. = 3) | | | | | |
| <i>Asterias rubens</i> (Bruun 1968, Gulliksen & Skjæveland 1973, Anger et al. 1977, Saier 2001) | | | | | |
| <i>Crossaster</i> and <i>Solaster</i> (Himmelman & Dutil 1991, Gaymer et al. 2004) | | | | | |

84 Predatory gastropods

This group comprise large gastropods (*Buccinum* sp., *Colus sabini*) and smaller boring gastropods (Table S1-1). Biomass was calculated from total macrofauna carbon biomass and proportion of gastropods from (Denisenko 2004), assuming all gastropods were predatory (Table S2-88).

The P/B-value was estimated for the inner Porsangerfjord (Pedersen et al. 2018). Q/B was calculated to 1.10 year⁻¹ assuming a P/Q of 0.20 estimated as average for *Buccinum undatum* and a boring snail (Kideys 1998). UC was calculated to 0.37 as average for the same two species. The large gastropods (*Buccinum* and *Colus*) feed on large bivalves (Nielsen 1974), polychaetes (Taylor 1978) and carrion (Evans et al. 1996). Boring gastropods feed on large bivalves and small molluscs (Kitchell et al. 1981). The model diet was composed of large bivalves, small molluscs, detritivorous polychaetes and detritus.

| Table S2-84 Predatory gastropods | | | | | |
|--|-------|-----|-------------|---|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.052 | 5 | | Calculated from | (Denisenko 2004) |
| C/WW | 0.055 | | | <i>Buccinum undatum</i> | (Ricciardi & Bourget 1998) |
| P/B (year ⁻¹) | 0.219 | 5 | | Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.20 | | | Av. For <i>Buccinum</i> and a Naticidae species | (Kideys 1998) |
| Q/B (year ⁻¹) | 1.10 | 5 | | Calculated from P/B and P/Q | |
| UC | 0.37 | | | Av. For <i>Buccinum</i> and a Naticidae species | (Kideys 1998) |
| Diet (Pe. = 3) | | | | | |
| Naticidae (boring gastropods) (Kitchell et al. 1981) | | | | | |
| <i>Buccinum</i> , <i>Neptunea</i> (Nielsen 1974, Taylor 1978, Evans et al. 1996) | | | | | |

85 Predatory polychaetes

This group mainly consists of free-living mobile species. There was no separate sample-based biomass estimate of predatory polychaetes available for the Barents Sea. The biomasses of predatory and detritivorous polychaetes were calculated by assuming that the proportions of these groups in the Barents Sea were equal to the average proportions (predatory polychaetes 13% and detritivorous polychaetes 87%) in the inner 4 areas of Porsangerfjorden (Pedersen et al. 2018). The carbon biomass was then calculated from biomass estimates for the Barents Sea (Denisenko 2004)(Table S2-89).

P/B was set to 0.84 year⁻¹ which is equal to the value estimated for inner Porsangerfjord. Q/B was calculated to 4.43 year⁻¹ assuming a P/Q of 0.19 calculated for *Nereis virens* (Table S2-89).

Predatory polychaetes feed on other small polychaetes, small amphipods, molluscs, foraminiferans, nematodes, benthic ostracods and copepods (Jumars et al. 2015). Cannibalism is also likely and there is evidence of detritus feeding for some species. Dietary composition used in the models was dominated by detritivorous polychaetes, bacteria, detritus, small benthic crustaceans, predatory polychaetes and small molluscs. Several fish and invertebrate groups feed on predatory polychaetes.

| Table S2-85 Predatory polychaetes | | | | | |
|-----------------------------------|-------|-----|-------------|--|--|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.178 | 5 | | 13% of total polychaete biomass | (Denisenko 2004) |
| C/WW | 0.068 | | | Errantia, Polychaeta | (Ricciardi & Bourget 1998) |
| P/B (year ⁻¹) | 0.842 | 5 | | Inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.19 | | | for <i>Nephtys</i> spp. | (Baird et al. 2004) |
| Q/B (year ⁻¹) | 4.43 | 5 | | From P/B and P/Q | |
| UC | 0.19 | | | For <i>Nereis virens</i> fed animals, average of two studies | (Kay & Brafield 1973, Tenore & Gopalan 1974) |
| Diet (Pe. 3) | | | | | |
| Review (Jumars et al. 2015) | | | | | |

86 Other predatory benthic invertebrates

The group is comprised of various taxa; Nemertini, Pycnogonidae, predatory Anthozoa, Hydrozoa, Gorgonaceae, Priapulidae. Biomass was calculated based on (Denisenko 2004) by adding proportions of Actinaria and Nemertini.

P/B was set to 0.50 year⁻¹ based on data from inner Porsangerfjord. Q/B was set to 2.49 year⁻¹, assuming a P/Q of 0.19 (Table S2-90). Nemerteans feed mainly on polychaetes and crustaceans (Thiel & Kruse 2001). Pycnogonidae feeds mainly on porifera and hydroids (Arnaud & Bamber 1988). Actinarians also feed on zooplankton. The dietary composition for the group was dominated by detritivorous polychaetes and medium sized zooplankton, with lower proportions of small benthic crustaceans, large epibenthic suspension feeders, small krill and small molluscs.

| Table S2-86 Other predatory benthic invertebrates | | | | | |
|---|-------|-----|-------------|-----------------------------------|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.099 | 5 | 1968 -1970 | | (Denisenko 2004) |
| C/WW | 0.095 | | | | (Ricciardi & Bourget 1998) |
| P/B (year ⁻¹) | 0.498 | 5 | | From inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.19 | | | Same as for predatory polychaetes | |
| Q/B (year ⁻¹) | 2.49 | 5 | | From P/B and P/Q | |
| UC | 0.19 | | | Same as for predatory polychaetes | |
| Diet (Pe. 3) | | | | | |
| Nemertini, review (Thiel & Kruse 2001) | | | | | |
| Pycnogonida (Arnaud & Bamber 1988) | | | | | |

87 Detritivorous polychaetes

The group comprises a large number of species with variable body sizes, but many species have small body sizes. The biomasses of predatory and detritivorous polychaetes were calculated by assuming that the proportions of these groups in the Barents Sea were equal to the average proportions (13% predatory polychaetes and 87% detritivorous polychaetes) in the inner four areas of Porsangerfjorden (Pedersen et al. 2018). The carbon biomass of the group was then calculated from biomass estimates for the Barents Sea (Denisenko 2004).

P/B of the in the model was set to 1.12 year^{-1} as estimated for inner Porsangerfjord (Table S2-91). Q/B was set to 10.2 year^{-1} , assuming a P/Q of 0.11 calculated as the average from seven predominantly non-predatory polychaete species (Baird et al. 2004). UC was calculated to 0.58 for the same species (Baird et al. 2004).

Detritivorous polychaetes mainly feed on detritus, bacteria and phytoplankton (Jumars et al. 2015). The dietary composition in the model was very similar to the diet for the group in the Sør fjord-model (Pedersen et al. 2008) and was dominated by detritus from pelagic groups, bacteria and some phytoplankton.

| Table S2-87 Detritivorous polychaetes | | | | | |
|---------------------------------------|-------|-----|-------------|---------------------------------|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 1.19 | 5 | | 87% of total polychaete biomass | (Denisenko 2004) |
| C/WW | 0.072 | | | Sedentaria, Polychaeta | (Ricciardi & Bourget 1998) |
| P/B (year^{-1}) | 1.12 | 5 | | Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.11 | | | average for seven species | (Baird et al. 2004) |
| Q/B (year^{-1}) | 10.2 | 5 | | | |
| UC | 0.58 | | | average for seven species | (Baird et al. 2004) |
| Diet (Pe. = 3) | | | | | |
| Review (Jumars et al. 2015) | | | | | |

88 Small benthic crustaceans

This group comprises various small crustaceans (Table S1-1). Cirripeds is the dominant taxa within this group in the Barents Sea (Denisenko 2004). Biomass was calculated based on (Denisenko 2004) (Table S2-92).

A P/B-value of 1.11 year^{-1} estimated for *Balanus crenatus* from the North Sea (Asmus 1987) was used in the model. This is lower than the value ($P/B = 1.77 \text{ year}^{-1}$) estimated for small benthic crustaceans in Porsangerfjord where Cirripedia is rare but small amphipods with high P/B are abundant. Q/B was set to 6.94 year^{-1} based on a P/Q (excluding shell production) of 0.16 and UC was set to 0.075 as estimated for *Balanus glandula* (Wu & Levings 1978). Cirripeds are suspension feeders that feed on a wide size-range of particles (c. $2 \mu\text{m} - 1 \text{ mm}$) including phytoplankton and zooplankton (Southward 1955, Riisgård & Larsen 2010).

| Table S2-88 Small benthic crustaceans | | | | | |
|---|-------|-----|-------------|--|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 0.645 | 5 | | | (Denisenko 2004) |
| C/WW | 0.020 | | | For Cirripedia | (Ricciardi & Bourget 1998) |
| P/B (year^{-1}) | 1.11 | 5 | | <i>Balanus crenatus</i> | (Asmus 1987) |
| P/Q | 0.16 | | | (not inc. shell prod.) for <i>Balanus glandula</i> | (Wu & Levings 1978) |
| Q/B (year^{-1}) | 6.94 | 5 | | From P/B and P/Q | |
| UC | 0.075 | | | for <i>Balanus glandula</i> | (Wu & Levings 1978) |
| Diet (Pe. = 3) | | | | | |
| Barnacle feeding (Southward 1955, Riisgård & Larsen 2010) | | | | | |

89 Small benthic molluscs

This group comprises mainly detritivores and some grazers (small bivalve species < 30 mm adult size), herbivore and detritivorous gastropods, Polyplacophora, Scaphopoda and Caudofoveata. Many of the species are hard bottom inhabitants that are not well sampled by grab and biomass was estimated by the model.

P/B was set to 0.64 year^{-1} , equal to the value for inner Porsangerfjord, and Q/B was calculated from a P/Q of 0.09 (Table S2-93). UC was set to 0.37 as for large bivalves. The dietary composition in the models was dominated by detritus from pelagic groups and other sources, phytoplankton and foraminiferans.

| Table S2-89 Small benthic molluscs | | | | | |
|---|-------|-----|-------------|---|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | M | 1 | | Estimated by model | |
| C/WW | 0.083 | | | Av. for Polyplacophora and small bivalves | (Ricciardi & Bourget 1998) |
| P/B (year^{-1}) | 0.636 | 5 | | From inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.09 | | | Same as for "Large bivalves" | |
| Q/B (year^{-1}) | 7.07 | 5 | | Calc. from P/B and P/Q | |
| UC | 0.37 | 6 | | Same as for "Large bivalves" | |
| Diet (Pe. = 3) | | | | | |
| Review feeding of suspension-feeders (Riisgård & Larsen 2010) | | | | | |
| Small bivalves (Pedersen et al. 2018) | | | | | |

90 Large bivalves

This group comprise bivalve species that are larger than 30 mm as adults. Studies of age-composition of large bivalves (*Serripes groenlandicus*, *Clinocardium ciliatum*, *Chlamys islandica*) from the Barents Sea show that they are long-lived and slow growing (Wiborg et al. 1974, Carroll et al. 2011a, Carroll et al. 2011b, Carroll et al. 2014). They are mainly distributed in the shallower part of the Barents. Biomass was calculated based on (Denisenko 2004) (Table S2-94). There was a intensive dredge fishery on *Chlamys islandica* in the Svalbard zone starting in 1986 that lasted for some years, but after 1995 when the biomass had drastically decreased due to the fishery, catches has been very low (Garcia 2006, Misund et al. 2016). Biomass was calculated from the proportion of large bivalves of total macrofauna carbon biomass (Denisenko 2004).

The P/B-value used in the model ($P/B = 0.12 \text{ year}^{-1}$) was from inner part of Porsangerfjord (Pedersen et al. 2018). P/Q was set to 0.09 and Q/B was calculated from P/B and P/Q. The model diet of large bivalves is dominated by detritus, phytoplankton and bacteria (Ward & Shumway 2004, Kach & Ward 2008).

| Table S2-90 Large bivalves | | | | | |
|---|-------|-----|-------------|--|-----------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 1.80 | 5 | | | (Denisenko 2004) |
| C/WW | 0.028 | | | Weighted, 0.044 for shell free stomach data | (Ricciardi & Bourget 1998) |
| P/B (year ⁻¹) | 0.119 | 5 | | From inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.09 | | | From studies on <i>Mytilus edulis</i> , <i>Cerastoderma edule</i> , <i>Mya arenaria</i> | (Loo & Rosenberg 1996) |
| Q/B (year ⁻¹) | 1.32 | 5 | | From P/B and P/Q | |
| UC | 0.37 | | | <i>Chlamys islandica</i> , <i>Mytilus edulis</i> , <i>Cerastoderma edule</i> , <i>Mya arenaria</i> | (Vahl 1980, Loo & Rosenberg 1996) |
| Diet (Pe. 3) <i>Chlamys islandica</i> (Vahl 1973, 1980) Review and experiments (Ward & Shumway 2004, Kach & Ward 2008) Review (Riisgård & Larsen 2010) | | | | | |

91 Detritivorous echinoderms

The group comprises many ophiuroids, detritivorous asteroids (e.g., *Ctenodiscus crispatus*), holothuroids (e.g., *Cucumaria frondosa*, *Molpadia borealis*), some echinoids (e.g., *Strongylocentrotus pallidus*). Biomass was calculated based on (Denisenko 2004) (Table S2-95).

P/B was estimated to 0.07 year⁻¹ for the long-lived sea urchin (*Strongylocentrotus pallidus*) in the northern part of the Barents Sea (Bluhm et al. 1998). A P/B value of 0.17 year⁻¹ measured in inner Porsangerfjord was used in the model. A P/Q of 0.08 and a value for UC of 0.50 and estimated for *Strongylocentrotus intermedius* was used in the model (Table S2-95).

The very abundant asteroid *Ctenodiscus crispatus* is a deposit feeder and obtains its food from the surface layer of the sediments (Shick et al. 1981, Hopkins et al. 1989). Its fatty acid composition indicates microbial input (*ibid.*). Dietary composition for the group in the models was dominated by detritus from pelagic groups, bacteria, macroalgae and other benthic invertebrates.

| Table S2-91 Detritivorous echinoderms | | | | | |
|--|-------|-----|-------------|---|---|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m ⁻²) | 0.671 | 5 | | | (Denisenko 2004) |
| C/WW | 0.037 | | | | (Rumohr et al. 1987) |
| P/B (year ⁻¹) | 0.171 | 6 | | From Inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.08 | | | | (Lawrence 1985, Loo & Rosenberg 1996, Yuan et al. 2006) |
| Q/B (year ⁻¹) | 2.14 | 5 | | From P/B and P/Q | |
| UC | 0.50 | | | Average from studies, <i>Strongylocentrotus intermedius</i> and <i>Apostichopus japonicas</i> | (Fuji 1967, Yuan et al. 2006) |
| Diet (Pe. = 3) | | | | | |
| <i>C. crispatus</i> feeding (Shick et al. 1981, Hopkins et al. 1989) | | | | | |
| <i>Cucumaria frondosa</i> (Hamel & Mercier 1998) | | | | | |
| <i>Ophiopholis aculeata</i> (ophiurid), <i>C. crispatus</i> , (Pedersen et al. 2018) | | | | | |

92 Large epibenthic suspension feeders

The group comprises sponges, ascidians, bryozoans and brachiopods. Biomass estimates (0.104 g C m^{-2}) for the group from grab samples based on (Denisenko 2004) were higher than biomass of sponges estimated from sampling by Campelen bottom trawl (0.063 g C m^{-2}) (Lis L. Jørgensen, unpubl. data), and the higher grab-estimate for biomass was used in the model.

P/B was set to the estimate ($P/B = 0.095 \text{ year}^{-1}$) for inner Porsangerfjord (Table S2-96). Q/B was set to 0.41 yr^{-1} based on a P/Q of 0.23 and UC was set to 0.50 from an estimate for the ascidian *Ciona intestinalis* (Petersen et al. 1995). The dietary composition used in the model was comprised by detritus, bacteria and microzooplankton (ciliates and heterotrophic dinoflagellates).

| Table S2-92 Large epibenthic suspension feeders | | | | | |
|---|-------|-----|-------------|--|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 0.135 | 5 | | | (Denisenko 2004) |
| C/WW | 0.045 | | | Average for Porifera, Bryozoa and benthic Tunicata | (Steimle & Terranova 1985) |
| P/B (year^{-1}) | 0.095 | 7 | | From inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.23 | | | <i>Ciona intestinalis</i> | (Petersen et al. 1995) |
| Q/B (year^{-1}) | 0.41 | 5 | | From P/B and P/Q | |
| UC | 0.50 | | | <i>Ciona intestinalis</i> | (Petersen et al. 1995) |
| Diet (Pe. 3) Review (Bell 2008) | | | | | |

93 Other benthic invertebrates

The group comprises Sipunculida and Echiura. The sipunculid (*Golfingia margaritacea*) is very abundant and has high biomass in the Barents Sea (Denisenko 2004). Biomass was calculated based on Denisenko (2004).

The P/B-value used ($P/B = 1.0 \text{ year}^{-1}$) in the model was taken from inner Porsangerfjord (Table S2-97). Q/B was calculated using the same P/Q as for detritivorous polychaetes. The species in this group were considered mainly to be detritivores (Macdonald 2010). Dietary composition in the model was dominated by detritus from pelagic groups and bacteria.

| Table S2-93 Other benthic invertebrates | | | | | |
|---|-------|-----|-------------|----------------------------------|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 0.520 | 5 | | Calculated from source | (Denisenko 2004) |
| C/WW | 0.056 | | | For Sipunculida | (Ricciardi & Bourget 1998) |
| P/B (year^{-1}) | 1.003 | 5 | | From inner Porsangerfjord | (Pedersen et al. 2018) |
| P/Q | 0.11 | | | As for detritivorous polychaetes | |
| Q/B (year^{-1}) | 9.12 | 6 | | From P/B and P/Q | |
| UC | 0.58 | | | As for detritivorous polychaetes | |
| Diet (Pe. 3) Feeding guild classification (Macdonald 2010) | | | | | |

Meiofauna, bacteria and foraminifera

94 Meiofauna

Nematodes are the most dominant taxa in the meiofauna in the Barents Sea (Piepenburg et al. 1995). Most meiofauna studies in the Barents Sea are from the northwestern part. Local estimates of biomass varies with most values ranging from 0.2 to 0.8 g WW m⁻² (Piepenburg et al. 1995, Górska & Włodarska-Kowalczyk 2017), (Kotwicki et al. 2018), except for a study which report much higher values (Pfannkuche & Thiel 1987). A biomass value 0.06 g C m⁻² from East and north of Svalbard from Piepenburg et al. (1995) was chosen as input to the model. However, the uncertainty is high since we found no studies from the central and southern part of the Barents Sea.

P/B was calculated to 7.63 year⁻¹ based on as study from fjords at Svalbard (Górska & Włodarska-Kowalczyk 2017). Marine meiofauna nematodes have low assimilation efficiency (assimilation/consumption, c. 6-26%), but have high production efficiency (Heip et al. 1985). Much of the production is used for egg production so somatic growth efficiency (P/Q) is lower, c. 0.05 (Heip et al. 1985). This result in a high value for Q/B of 162 year⁻¹ used in the model. Meiofauna nematodes may feed on bacteria, algae and detritus and other nematodes (predatory forms), and these groups comprise the model diet composition.

| Table S2-94 Meiofauna | | | | | |
|---|-------|-----|-------------|---|-------------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m ⁻²) | 0.060 | 5 | 2000 | Calculated from reference | (Piepenburg et al. 1995) |
| C/WW | 0.106 | | | | (Heip et al. 1985) |
| P/B (year ⁻¹) | 7.63 | 5 | July 2010 | Hornsund & Kongsfjorden, Svalbard | (Górska & Włodarska-Kowalczyk 2017) |
| P/Q | 0.05 | | | Somatic growth/consumption for 3 nematode species | (Heip et al. 1985) |
| Q/B (year ⁻¹) | 162 | 5 | | From P/B and P/Q | |
| UC | 0.83 | | | Average for 3 nematod species | (Heip et al. 1985) |
| Diet (Pe. 3) | | | | | |
| Detritus, bacteria, predation on nematodes (Heip et al. 1985) | | | | | |

95 Bacteria

Bacteria consume dissolved organic carbon (DOC), and biomass and production of bacteria increase seasonally during and after the spring phytoplankton bloom when DOC is released during growth of phytoplankton, grazing by zooplankton and viral lysis of algae and bacteria (Paulsen et al. 2018). The average ratio of bacterial to primary production (Bact P/PP) for the North Atlantic was 0.25 (Ducklow 2000) and 0.32 for the Northern Barents Sea (Sturluson et al. 2008). The biomass value used in the model was taken from a study in Kongsfjorden (Iversen & Seuthe 2011) (Table S2-95). Biomass in the model was set to 0.84 g C m^{-2} based on data from Kongsfjorden (Iversen & Seuthe 2011).

Bacteria production has been estimated to $15\text{-}18 \text{ g C m}^{-2} \text{ year}^{-1}$ in two studies from Kongsfjorden and from west of Svalbard (Iversen & Seuthe 2011, Paulsen et al. 2018). P/B was calculated from the P and B from the Kongsfjorden study (Iversen & Seuthe 2011), and Q/B was calculated by assuming a P/Q of 0.33 (Del Giorgio & Cole 1998). Bacteria are consumed by heterotrophic nanoflagellates and ciliates in the pelagic and by benthic invertebrates at the bottom.

| Table S2-95 Bacteria | | | | | |
|---|--------------|-----|-------------|--|--|
| Variable | Value | Pe. | Time period | Comments | References |
| B (g C m^{-2}) | 0.84 | 5 | | Kongsfjord, calculated from | (Iversen & Seuthe 2011) |
| P/B (year^{-1}) | 21.2 | 7 | | Kongsfjord, calculated | (Iversen & Seuthe 2011) |
| P/Q | 0.33 | | | Model input, from | (Del Giorgio & Cole 1998) |
| Q/B (year^{-1}) | 53.0 | 5 | | From P/B and P/Q | |
| Production ($\text{g C m}^{-2} \text{ year}^{-1}$) | 17.9 15.3 | | | Kongsfjord, Svalbard, calculated from West of Svalbard, calculated from | (Iversen & Seuthe 2011) (Paulsen et al. 2018) |
| Diet (Pe. 3) | | | | | |
| Feed on dissolved organic material (Paulsen et al. 2018). | | | | | |

96 Benthic foraminifera

Foraminiferans are common both in the benthic and pelagic habitat. At St. Ann through in the Northeast Barents Sea, biomasses in the range of $0.06 - 1.7 \text{ g WW m}^{-2}$ were measured (Korsun et al. 1998). According to Korsun et al. (1994) cited in Vetrov and Romankevich (2004), average biomass of foraminiferans in the Barents Sea was 0.5 g WW m^{-2} (shell-free biomass). This corresponds to a biomass of c. 0.05 g C m^{-2} , which is input value to the model (Table S2-96).

There are sparse data on P/B, but a value ($P/B = 3.1 \text{ year}^{-1}$) calculated from Altenbach (1992) was used in the model. Q/B was calculated to 15.6 year^{-1} assuming $P/Q = 0.20$ (Altenbach 1992). Foraminiferans feed on detritus and bacteria and can react very rapidly to pulses of food by increasing cytoplasmic volume (Linke et al. 1995, Nomaki et al. 2006). Different foraminifera has different feeding modes ingesting either fresh phytodetritus or “older” sediment carbon, and the model diet composition was composed of detritus and bacteria (Nomaki et al. 2006). Foraminifera are prey for a number of invertebrates, e.g. *Pandalus borealis*, red king crab, Caudofoveata and Schapopoda (Berenboim 1981, Britayev et al. 2010, Fontoura-da-Silva et al. 2017).

| Table S2-96 Foraminifera | | | | | |
|--|-------|-----|-------------|------------------|-----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g C m^{-2}) | 0.05 | 5 | 2000 | | (Vetrov & Romankevich 2004) |
| C/WW | 0.10 | | | | (Korsun et al. 1998) |
| P/B (year^{-1}) | 3.12 | 5 | | Kieler Bucht | (Altenbach 1992) |
| P/Q | 0.20 | | | Kieler Bucht | (Altenbach 1992) |
| Q/B (year^{-1}) | 15.6 | 5 | | From P/B and P/Q | |
| UC | 0.20 | | | Assumed | |
| Diet (Pe. = 3) | | | | | |
| Detritus and bacteria, tracing experiment (Nomaki et al. 2006) | | | | | |

Primary producers

97-98 Diatoms and Autotroph flagellates

The main phytoplankton groups in the Barents Sea are diatoms and flagellates and these groups have different trophic couplings and fates in the food-web. Autotrophic flagellates are to a large degree grazed by microzooplankton while diatoms are major food sources for copepods, krill and other larger zooplankton groups (Våge et al. 2018).

Phytoplankton has had high growth and P/B-rates, and primary production rates are seasonally, temporally and spatially variable and difficult to measure *in situ* at the ecosystem scale. Several approaches has been applied to estimate primary production in the Barents Sea; direct in situ measurements (Hegseth 1998), coupled physical-lower trophic models (Slagstad et al. 2011), (Skogen et al. 2018), satellite measurements (Dalpadado et al. 2020) and inference from nutrient depletion (Reigstad et al. 2002).

Total phytoplankton primary production for the Barents Sea has been calculated to about 100-110 g C m⁻² year⁻¹ for the total Barents Sea and a value of 110 g C m⁻² year⁻¹ was chosen for year 2000 (Table S2-97-98). Primary production has been higher in Atlantic water than in Arctic water (Reigstad et al. 2011). The total biomass in the 2000 model was set to 2.0 g C m⁻² (Sakshaug et al. 1994) and autotroph flagellates and diatoms made up 33 and 67% of the total biomass, respectively (Wassmann et al. 2006b). The P/B –value was calculated as production/biomass (Table S2-97-98).

There are clear evidence that ice-coverage in the Barents Sea affect phytoplankton production, with low ice-coverage causing higher light intensities promoting high primary production rates over a large area (Dalpadado et al. 2020). There has been a trend of increasing temperature, decreasing ice-coverage and increasing primary production during the period 1998 – 2017 (Dalpadado et al. 2020).

| Table S2-97-98 Diatoms and autotroph flagellates | | | | | |
|--|-------|----|-------------|--------------------------------------|-------------------------|
| Variable | Value | Pe | Time period | Comment | References |
| Phytoplankton production (g C m ⁻² year ⁻¹) | 110 | | 1980s | | (Sakshaug et al. 1994) |
| | 93 | | 1981-1999 | Annual variation (+/- 19%), modelled | (Wassmann et al. 2006b) |
| | 100 | | 1995-2007 | Annual averages | (Reigstad et al. 2011) |
| Phytoplankton biomass (g C m ⁻²) | 2.0 | 5 | | | (Sakshaug et al. 1994) |
| Diatom biomass (g C m ⁻²) | 1.5 | 5 | | 67% of total phytopl. biomass | (Wassmann et al. 2006b) |
| Autotroph flagellate biomass (g C m ⁻²) | 0.5 | 5 | | 33% of total phytopl. biomass | |
| P/B (year ⁻¹) | 55 | 8 | | From production/biomass | (Sakshaug et al. 1994) |

99 Ice algae

The ice-algae flora has been dominated by pennate and some centric diatoms (e.g. *Nitzschia frigida* and *Melosira arctica*) (Hegseth 1998). In the 1990s, the local primary production in ice-covered areas was estimated to ca. $5.3 \text{ g C m}^{-2} \text{ year}^{-1}$ (Hegseth 1998), and this “ice-production” amounted to 16-22 % of the total primary production of the Northern Part of the Barents Sea. In addition to the production within the Barents Sea, an area of about $130\text{-}230 \cdot 10^3 \text{ km}^2$ ice were annually imported to the Barents Sea in the area between Svalbard and Franz Josef land and between Franz Josef land and Novaja Zemlja (Wassmann et al. 2006a). This amounted to an import of ice-algae of c. $0.01 \text{ g C m}^{-2} \text{ year}^{-1}$ for the whole Barents Sea (Table S2-103). (Sakshaug 1997) give a biomass value of 0.10 g C m^{-2} for ice-covered areas which correspond to 0.040 g C m^{-2} for the whole Barents Sea and this was used as the biomass value in the models.

A P/B of 53.0 year^{-1} was calculated from the production and biomass values (Table S2-103).

| Table S2-99 Ice-algae | | | | | |
|--|-------|-----|-------------|---|----------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| Production ($\text{g C m}^{-2} \text{ year}^{-1}$) | 5.3 | | 1996 | In ice-covered areas, 0.8 mill. km^2 | (Hegseth 1998) |
| Production ($\text{g C m}^{-2} \text{ year}^{-1}$) | 2.11 | | | Average for whole Barents Sea, 2.01 mill. km^2 | |
| Biomass (g C m^{-2}) | 0.10 | | | In ice-covered areas, 0.8 mill. km^2 | (Sakshaug 1997) |
| Biomass (g C m^{-2}) | 0.040 | 5 | | Average for whole Barents Sea, area 2.01 mill. km^2 | |
| P/B (year^{-1}) | 53.0 | 8 | | From production/biomass | |
| Ice import (mill. $\text{km}^2 \text{ year}^{-1}$) | 0.228 | | 2002-2003 | | (Hop & Pavlova 2008) |
| Import ice algae ($\text{g C m}^{-2} \text{ year}^{-1}$) | 0.01 | 4 | | Based on ice import of 0.23 mill. $\text{km}^2 \text{ year}^{-1}$, average for whole Barents Sea | |

100 Macroalgae

Macroalgae, both kelp and littoral algae are locally abundant in shallow waters with hard bottom substrates. Precise estimates of biomass for the Barents Sea are not available, but Gundersen et al. (2011) gave biomass values for macroalgae for different areas along the Norwegian coast. Values for both littoral algae and kelp were available. The values given were adjusted (multiplied by two) since our definition of the Barents Sea LME imply that coastal line length is roughly double the size that used by (Gundersen et al. 2011).

Most of the macroalgae production, ca. 80% on worldwide basis (Krumhansl & Scheibling 2012) is not grazed directly but contribute to detritus.

| Table S2-100 Macroalgae | | | | | |
|---|-----|-------|-------------|--|---|
| Sub-group and variable | Pe. | Value | Time period | Comment | Reference |
| Littoral algae biomass (mill. t WW) | | 0.07 | | Norwegian Barents sea coast senso Gundersen et al. 2011 | (Gundersen et al. 2011) |
| | | 0.14 | | Whole Norwegian Barents Sea LME Coast, value above multiplied by two | |
| Kelp biomass (mill. t WW) | | 5.0 | | Norwegian Barents sea coast senso Gundersen et al. (2011) | |
| | | 10.0 | | Whole Norweigan Barents Sea LME Coast, value above multiplied by two | (Gundersen et al. 2011) |
| Littoral algae C/WW | | 0.129 | | | (Pedersen et al. 2016b) |
| Kelp C/WW | | 0.067 | | Based on DW/WW = 0.192 and C/DW = 0.35 | (K. Sivertsen, UiT, unpubl. data) (Dunton & Dayton 1995) |
| Macroalgae biomass (mill. t C) | | 0.69 | | For Barents Sea | |
| Macroalgae biomass (g C m ⁻²) | 4 | 0.34 | | Average for Barents Sea | |
| Littoral algae P/B (year ⁻¹) | | 0.49 | | Average estimates for <i>A. nodosum</i> | (Cousens 1984, Vadas et al. 2004) |
| Kelp (P/B) | | 0.63 | | <i>L. hyperboreus</i> , Porsangerfjorden | (Pedersen et al. 2018) |
| Macroalgae (P/B, year ⁻¹) | 7 | 0.63 | | Weighted average for kelp and littoral algae | |

Expansive crabs

101 Snow crab

Snow crab is a recent expanding species that was recorded for the first time in 1996 in the Barents Sea (Alvsvåg et al. 2009). The species is mainly distributed in the northeastern cold part of the Barents Sea but is expected to spread westwards and into the Svalbard area. In the year 2000 model, biomass was set to $9.6 \cdot 10^{-6} \text{ g C m}^{-2}$ (Table S2-101). Biomass increased rapidly after year 2000 and the commercial fishery on snow crab increased from 2013 (ICES 2019d).

P/B and Q/B were set to the same value as for “Other large crustaceans” (Table S2-101). Feeding studies from the Barents Sea show that snow crab feeds on benthic invertebrates and fish (Agnalt et al. 2011, Hansen 2015, Zakharov et al. 2020). Snow crab is prey for several fish species including cod (ICES 2019d).

| Table S2-101 Snow crab | | | | | |
|---|---------------------|-----|-------------|---|------------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (g WW m ⁻²) | $9.6 \cdot 10^{-6}$ | 5 | 2000 | Calculated from total biomass of 200 t WW | (Dvoretsky & Dvoretsky 2015) |
| C/WW | 0.097 | | | Same as for other large crustaceans | |
| Z (year ⁻¹) | 0.50 | 2 | | Same as for other large crustaceans | |
| P/Q | 0.24 | | | For Tanner crab | (Paul & Fuji 1989) |
| Q/B | 2.08 | 5 | | Assuming P/Q = 0.24 | |
| UC | 0.11 | | | Estimated for Tanner crab | (Paul & Fuji 1989) |
| Diet (Pe. 4) Diet composition was average of three studies 2000-2005, South-eastern Barents Sea, n = 115 st., Foc, Wp (Agnalt et al. 2011) 2011-2014, Barents Sea, autumn and winter, n = 171 st., Foc (Hansen 2015) 2000-2019, Eastern Barents Sea, n = 971 st., Foc (Zakharov et al. 2020) | | | | | |

102-104 Red king crab (RKC)

Red king crab, a native species of the Pacific, was released into the Murman coast area in the 1960s by Soviet scientists in order to establish a stock in the Northeast Atlantic (Orlov & Ivanov 1978). The stock increased in size, and in the mid-1990s, they entered Norway waters and since then spread westwards and southwards along the coast on Finnmark and Troms county in Norway (Windsland et al. 2014). In the model RKC is represented by three multi-stanza groups; “Large”, “Medium” and “Small” Red king crab. Large Red king crab was the leading multistanza group. Fishery is mainly targeting the large group which is composed of sexually mature males. Fishery on Red king crab has increased both in Russian and Norwegian areas and has amounted to between 5000 to 15000 t WW in the period 2005-2013 (ICES 2020b).

P/B-values in the model were based on studies from the Norwegian coast and the Q/B-value was based on laboratory experiments (Table S2-102). Red king crab feed on a wide range of benthic invertebrates and some fish and are consumed by several fish species (Table S2102-104).

| Table S2-102 Large Red king crab | | | | | |
|--|-------|--------|-------------|--|----------------------------|
| Variable | Value | Pe. | Time period | Comments | Reference |
| B (t WW) | 2880 | 4 | 2000 | Calculated as $B = \text{Catch}/F$ where F is assumed to be 0.10 year^{-1} | |
| Catch (t WW) | 288 | 6 | 2000 | | ICES Catch Statistics* |
| C/WW | 0.049 | | | Red king crab | (Paul & Paul 1996) |
| Z (year^{-1}) | 0.38 | 8 (10) | 1995-2001 | Males, average of estimates from trap and trawl | (Windsland 2015) |
| | 0.60 | 8 (10) | 2002-2007 | For 2008-2012, $M = 0.35 \text{ year}^{-1}$ | |
| | 1.03 | 8 (10) | 2008-2012 | | (Windsland 2015) |
| Q/B | 3.34 | 8 | | From experiment, Red k. crab | (Siikavuopio & James 2015) |
| UC | 0.11 | | | Estimated for Tanner crab | (Paul & Fuji 1989) |
| Diet (Pe. 4) 1994-1996, Varangerfjord, $n = 182 \text{ st.}$, Foc, Wp (Rafter et al. 1996) 1995-1996, Varangerfjord, $n = 234 \text{ st.}$, Foc, Wp (Gerasimova 1997) 1999-2000 Kola Bay, $n = 43 \text{ st.}$, Wp (Gudimov et al. 2003) 1994-1996, Varangerfjord, May, September, November, $n = 641 \text{ st.}$, Foc (Sundet et al. 2000) Kola Peninsula, review, stomach data (Britayev et al. 2010) 2011, Porsangerfjord, Norway, May and October, $n = 129 \text{ st.}$, Foc (Fuhrmann et al. 2017) | | | | | |

* <https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx>

| Table S2-103 Medium sized Red king crab | | | | | |
|---|-------|--------|-------------|---------------------------|--------------------|
| Variable | Value | | Time period | Comments | Reference |
| B | | 6 | | Multistanza | |
| C/WW | 0.049 | | | Red king crab | (Paul & Paul 1996) |
| Z (year^{-1}) | 0.35 | 8 (10) | | Natural mortality rate | (Windsland 2015) |
| Q/B | 4.49 | 8 | | Multistanza | |
| UC | 0.11 | | | estimated for Tanner crab | (Paul & Fuji 1989) |
| Diet (Pe. = 4) See sources for "Large RKC" | | | | | |

| Table S2-104 Small Red king crab | | | | | |
|---|-------|----|-------------|--|--------------------|
| Variable | Value | Pe | Time period | Comments | Reference |
| B | | 4 | | Multistanza | |
| C/WW | 0.049 | | | Red king crab | (Paul & Paul 1996) |
| Z (year^{-1}) | 0.50 | 4 | | Equal to Z for Other large crustaceans | (Windsland 2015) |
| Q/B | 9.19 | 8 | | Multistanza | |
| UC | 0.11 | | | estimated for Tanner crab | (Paul & Fuji 1989) |
| Diet (Pe. = 4) See sources for "Large RKC" | | | | | |

Detritus groups

Detritus as defined in the model is dead organic material, and for all groups in the model, the fate of detritus from the group is specified as input data. The biomass values that are input for the detritus groups are not affecting the flow values of the detritus groups that is estimated within the model.

105 Dead carcasses

This group contains body carcasses produced by animals larger than ca 0.1 kg WW including ctenophores, schyphozoa, benthic invertebrates, fish, mammals and bird groups.

106 Detritus from other sources

This group consists of both dissolved organic carbon (DOC) and particulate detritus. We did not differ between benthic and pelagic detritus since resuspension may be frequent. During resuspension events detritus that have settled to the sea floor are resuspended into the water column (Sternberg et al. 2001).

DOC is produced by phytoplankton and also during the consumption of phytoplankton by zooplankton (e.g. copepods) and from leakage from fecal pellets (Sakshaug et al. 1994, Møller et al. 2003). Fecal pellets from zooplankton feeding on phytoplankton may be an important part of the particulate detritus (Riser et al. 2008). A total sedimentation rate of particulate detritus at 90 m depth in the Barents Sea has been calculated to ca. 32 and 44 $\text{g C m}^{-2} \text{ year}^{-1}$ in Arctic and Atlantic water, respectively (Reigstad et al. 2008).

Values for DOC from the Fram Strait west of Svalbard partly within the Barents Sea LME, indicate an annual average of 720 $\mu\text{g C l}^{-1}$ corresponding to 166 g C m^{-2} for a 230 m column (Paulsen et al. 2018). For the northern Barents Sea a value of 68 $\mu\text{mol C l}^{-1}$ was measured corresponding to 186 g C m^{-2} for a 230 m column (Gašparović et al. 2007). An average value of DOC “biomass” of 176 g C m^{-2} was assumed in the models (Table S2-106). However, a large part of this pool consists of refractory DOC (De Laender et al. 2010).

A major part of the production of macroalgae is not grazed directly (Krumhansl & Scheibling 2012), but enter the detritus group both as particulate detritus and as DOC. Since production of macroalgae is small compared to that of phytoplankton in the Barents Sea, this contribution to detritus production is relatively small (Table S2-106).

The biomass of this group was set equal to the value of DOC.

| Table S2-106 Detritus from other sources | | | | | |
|--|----------------------|---|-------------|---|---|
| Detritus source/process | Detritus type | Value | Time period | Comment | Reference |
| Phytoplankton production | DOC | 15 $\text{g C m}^{-2} \text{ year}^{-1}$ | | Release of DOC by phytoplankton | (Sakshaug et al. 1994) |
| Macroalgae | Particulate and DOC | Ca. 0.8 $\text{g C m}^{-2} \text{ year}^{-1}$ | | Detritus production ca 80 % of production | (Krumhansl & Scheibling 2012) |
| Sedimentation out of euphotic zone at 90 m | Particulate detritus | 32-44 $\text{g C m}^{-2} \text{ year}^{-1}$ | | | (Reigstad et al. 2008) |
| Biomass DOC | DOC | 176 g C m^{-2} | | | (Gašparović et al. 2007, Paulsen et al. 2018) |

107 Detritus from ice algae

Detritus from ice algae was defined as a separate group since it is a major food source for ice associated (symphagic) amphipods (Poltermann 2001).

108 Offal

Offal is material from fish that are eviscerated and may consist of heads, intestines and liver. This has earlier been discarded to the sea and been a food source for birds, fish and invertebrates.

Import and export of detritus to sediment and organic burial rates

Average organic carbon burial rates in the Barents Sea is ca $6 \text{ g C m}^{-2} \text{ year}^{-1}$ and in a fjord at Svalbard it was ca $15 \text{ g C m}^{-2} \text{ year}^{-1}$ (Carroll et al. 2008a, Zaborska et al. 2016). In the model, a burial rate of $6 \text{ g C m}^{-2} \text{ year}^{-1}$ was assumed and specified as “emigration” in the Ecopath model. DOC is imported to the Barents Sea mainly in the inflow between Norway and Svalbard and exported mainly through the outflows in the eastern part and the import and export balances each other with very little net import (Kivimäe et al. 2010). Thus, no net import of detritus was assumed.

References

- Acuña JL, Deibel D, Saunders PA, Booth B, Hatfield E, Klein B, Mei Z-P, Rivkin R (2002) Phytoplankton ingestion by appendicularians in the North Water. *Deep Sea Research Part II: Topical Studies in Oceanography* 49:5101-5115
- Agnalt A-L, Pavlov V, Jørstad KE, Farestveit E, Sundet J (2011) The snow crab, *Chionoecetes opilio* (Decapoda, Majoidea, Oregoniidae) in the Barents Sea. In the Wrong Place-Alien Marine Crustaceans: Distribution, Biology and Impacts. Springer
- Ajiad AM, Gjøsæter H (1990) Diet of polar cod, *Boreogadus saida*, in the Barents Sea related to fish size and geographical distribution. *ICES CM* 1990/G:48
- Ajiad AM, Oganin IA, Gjøsæter H (2011) 5.9 Polar cod. In: Jakobsen T, Ozhigin VK (eds) *The Barents Sea - Ecosystem, resources, management*. Tapir Academic Press, Trondheim
- Ajiad AM, Pushchaeva TY (1992) The daily feeding dynamics in various length groups of the Barents Sea capelin. Interrelations between fish populations in the Barents Sea Proceedings of the fifth PINRO-IMR Symposium on the Barents Sea capelin, 12-16 August 1991. Institute of Marine Research, Bergen, Norway
- Aksnes D, Blindheim J (1996) Circulation patterns in the North Atlantic and possible impact on population dynamics of *Calanus finmarchicus*. *Ophelia* 44:7-28
- Albert OT (2016) Growth and formation of annual zones in whole otoliths of Greenland halibut, a slow-growing deep-water fish. *Marine and Freshwater Research* 67:937-942
- Albert OT, Eliassen J-E, Høines Å (1998) Flatfishes of Norwegian coasts and fjords. *Journal of Sea Research* 40:153-171
- Albert OT, Mokeeva N, Sunnanå K (1994) Long rough dab (*Hippoglossoides platessoides*) of the Barents Sea and Svalbard area: ecology and resource evaluation. *ICES CM* 1994/O:8
- Albert OT, Vollen T (2014) A major nursery area around the Svalbard archipelago provides recruits for the stocks in both Greenland halibut management areas in the Northeast Atlantic. *ICES Journal of Marine Science* 72:872-879
- Allen RC, Keay I (2006) Bowhead whales in the Eastern Arctic, 1611-1911: Population reconstruction with historical whaling. *Environment and history* 12:89-113
- Altenbach A (1992) Short term processes and patterns in the foraminiferal response to organic flux rates. *Mar Micropaleontol* 19:119-129
- Alvsvåg J, Agnalt A-L, Jørstad K (2009) Evidence for a permanent establishment of the snow crab (*Chionoecetes opilio*) in the Barents Sea. *Biological Invasions* 11:587-595
- Andersen SM, Lydersen C, Grahl-Nielsen O, Kovacs KM (2004) Autumn diet of harbour seals (*Phoca vitulina*) at Prins Karls Forland, Svalbard, assessed via scat and fatty-acid analyses. *Canadian journal of zoology* 82:1230-1245
- Anger K, Rogal G, Schreiber G, Valentin C (1977) *In situ* investigations on the echinoderm *Asterias rubens* as a predator of soft-bottom communities in the western Baltic Sea. *Helgoländer Meeresuntersuchungen* 29:439-459
- Anisimova NA, Jørgensen LL, Lyubin P, Manushin I (2010) Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results from the joint Russian-Norwegian benthic programme 2006-2008. *IMR-PINRO Joint Report Series* 1-2010
- Anker-Nilssen T, Bakken V, Strøm H, Golovkin AN, Bianki VV, Tatarinkova IP (2000) The status of marine birds breeding in the Barents Sea region. *Norwegian Polar Institute Report Serie* 113-2000
- Anker-Nilssen T, Barrett RT (1991) Status of seabirds in northern Norway. *BrBirds* 84:329-341
- Arashkevich E, Wassmann P, Pasternak A, Riser CW (2002a) Seasonal and spatial changes in biomass, structure, and development progress of the zooplankton community in the Barents Sea. *Journal of Marine Systems* 38:125-145

- Arashkevich E, Wassmann P, Pasternak A, Riser CW (2002b) Seasonal and spatial changes in biomass, structure, and development progress of the zooplankton community in the Barents Sea. *Journal of Marine Systems* 38:125-145
- Archer SD, Verity PG, Stefels J (2000) Impact of microzooplankton on the progression and fate of the spring bloom in fjords of northern Norway. *Aquatic Microbial Ecology* 22:27-41
- Arnaud F, Bamber R (1988) The biology of Pycnogonida. *Advances in marine biology* 24:1-96
- Asmus H (1987) Secondary production of an intertidal mussel bed community related to its storage and turnover compartments. *Marine Ecology Progress Series* 39:251-266
- Auel H, Werner I (2003) Feeding, respiration and life history of the hyperiid amphipod *Themisto libellula* in the Arctic marginal ice zone of the Greenland Sea. *Journal of Experimental Marine Biology and Ecology* 296:183-197
- Aykanat T, Rasmussen M, Ozerov M, Niemelä E, Paulin L, Vähä J-P, Hindar K, Wennevik V, Pedersen T, Svenning M-A (2020) Life history genomic regions explain differences in Atlantic salmon marine diet specialization. *Journal of Animal Ecology* 89:2677-2691
- Bachiller E, Utne KR, Jansen T, Huse G (2018) Bioenergetics modeling of the annual consumption of zooplankton by pelagic fish feeding in the Northeast Atlantic. *PLoS One* 13:e0190345
- Baird D, Asmus H, Asmus R (2004) Energy flow of a boreal intertidal ecosystem, the Sylt-Romo Bight. *Marine Ecology Progress Series* 279:45-61
- Bakketeig IE, Gjøsæter H, Hauge M, Sunnset BH, Toft KØ (2015) Havforskningsrapporten 2015. Fisken og havet Særnr. 1–2015.
- Balazy P, Kuklinski P, Włodarska-Kowalczyk M, Barnes D, Kędra M, Legeżyńska J, Węśławski JM (2015) Hermit crabs (*Pagurus* spp.) at their northernmost range: distribution, abundance and shell use in the European Arctic. *Polar Research* 34:21412
- Barlow J, Clapham PJ (1997) A new birth-interval approach to estimating demographic parameters of Humpback whales. *Ecology* 78:535-546
- Barrett RT (2007) Food web interactions in the southwestern Barents Sea: black-legged kittiwakes *Rissa tridactyla* respond negatively to an increase in herring *Clupea harengus*. *Marine Ecology Progress Series* 349:269-276
- Barrett RT, Anker-Nilssen T, Gabrielsen GW, Chapdelaine G (2002) Food consumption by seabirds in Norwegian waters. *ICES Journal of Marine Science* 59:43-57
- Barrett RT, Bakken V, Krasnov JV (1997) The diets of common and Brunnich's guillemots *Uria aalge* and *U. lomvia* in the Barents Sea region. *Polar Research* 16:73-84
- Barrett RT, Furness RW (1990) The prey and diving depths of seabirds on Hornø, North Norway after a decrease in the Barents Sea capelin stocks. *Ornis Scandinavica* 21:179-186
- Basedow SL, Tande KS (2006) Cannibalism by female *Calanus finmarchicus* on naupliar stages. *Marine Ecology Progress Series* 327:247-255
- Basedow SL, Zhou M, Tande KS (2014) Secondary production at the Polar Front, Barents Sea, August 2007. *Journal of Marine Systems* 130:147-159
- Bednaršek N, Tarling G, Fielding S, Bakker D (2012) Population dynamics and biogeochemical significance of *Limacina helicina antarctica* in the Scotia Sea (Southern Ocean). *Deep Sea Research Part II: Topical Studies in Oceanography* 59:105-116
- Belikov SV, Oganin IA, Høines Å (2011) 5.13 Blue whiting. In: Jakobsen T, Qzhigin VK (eds) *The Barents Sea - Ecosystem, Resources and Management*. Tapir Academic Press, Trondheim
- Bell JJ (2008) The functional roles of marine sponges. *Estuarine, Coastal and Shelf Science* 79:341-353
- Benjaminsen T (1973) Age determination and the growth and age distribution from cementum growth layers of bearded seals at Svalbard. *Fisk Dir Skr Ser Havunders* 16:159-170
- Bennett KA, Speakman JR, Moss SE, Pomeroy P, Fedak MA (2007) Effects of mass and body composition on fasting fuel utilisation in grey seal pups (*Halichoerus grypus* Fabricius): an experimental study using supplementary feeding. *Journal of Experimental Biology* 210:3043-3053

- Bentley JW, Serpetti N, Heymans JJ (2017) Investigating the potential impacts of ocean warming on the Norwegian and Barents Seas ecosystem using a time-dynamic food-web model. *Ecological Modelling* 360:94-107
- Berenboim B (1981) Feeding of northern shrimp in Barents Sea (*Pandalus borealis*). *Soviet Journal of Marine Biology (USA)* 7:294-297
- Berestovsky E, Matishov G (2001) New data on the population structure of Long rough dab in the Barents Sea. *Doklady Biological Sciences* 376:67-69
- Berestovsky EG (1989) Feeding of skates *Raja radiata* Donovan and *Raja fyllae* Lutken (Rajidae) in the Barents and Norwegian Seas. *Voprosy ihtiologii* 29:994-1002 (in Russian)
- Berg E, Pedersen T (2001) Variability in recruitment, growth and sexual maturity of coastal cod (*Gadus morhua* L.) in a fjord system in northern Norway. *Fisheries Research* 52:179-189
- Berg I, Haug T, Nilssen KT (2002) Harbour seal (*Phoca vitulina*) diet in Vesterålen, north Norway. *Sarsia* 87:451-461
- Berge J, Heggland K, Lønne OJ, Cottier F, Hop H, Gabrielsen GW, Nøttestad L, Misund OA (2015) First records of Atlantic mackerel (*Scomber scombrus*) from the Svalbard archipelago, Norway, with possible explanations for the extensions of its distribution. *Arctic* 68:54-61
- Bergstad OA, Jørgensen T, Dragesund O (1987) Life history and ecology of the gadoid resources of the Barents Sea. *Fisheries Research* 5:119-161
- Best RC (1985) Digestibility of ringed seals by the polar bear. *Canadian Journal of Zoology* 63:1033-1036
- Beuchel F, Lønne O (2002) Population dynamics of the sympagic amphipods *Gammarus wilkitzkii* and *Apherusa glacialis* in sea ice north of Svalbard. *Polar Biology* 25:241-250
- Birkely S, Gulliksen B (2003a) Feeding ecology in five shrimp species (Decapoda, Caridea) from an Arctic fjord (Isfjorden, Svalbard), with emphasis on *Sclerocrangon boreas* (Phipps, 1774). *Crustaceana - International Journal of Crustacean Research* 76:699-716
- Birkely S, Gulliksen B (2003b) Population features of the caridean shrimp, *Sclerocrangon boreas* (Phipps, 1774) in Isfjorden, Spitsbergen. *Crustaceana - International Journal of Crustacean Research* 76:87-102
- Bjørge A (2003) The harbour porpoise (*Phocoena phocoena*) in the North Atlantic: Variability in habitat use, trophic ecology and contaminant exposure. *NAMMCO Scientific Publications* 5:223-228
- Bjørge A, Christensen I, Øritsland T (1981) Current problems and research related to interactions between marine mammals and fisheries in Norwegian coastal and adjacent waters. *ICES CM* 1981:N18
- Bjørge A, Skern-Mauritzen M, Rossman MC (2013) Estimated bycatch of harbour porpoise (*Phocoena phocoena*) in two coastal gillnet fisheries in Norway, 2006–2008. Mitigation and implications for conservation. *Biological conservation* 161:164-173
- Bjørge A, Aarefjord H, Kaarstad S, Kleivane L, Øien N (1991) Harbor porpoise (*Phocoena phocoena*) in Norwegian waters. *CM* 1991:/N16
- Bjørke H (1976) Some preliminary results on food and feeding of young capelin larvae. *ICES CM* 1976/:H:37
- Bjørke H (2001) Predators of the squid *Gonatus fabricii* (Lichtenstein) in the Norwegian Sea. *Fisheries Research* 52:113-120
- Blachowiak-Samolyk K, Søreide JE, Kwasniewski S, Sundfjord A, Hop H, Falk-Petersen S, Hegseth EN (2008) Hydrodynamic control of mesozooplankton abundance and biomass in northern Svalbard waters (79–81 °N). *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2210-2224
- Blanchard J, Pinnegar J, Mackinson S (2002) Exploring marine mammal-fishery interactions using 'Ecopath with Ecosim': modelling the Barents Sea ecosystem. *Sci Ser Tech Rep, CEFAS Lowestoft*, 117: 52pp

- Bluhm BA, Piepenburg D, von Juterzenka K (1998) Distribution, standing stock, growth, mortality and production of *Strongylocentrotus pallidus* (Echinodermata : Echinoidea) in the northern Barents Sea. *Polar Biology* 20:325-334
- Bochdansky AB, Deibel D, Rivkin RB (1999) Absorption efficiencies and biochemical fractionation of assimilated compounds in the cold water appendicularian *Oikopleura vanhoeffeni*. *Limnology and Oceanography* 44:415-424
- Boehnke R, Gluchowska M, Wojczulanis-Jakubas K, Jakubas D, Karnovsky NJ, Walkusz W, Kwasniewski S, Błachowiak-Samotył K (2015) Supplementary diet components of little auk chicks in two contrasting regions on the West Spitsbergen coast. *Polar Biology* 38:261-267
- Bogstad B, Dalpadado P, Hop H, Orlova E, Prokopchuk I, Rudneva G, Nesterova V (2011) Feeding of polar cod (*Boreogadus saida*) in the Barents Sea related to food abundance and oceanographic conditions. IMR-PINRO Joint Report Series 2-2011:7-8
- Bogstad B, Gjørsæter H, Haug T, Lindstrøm U (2015) A review of the battle for food in the Barents Sea: cod vs. marine mammals. *Frontiers in Ecology and Evolution* 3:1-17
- Bogstad B, Haug T, Mehl S (2000) Who eats whom in the Barents Sea. *North Atlantic Marine Mammals Commission Scientific Publications* 2:98-119
- Bogstad B, Yaragina NA, Nash RD (2016) The early life-history dynamics of Northeast Arctic cod: levels of natural mortality and abundance during the first 3 years of life. *Canadian Journal of Fisheries and Aquatic Sciences* 73:246-256
- Boltunov AN, Belikov SE (2002) Belugas (*Delphinapterus leucas*) of the Barents, Kara and Laptev seas. *NAMMCO Scientific Publications* 4:149-168
- Born E, Rysgaard S, Ehlme G, Sejv M, Acquarone M, Levermann N (2003) Underwater observations of foraging free-living Atlantic walruses (*Odobenus rosmarus rosmarus*) and estimates of their food consumption. *Polar Biology* 26:348-357
- Born EW, Gjertz I, Reeves RR (1995) Population assessment of Atlantic walrus (*Odobenus rosmarus rosmarus* L.). *Norwegian Polar Institute Meddelelser* nr 135-1995
- Bowen W, Iverson SJ, Boness DJ, Oftedal OT (2001) Foraging effort, food intake and lactation performance depend on maternal mass in a small phocid seal. *Functional Ecology*:325-334
- Brekke B, Gabrielsen GW (1994) Assimilation efficiency of adult kittiwakes and Bruennich's guillemots fed capelin and Arctic cod. *Polar Biology* 14:279-284
- Brett J, Groves T (1979) Physiological energetics. In: Hoar WS, Randall DJ, Brett JR (eds) *Fish physiology*, Book 8. Academic Press, New York
- Britayev TA, Rzhavsky AV, Pavlova LV, Dvoretzky AG (2010) Studies on impact of the alien Red King Crab (*Paralithodes camtschaticus*) on shallow water benthic communities of the Barents Sea. *Journal of Applied Ichthyology* 26:66-73
- Bruun E (1968) Extreme population density of the starfish *Asterias rubens* L. on a bed of Iceland scallop *Chlamys islandica* (O.F. Muller). *Astarte* 32:1-4
- Bugge J, Barrett RT, Pedersen T (2011) Optimal foraging in chick-raising Common Guillemots (*Uria aalge*). *Journal of Ornithology* 152:253-259
- Bustnes JO, Erikstad KE (1988) The diets of sympatric wintering populations of Common Eider *Somateria mollissima* and King Eider *S. spectabilis*. *Ornis Fennica* 65:163-168
- Bustnes JO, Lønne OJ (1994) Sea ducks as predators on sea urchins in a northern kelp forest. In: Skjoldal HR, Hopkins C, Erikstad KE, Leinaas HP (eds) *Ecology of Fjords and Coastal Waters*. Elsevier, Amsterdam
- Bærum KM, Anker-Nilssen T, Christensen-Dalsgaard S, Fangel K, Williams T, Vølstad JH (2019) Spatial and temporal variations in seabird bycatch: Incidental bycatch in the Norwegian coastal gillnet-fishery. *PLoS One* 14:e0212786
- Böer M, Gannefors C, Kattner G, Graeve M, Hop H, Falk-Petersen S (2005) The Arctic pteropod *Clione limacina*: seasonal lipid dynamics and life-strategy. *Marine Biology* 147:707-717

- Bøthun G, Skaug HJ, Øien NI (2009) Abundance of minke whales in the Northeast Atlantic based on survey data collected over the period 2002-2007. Unpublished manuscript (Document SC/61/RMP2 for the IWC Scientific Committee)
- Båmstedt U, Eilertsen HC, Tande KS, Slagstad D, Skjoldal HR (1991) Copepod grazing and its potential impact on the phytoplankton development in the Barents Sea. *Polar Research* 10:339-354
- Båmstedt U, Martinussen MB, Matsakis S (1994) Trophodynamics of the 2 schypozoan jellyfishes, *Aurelia aurita* and *Cyanea capillata*, in western Norway. *ICES Journal of Marine Science* 51:369-382
- Canning SJ, Santos MB, Reid RJ, Evans PGH, Sabin RC, Bailey N, Pierce GJ (2008) Seasonal distribution of white-beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use. *Journal of the Marine Biological Association of the United Kingdom* 88:1159-1166
- Carlson L (1958) Håkjerringa og håkjerringfisket. *Fisk Dir Dkr Ser Havunders* 9(1):5-36
- Carroll J, Zaborska A, Papucci C, Schirone A, Carroll ML, Pempkowiak J (2008a) Accumulation of organic carbon in western Barents Sea sediments. *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2361-2371
- Carroll ML, Ambrose Jr WG, Levin BS, Henkes GA, Hop H, Renaud PE (2011a) Pan-Svalbard growth rate variability and environmental regulation in the Arctic bivalve *Serripes groenlandicus*. *Journal of Marine Systems* 88:239-251
- Carroll ML, Ambrose Jr WG, Levin BS, Ryan SK, Ratner AR, Henkes GA, Greenacre MJ (2011b) Climatic regulation of *Clinocardium ciliatum* (bivalvia) growth in the northwestern Barents Sea. *Palaeogeogr, Palaeoclimatol, Palaeoecol* 302:10-20
- Carroll ML, Ambrose Jr WG, Ryan SK, Johnson BJ (2014) Bivalve growth rate and isotopic variability across the Barents Sea Polar Front. *Journal of Marine Systems* 130:167-180
- Carroll ML, Denisenko SG, Renaud PE, Ambrose Jr WG (2008b) Benthic infauna of the seasonally ice-covered western Barents Sea: patterns and relationships to environmental forcing. *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2340-2351
- Castro G, Stoyan N, Myers J (1989) Assimilation efficiency in birds: a function of taxon or food type? *Comparative Biochemistry and Physiology Part A: Physiology* 92:271-278
- Cherel Y, Ridoux V, Weimerskirch H, Tveraa T, Chastel O (2001) Capelin (*Mallotus villosus*) as an important food source for northern fulmars (*Fulmarus glacialis*) breeding at Bjørnøya (Bear Island), Barents Sea. *ICES Journal of Marine Science* 58:355-361
- Choe N, Deibel D (2011) Life history characters and population dynamics of the boreal larvacean *Oikopleura vanhoeffeni* (Tunicata) in Conception Bay, Newfoundland. *Journal of the Marine Biological Association of the United Kingdom* 91:1587-1598
- Christensen I (1982) Killer whales in Norwegian coastal waters. *Rep int Whal Commn* 32:633-642
- Christensen I (1988) Distribution, movements and abundance of killer whales (*Orcinus orca*) in Norwegian coastal waters, 1982-1987, based on questionnaire surveys. *Rit Fiskideildar* 11:79-88
- Christensen I, Haug T, Øien N (1992a) A review of feeding and reproduction in large baleen whales (Mysticeti) and sperm whales *Physeter macrocephalus* in Norwegian and adjacent waters. *Fauna Norvegica, Serie A* 13:39-48
- Christensen I, Haug T, Øien N (1992b) Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. *ICES Journal of Marine Science* 49:341-355
- Christensen V (1995) A model of trophic interactions in the North Sea in 1981, the year of the stomach. *Dana* 11:1-28
- Chumakov A, Podrazhanskaya S (1986) Feeding of Greenland Halibut (*Reinhardtius hippoglossoides*) in the Northwest Atlantic. *NAFO Sci Coun Studies* 10:47-52
- Clarke A (1987) Temperature, latitude and reproductive effort. *Marine Ecology Progress Series* 38:89-99

- Clarke A, Morris D (1983) Towards an energy budget for krill: the physiology and biochemistry of *Euphausia superba* Dana. *Polar Biology* 2:69-86
- Cleary AC, Søreide JE, Freese D, Niehoff B, Gabrielsen TM, Fields HeD (2017) Feeding by *Calanus glacialis* in a high arctic fjord: potential seasonal importance of alternative prey. *ICES Journal of Marine Science* 74:1937-1946
- Conover RJ (1966) Assimilation of organic matter by zooplankton. *Limnology and oceanography* 11:338-345
- Cosentino AM (2015) First record of Norwegian killer whales attacking and feeding on a harbour porpoise. *Marine Biodiversity Records* 8:1-5
- Cousens R (1984) Estimation of annual production by intertidal brown alga *Ascophyllum nodosum* (L) Lejolis. *Botanica Marina* 27:217-227
- Dahl TM, Lydersen C, Kovacs KM, Falk-Petersen S, Sargent J, Gjertz I, Gulliksen B (2000) Fatty acid composition of the blubber in white whales (*Delphinapterus leucas*). *Polar Biology* 23:401-409
- Dale K, Falk-Petersen S, Hop H, Fevolden S-E (2006) Population dynamics and body composition of the Arctic hyperiid amphipod *Themisto libellula* in Svalbard fjords. *Polar Biology* 29:1063
- Dalpadado P (2002) Inter-specific variations in distribution, abundance and possible life-cycle patterns of *Themisto* spp. (Amphipoda) in the Barents Sea. *Polar Biology* 25:656-666
- Dalpadado P, Arrigo KR, van Dijken GL, Skjoldal HR, Bagøien E, Dolgov A, Prokopchuk I, Sperfeld E (2020) Climate effects on temporal and spatial dynamics of phytoplankton and zooplankton in the Barents Sea. *Progress in Oceanography* 185:102320
- Dalpadado P, Bogstad B, Eriksen E, Rey L (2009) Distribution and diet of 0-group cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) in the Barents Sea in relation to food availability and temperature. *Polar Biology* 32:1583-1596
- Dalpadado P, Bogstad B, Gjøs H, Mehl S, Skjoldal HR (2002) Chap. 9 Zooplankton-fish interactions in the Barents Sea. In: Sherman K, Skjoldal HR (eds) *Large Marine Ecosystems of the North Atlantic*, Book 10. Elsevier, Amsterdam
- Dalpadado P, Borkner N, Bogstad B, Mehl S (2001) Distribution of *Themisto* (Amphipoda) spp in the Barents Sea and predator-prey interactions. *ICES Journal of Marine Science* 58:876-895
- Dalpadado P, Ellertsen B, Johannessen S (2008a) Inter-specific variations in distribution, abundance and reproduction strategies of krill and amphipods in the Marginal Ice Zone of the Barents Sea. *Deep-Sea Research Part II-Topical Studies in Oceanography* 55:2257-2265
- Dalpadado P, Ingvaldsen RB, Stige LC, Bogstad B, Knutsen T, Ottersen G, Ellertsen B (2012) Climate effects on Barents Sea ecosystem dynamics. *ICES Journal of Marine Science* 69:1303-1316
- Dalpadado P, Mowbray F (2013) Comparative analysis of feeding ecology of capelin from two shelf ecosystems, off Newfoundland and in the Barents Sea. *Progress in Oceanography* 114:97-105
- Dalpadado P, Skjoldal HR (1991) Distribution and life history of krill from the Barents Sea. *Polar Research* 10:443-460
- Dalpadado P, Skjoldal HR (1996) Abundance, maturity and growth of the krill species *Thysanoessa inermis* and *T. longicaudata* in the Barents Sea. *Marine Ecology Progress Series* 144:175-183
- Dalpadado P, Yamaguchi A, Ellertsen B, Johannessen S (2008b) Trophic interactions of macro-zooplankton (krill and amphipods) in the Marginal Ice Zone of the Barents Sea. *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2266-2274
- Davis N, Myers K, Ishida Y (1998) Caloric value of high-seas salmon prey organisms and simulated salmon ocean growth and prey consumption. *North Pacific Anadromous Fish Commission Bulletin* 1:146-162
- Davoult D, Degros N, Janquin M, Soyeux B (1992) Biometrics, carbon and nitrogen content in the ophiuroid *Ophiothrix fragilis*. *Journal of the Marine Biological Association of the United Kingdom* 72:915-918

- De Laender F, Oevelen Dv, Soetaert K, Middelburg JJ (2010) Carbon transfer in herbivore-and microbial loop-dominated pelagic food webs in the southern Barents Sea during spring and summer. *Marine Ecology-Progress Series* 398:93-107
- Degen R, Jørgensen LL, Ljubin P, Ellingsen IH, Pehlke H, Brey T (2016) Patterns and drivers of megabenthic secondary production on the Barents Sea shelf. *Marine Ecology Progress Series* 546:1-16
- Deibel D (1986) Feeding mechanism and house of the appendicularian *Oikopleura vanhoeffeni*. *Marine Biology* 93:429-436
- Del Giorgio PA, Cole JJ (1998) Bacterial growth efficiency in natural aquatic systems. *Annual Review of Ecology and Systematics* 29:503-541
- Denisenko S (2001) Long-term changes of zoobenthos biomass in the Barents Sea. *Proc Zool Inst Russ Acad Sci* 289:59-66
- Denisenko S, Denisenko N, Lehtonen K, Andersin A-B, Laine A (2003) Macrozoobenthos of the Pechora Sea (SE Barents Sea): community structure and spatial distribution in relation to environmental conditions. *Marine Ecology Progress Series* 258:109-123
- Denisenko S, Titov O (2003) Distribution of zoobenthos and primary production of plankton in the Barents Sea. *Oceanology* 43:72-82
- Denisenko SG (2004) Structurally-functional characteristics of the Barents Sea zoobenthos. *Proc Zool Inst Russ Acad Sci* 300:43-52
- Derocher A, Wiig Ø (2002) Postnatal growth in body length and mass of polar bears (*Ursus maritimus*) at Svalbard. *Journal of Zoology* 256:343-349
- Derocher AE, Wiig Ø, Andersen M (2002) Diet composition of polar bears in Svalbard and the western Barents Sea. *Polar Biology* 25:448-452
- Dietz R, Heide-Jørgensen M, Born EW, Glahder CM (1994) Occurrence of narwhals (*Monodon monoceros*) and white whales (*Delphinapterus leucas*) in East Greenland. *Meddelelser om Grønland, Bioscience* 39:69-86
- Dolgov A (1994) Some aspects of biology of non-target fish species in the Barents Sea. *ICES CM* 1994/O:12
- Dolgov A (2000) Feeding and food consumption by the Barents Sea predatory fishes in 1980-1990s'. *ICES CM* 2000/Q:02
- Dolgov A (2005) Feeding and food consumption by the Barents Sea skates. *Journal of Northwest Atlantic Fishery Science* 35:495-503
- Dolgov A (2016) Composition, formation and trophic structure of the Barents Sea fish communities. PINRO, Murmansk (In Russian)
- Dolgov A, Drevetnyak K (1990) Estimation of rations and food consumption of deep-water redfish (*Sebastes mentella*) from the Norwegian-Barents Sea stock. *ICES CM* 1990/G:11
- Dolgov A, Drevetnyak K, Gusev E (2005a) The status of skate stocks in the Barents Sea. *Journal of Northwest Atlantic Fishery Science* 35:249-260
- Dolgov A, Grekov A, Shestopal I, Sokolov K (2005b) By-catch of skates in trawl and long-line fisheries in the Barents Sea. *Journal of Northwest Atlantic Fishery Science* 35:357-366
- Dolgov AV (2009) Trophic structure of the Barents Sea fish assemblage with special reference to the cod stock recoverability. *Progress in Oceanography* 81:165-173
- Dolgov AV, Johannesen E, Heino M, Olsen E (2010) Trophic ecology of blue whiting in the Barents Sea. *ICES Journal of Marine Science* 67:483-493
- Domingues P, Ferreira A, Marquez L, Andrade JP, Lopez N, Rosas C (2008) Growth, absorption and assimilation efficiency by mature cuttlefish (*Sepia officinalis*) fed with alternative and artificial diets. *Aquacult Int* 16:215-229
- Dommasnes A, Christensen V, Ellertsen B, Kvamme C, Melle W, Nøttestad L, Pedersen T, Tjelmeland S, Zeller D (2002) An ECOPATH model for the Norwegian and Barents Sea. *Fisheries Impact on North Atlantic Ecosystems: Models and Analyses. Fisheries Centre Research Reports no. 9(4).*

- In: Guénette S, Christensen V, Pauly D (eds) Fisheries Centre Research Reports, Book 9(4), Vancouver
- Drevetnyak K, Prozorkevich D, Dolgov A, Murashko P (2010) The Barents Sea skates: using the fishery-independent surveys for estimation of long-term trends in relative abundance and possible considerations to reduce their bycatch. ICES CM 2010/E:3
- Drobysheva S (1994) The Barents Sea euphausiids and their role in the formation of commercially valuable biological resources. PINRO Press, Murmansk
- Ducklow H (2000) Bacterial production and biomass in the oceans. In: Kichmann D (ed) Microbial ecology of the oceans. Wiley-Liss, New York
- Dunton KH, Dayton PK (1995) The biology of high latitude kelp. In: Skjoldal HR, Hopkins C, Erikstad KE, Leinaas HP (eds) Ecology of Fjords and Coastal Waters. Elsevier, Amsterdam
- Dvoretzky AG, Dvoretzky VG (2015) Commercial fish and shellfish in the Barents Sea: have introduced crab species affected the population trajectories of commercial fish? Reviews in Fish Biology and Fisheries 25:297-322
- Dvoretzky VG, Dvoretzky AG (2009) Summer mesozooplankton distribution near Novaya Zemlya (eastern Barents Sea). Polar biology 32:719-731
- Dvoretzky VG, Dvoretzky AG (2010) Checklist of fauna found in zooplankton samples from the Barents Sea. Polar biology 33:991-1005
- Daase M, Eiane K (2007) Mesozooplankton distribution in northern Svalbard waters in relation to hydrography. Polar Biology 30:969-981
- Eilertsen K, Barrett RT, Pedersen T (2008) The effect of changes in diet of Atlantic Puffin *Fratercula arctica* on their growth and survival. Waterbird 31:107-114
- Eliassen JE, Jobling M (1985) Food of the roughhead grenadier, *Macrourus berglax*, Lapeyre in North Norwegian waters. Journal of fish biology 26:367-376
- Eriksen E, Bogstad B, Dolgov A, Beck I (2018) Cod diet as an indicator of Ctenophora abundance dynamics in the Barents Sea. Marine Ecology Progress Series 591:87-100
- Eriksen E, Dalpadado P (2011) Long-term changes in Krill biomass and distribution in the Barents Sea: are the changes mainly related to capelin stock size and temperature conditions? Polar Biology 34:1399-1409
- Eriksen E, Durif CM, Prozorkevich D (2014) Lumpfish (*Cyclopterus lumpus*) in the Barents Sea: development of biomass and abundance indices, and spatial distribution. ICES Journal of Marine Science 71:2398-2402. doi: 2310.1093/icesjms/fsu2059.
- Eriksen E, Prozorkevich D, Trofimov A, Howell D (2012) Biomass of scyphozoan jellyfish, and its spatial association with 0-group fish in the Barents Sea. PLoS One 7:e33050
- Eriksen E, Skjoldal HR, Dolgov AV, Dalpadado P, Orlova EL, Prozorkevich DV (2016) The Barents Sea euphausiids: methodological aspects of monitoring and estimation of abundance and biomass. ICES Journal of Marine Science 73:1533-1544
- Eriksen E, Svetocheva O, Haug T (2011) Barents Sea Ammodytidae and their availability for the top predators during summer-autumn feeding. The 15th Russian-Norwegian Symposium, 6-9 September 2011 At: Longyearbyen, Norway (Manuscript)
- Erikstad KE (1989) Winter diets of four seabird species in the Barents Sea after a crash in the capelin stock. Polar Biology 10:619-627
- Evans PL, Kaiser MJ, Hughes RN (1996) Behaviour and energetics of whelks, *Buccinum undatum* (L.), feeding on animals killed by beam trawling. Journal of experimental marine biology and ecology 197:51-62
- Falk-Petersen I-B, Falk-Petersen S, Sargent JR (1986) Nature, origin and possible roles of lipid deposits in *Maurolicus muelleri* (Gmelin) and *Benthosema glaciale* (Reinhart) from Ullsfjorden, northern Norway. Polar Biology 5:235-240
- Falk-Petersen I, Frivoll V, Gulliksen B, Haug T, Vader W (1988) Age/size relations and food of two snailfishes, *Liparis gibbus* and *Careproctus reinhardtii* (Teleostei, Liparididae) from Spitsbergen coastal waters. Polar Biology 8:353-358

- Falk-Petersen IB, Kanapathippilai P, Primicerio R, Hansen TK (2010) Size, locality and seasonally related feeding preferences of common wolffish (*Anarhichas lupus* L.) from north-Norwegian waters. *Marine Biology Research* 6:201-212
- Falk-Petersen S (1981) Ecological investigation on the zooplankton community of Balsfjorden, northern Norway: seasonal changes in body weight and the main biochemical composition of *Thysanoessa inermis* (Krøyer) and *T. raschii* (M. Sars), and *Meganyctiphanes norvegica* (M. Sars) in relation to environmental factors. *Journal of Experimental Marine Biology and Ecology* 49:103-120
- Falk-Petersen S, Dahl TM, Scott CL, Sargent JR, Gulliksen B, Kwasniewski S, Hop H, Millar RM (2002) Lipid biomarkers and trophic linkages between ctenophores and copepods in Svalbard waters. *Marine Ecology Progress Series* 227:187-194
- Falk-Petersen S, Hopkins C (1981) Ecological investigations on the zooplankton community of Balsfjorden, northern Norway: population dynamics of the euphausiids *Thysanoessa inermis* (Krøyer), *Thysanoessa raschii* (M. Sars) and *Meganyctiphanes norvegica* (M. Sars) in 1976 and 1977. *Journal of Plankton Research* 3:177-192
- Falk-Petersen S, Pavlov V, Timofeev S, Sargent JR (2007) Climate variability and possible effects on arctic food chains: the role of *Calanus*. In: Ørbæk JB, Kallenborn R, Tombre I, Hegseth EN, Falk-Petersen S, Hoel AH (eds) *Arctic alpine ecosystems and people in a changing environment*. Springer, Springer, Berlin, Heidelberg
- Falk-Petersen S, Pedersen G, Kwasniewski S, Hegseth EN, Hop H (1999) Spatial distribution and life-cycle timing of zooplankton in the marginal ice zone of the Barents Sea during the summer melt season in 1995. *Journal of Plankton Research* 21:1249-1264
- Falkenhaug T (1991) Prey composition and feeding rate of *Sagitta elegans* var *arctica* (Chaetognatha) in the Barents Sea in early summer. *Polar Research* 10:487-506
- Fall J, Skern-Mauritzen M (2014) White-beaked dolphin distribution and association with prey in the Barents Sea. *Marine Biology Research* 10:957-971
- Fauchald P, Anker-Nilssen T, Barrett R, Bustnes JO, Bårdsen B-J, Christensen-Dalsgaard S, Descamps S, Engen S, Erikstad KE, Hanssen SA (2015) The status and trends of seabirds breeding in Norway and Svalbard. NINA Report 1151
- Finley KJ, Evans C (1983) Summer diet of the bearded seal (*Erignathus barbatus*) in the Canadian High Arctic. *Arctic* 36:82-89
- Finley KJ, Gibb EJ (1982) Summer diet of the narwhal (*Monodon monoceros*) in Pond Inlet, northern Baffin Island. *Canadian Journal of Zoology* 60:3353-3363
- Fisher K, Stewart R, Kastelein R, Campbell L (1992) Apparent digestive efficiency in walrus (*Odobenus rosmarus*) fed herring (*Clupea harengus*) and clams (*Spisula* sp.). *Canadian Journal of Zoology* 70:30-36
- Fisk AT, Lydersen C, Kovacs KM (2012) Archival pop-off tag tracking of Greenland sharks *Somniosus microcephalus* in the High Arctic waters of Svalbard, Norway. *Marine Ecology Progress Series* 468:255-265
- Fiske E, Røv N (1997) Survival rates of great cormorant (*Phalacrocorax carbo carbo*) from ring recovery data. *Suppl Ric Biol Selvaggina* 26:159-162
- Flint M, Poyarkov S, Timonin A, Soloviev K (2015) The structure of the mesoplankton community in the area of the continental slope of the St. Anna Trough (Kara Sea). *Oceanology* 55:583-594
- Folkow L, Haug T, Nilssen KT, Nordøy ES (2000) Estimated food consumption of minke whales (*Balaenoptera acutorostrata*) in Northeast Atlantic waters in 1992-1995. *NAMMCO Sci Publ* 2:65-80
- Fontoura-da-Silva V, de Souza Dantas RJ, Caetano CHS (2017) Foraging tactics in Mollusca: A look into the feeding behavior of their most obscure classes (Aplacophora, Monoplacophora, Polyplacophora, Scaphopoda and Cephalopoda). *Oecologia Australis* 17:358-373

- Foote A, Vikingsson G, Øien N, Bloch D, Davis C, Dunn T, Harvey P, Mandleberg L, Whooley P, Thompson P (2007) Distribution and abundance of killer whales in the North East Atlantic. IWC SC/59/SM5 10pp
- Forcucci D, Lawrence JM (1986) Effect of low salinity on the activity, feeding, growth and absorption efficiency of *Luidia clathrata* (Echinodermata: Asteroidea). Marine Biology 92:315-321
- Fossen I, Albert OT, Nilssen EM (1999) Back-calculated individual growth of long rough dab (*Hippoglossoides platessoides*) in the Barents Sea. ICES Journal of Marine Science 56:689-696
- Franzè G, Lavrentyev PJ (2017) Microbial food web structure and dynamics across a natural temperature gradient in a productive polar shelf system. Marine Ecology Progress Series 569:89-102
- Frisk MG, Miller TJ, Dulvy NK (2005) Life histories and vulnerability to exploitation of elasmobranchs: inferences from elasticity, perturbation and phylogenetic analyses. Journal of Northwest Atlantic Fishery Science 35:27-45
- Fuhrmann MM, Pedersen T, Nilssen EM (2015) Macrobenthic biomass and production in a heterogenic subarctic fjord after invasion by the red king crab. Journal of Sea Research 106:1-13
- Fuhrmann MM, Pedersen T, Nilssen EM (2017) Trophic niche of the invasive red king crab *Paralithodes camtschaticus* in a benthic food web. Marine Ecology Progress Series 565:113-129
- Fuji A (1967) Ecological studies on the growth and food consumption of Japanese common littoral sea urchin, *Strongylocentrotus intermedius* (A. Agassiz). Memoirs of the Faculty of Fisheries Hokkaido University 15:83-160
- Gales R, Renouf D, Noseworthy E (1994) Body composition of harp seals. Canadian journal of zoology 72:545-551
- Gannefors C, Böer M, Kattner G, Graeve M, Eiane K, Gulliksen B, Hop H, Falk-Petersen S (2005) The Arctic sea butterfly *Limacina helicina*: lipids and life strategy. Marine Biology 147:169-177
- Garcia EG (2006) The Fishery for Iceland Scallop (*Chlamys islandica*) in the Northeast Atlantic. Advances in marine biology 51:1-55
- Gašparović B, Plavšić M, Bošković N, Čosović B, Reigstad M (2007) Organic matter characterization in Barents Sea and eastern Arctic Ocean during summer. Marine chemistry 105:151-165
- Gaymer CF, Dutil C, Himmelman JH (2004) Prey selection and predatory impact of four major sea stars on a soft bottom subtidal community. Journal of Experimental Marine Biology and Ecology 313:353-374
- Gerasimova OV (1997) Analysis of king crab (*Paralithodes camtschatica*) trophic links in the Barents Sea. ICES CM 1997 GG03
- Gerlach S, Ekstrøm D, Eckardt P (1976) Filter feeding in the hermit crab. Oecologia 24:257-264
- Gilmer R, Harbison G (1991) Diet of *Limacina helicina* (Gastropoda: Thecosomata) in Arctic waters in midsummer. Marine ecology progress series 77:125-134
- Gjertz I (1990) Walrus predation of seabirds. Polar Rec 26:317-317
- Gjertz I (1991) The narwhal, *Monodon monoceros*, in the Norwegian high Arctic. Marine Mammal Science 7:402-408
- Gjertz I, Lydersen C (1986) The ringed seal (*Phoca hispida*) spring diet in northwestern Spitsbergen, Svalbard. Polar Research 4:53-56
- Gjertz I, Wiig O (1992) Feeding of walrus *Odobenus rosmarus* in Svalbard. Polar Rec 28:57-59
- Gjertz I, Wiig O, Øritsland NA (1998) Backcalculation of original population size for walruses *Odobenus rosmarus* in Franz Josef Land. Wildlife Biology 4:223-230
- Gjertz I, Wiig Ø (1995) The number of walruses (*Odobenus rosmarus*) in Svalbard in summer. Polar biology 15:527-530
- Gjøsæter H (1995) Pelagic fish and the ecological impact of the modern fishing industry in the Barents Sea. Arctic 48:267-278

- Gjørseter H (1998) The population biology and exploitation of capelin (*Mallotus villosus*) in the Barents sea. *Sarsia* 83:453-496
- Gjørseter J (1973) Age, growth, and mortality of the myctophid fish, *Benthosema glaciale* (Reinhardt), from Western Norway. *Sarsia* 52:1-14
- Godiksen J, Hallfredsson E, Pedersen T (2006) Effects of alternative prey on predation intensity from herring (*Clupea harengus*) and sand eel (*Ammodytes marinus*) on capelin (*Mallotus villosus*) larvae in the Barents Sea. *Journal of Fish Biology* 69:1807-1823
- Golikov AV, Sabirov RM, Lubin PA (2016) First assessment of biomass and abundance of cephalopods *Rossia palpebrosa* and *Gonatus fabricii* in the Barents Sea. *Journal of the Marine Biological Association of the United Kingdom* 97:1605-1616. doi:1610.1017/S0025315416001004
- Górska B, Włodarska-Kowalczyk M (2017) Food and disturbance effects on Arctic benthic biomass and production size spectra. *Progress in oceanography* 152:50-61
- Grigor JJ, Søreide JE, Varpe Ø (2014) Seasonal ecology and life-history strategy of the high-latitude predatory zooplankton *Parasagitta elegans*. *Marine Ecology Progress Series* 499:77-88
- Grosbois V, Thompson PM (2005) North Atlantic climate variation influences survival in adult fulmars. *Oikos* 109:273-290
- Gudimov AV, Gudimova EN, Pavlova LV (2003) Effect of the Red King crab *Paralithodes camtschaticus* on the Murmansk coastal macrobenthos: the first estimates using sea urchins of the genus *Strongylocentrotus* as an example. *Doklady Biological Sciences* 393:539-541
- Gulliksen B, Skjæveland SH (1973) The sea-star, *Asterias rubens* L., as predator on the ascidian, *Ciona intestinalis* (L.), in Borgenfjorden, North-Trøndelag, Norway. *Sarsia* 52:15-20
- Gundersen H, Christie HC, de Wit H, Norderhaug KM, Bekkby T, G WM (2011) Utredning om CO₂-opptak i marine naturtyper. NIVA RAPPORT LNR 6070-2010 (in Norwegian)
- Hallfredsson E (1998) Feeding of cod (*Gadus morhua*) and saithe (*Pollachius virens*) on the banks and coastal waters of Northern Norway with respect to competition, predation and consumption. Master thesis, University of Tromsø, Tromsø
- Hallfredsson E, Pedersen T (2007) Effects of predation from 0-group cod on mortality rates of capelin larvae in the Barents Sea. *Canadian Journal of Fisheries and Aquatic Sciences* 64:1710-1722
- Hamel J-F, Mercier A (1998) Diet and feeding behaviour of the sea cucumber *Cucumaria frondosa* in the St. Lawrence estuary, eastern Canada. *Canadian Journal of Zoology* 76:1194-1198
- Hansen B, Christiansen S, Pedersen G (1996) Plankton dynamics in the marginal ice zone of the central Barents Sea during spring: carbon flow and structure of the grazer food chain. *Polar Biology* 16:115-128
- Hansen H, Aschan M (2000) Growth, size-and age-at-maturity of shrimp, *Pandalus borealis*, at Svalbard related to environmental parameters. *Journal of Northwest Atlantic Fishery Science* 27:83-92
- Hansen HSB (2015) Snow crab (*Chionecetes opilio*) in the Barents Sea. Master thesis, UiT The Arctic University of Tromsø,
- Hansen L, Pethon P (1985) The food of Atlantic salmon, *Salmo salar* L., caught by long-line in northern Norwegian waters. *Journal of Fish Biology* 26:553-562
- Hansen PJ, Bjørnsen PK, Hansen BW (1997) Zooplankton grazing and growth: Scaling within the 2-2,-µm body size range. *Limnology and oceanography* 42:687-704
- Hassel A, Skjoldal HR, Gjørseter H, Loeng H, Omli L (1991) Impact of grazing from capelin (*Mallotus villosus*) on zooplankton: a case study in the northern Barents Sea in August 1985. *Polar Research* 10:371-388
- Haug T, Henriksen G, Kondakov A, Mishin V, Nilssen KT, Røv N (1994) The status of grey seals *Halichoerus grypus* in North Norway and on the Murman coast, Russia. *Biological Conservation* 70:59-67
- Haug T, Lindstrøm U, Nilssen KT (2002) Variations in minke whale (*Balaenoptera acutorostrata*) diet and body condition in response to ecosystem changes in the Barents Sea. *Sarsia* 87:409-422

- Heggland K, Ottesen CAM, Berge J (2015) Aspects of the life history of the Atlantic poacher, *Leptagonus decagonus*, in Svalbard waters. *Pol Polar Res* 36:79-87
- Heggland KN (2013) Relation between habitat characteristics and abundance, diet and condition of 0-group cod in two northern Norwegian fjords. Master thesis, University of Tromsø, Tromsø
- Hegseth EN (1998) Primary production of the northern Barents Sea. *Polar Research* 17:113-123
- Heip C, Vincx M, Vranken G (1985) The ecology of marine nematodes. *Oceanogr Mar Biol Ann Rev* 23. Aberdeen University Press, Aberdeen
- Himmelman JH, Dutil C (1991) Distribution, population structure and feeding of subtidal seastars in the northern Gulf of St. Lawrence. *Marine Ecology Progress Series* 76:61-72
- Hirche H-J, Kosobokova K (2011) Winter studies on zooplankton in Arctic seas: the Storfjord (Svalbard) and adjacent ice-covered Barents Sea. *Marine biology* 158:2359
- Hjelset AM, Andersen M, Gjertz M, Lydersen C, Gulliksen B (1999) Feeding habits of bearded seals (*Erignathus barbatus*) from the Svalbard area. *Polar Biology* 21:186-193
- Hop H, Gjørseter H (2013) Polar cod (*Boreogadus saida*) and capelin (*Mallotus villosus*) as key species in marine food webs of the Arctic and the Barents Sea. *Marine Biology Research* 9:878-894
- Hop H, Pavlova O (2008) Distribution and biomass transport of ice amphipods in drifting sea ice around Svalbard. *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2292-2307
- Hop H, Poltermann M, Lønne OJ, Falk-Petersen S, Korsnes R, Budgell WP (2000) Ice amphipod distribution relative to ice density and under-ice topography in the northern Barents Sea. *Polar Biology* 23:357-367
- Hop H, Tonn WM, Welch HE (1997) Bioenergetics of Arctic cod (*Boreogadus saida*) at low temperatures. *Canadian Journal of Fisheries and Aquatic Sciences* 54:1772-1784
- Hopkins CCE, Grotnes PE, Eliassen JE (1989) Organization of a fjord community at 70° North: The pelagic food web in Balsfjord, northern Norway. *Rapports et Proces-Verbaux des Reunions, Conseil International, pour l'Exploration scientifique de la Mer* 188:146-153
- Hosia A, Titelman J (2010) Intraguild predation between the native North Sea jellyfish *Cyanea capillata* and the invasive ctenophore *Mnemiopsis leidyi*. *Journal of Plankton Research* 33:535-540
- Hovde SC, Albert OT, Nilssen EM (2002) Spatial, seasonal and ontogenetic variation in diet of Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*). *ICES Journal of Marine Science* 59:421-437
- Hovinen JE, Welcker J, Descamps S, Strøm H, Jerstad K, Berge J, Steen H (2014) Climate warming decreases the survival of the little auk (*Alle alle*), a high Arctic avian predator. *Ecology and evolution* 4:3127-3138
- Hudson IR, Wigham BD (2003) In situ observations of predatory feeding behaviour of the galatheid squat lobster *Munida sarsi* using a remotely operated vehicle. *Journal of the Marine Biological Association of the United Kingdom* 83:463-464
- Huse G (1994) Interactions between herring (*Clupea harengus* L.) and capelin (*Mallotus villosus* Muller) in the Barents Sea. Cand. scient. thesis, University of Bergen, Norway, Bergen
- Huse G, Fernö A, Holst JC (2010) Establishment of new wintering areas in herring co-occurs with peaks in the 'first time/repeat spawner' ratio. *Marine Ecology Progress Series* 409:189-198
- Huse H, Toresen R (1996) A comparative study of feeding habits of herring (*Clupea harengus*, Clupeidae L.) and capelin (*Mallotus villosus*, Osmeridae, Muller) in the Barents Sea. *Sarsia* 81:143-153
- Hvingel C, Thangstad T (2010) Catch, effort and derived biomass and mortality indices from the Norwegian fishery for northern shrimp (*Pandalus borealis*) in the Barents Sea and round Svalbard. *NAFO SCR Doc* 10:1-14
- Hylen A (1964) Coastal cod and skrei in Lofoten. *Fiskeridirektoratets Skrifter Serie Havundersøkelser* 13:27-42
- Härkonen T, Heide-Jørgensen M-P (1990) Comparative life histories of East Atlantic and other harbour seal populations. *Ophelia* 32:211-235

- Høines ÅS, Bergstad O (2001) Density of wintering sand eel in the sand recorded by grab catches. Fisheries Research 49:295-301
- ICES (2016) ICES WGHARP REPORT 2016. ICES CM ACOM:21 2016
- ICES (2019a) Arctic Fisheries Working Group (AFWG). ICES Scientific Reports 1:30:<http://doi.org/10.17895/ices.pub.15292>
- ICES (2019b) Herring (*Clupea harengus*) in subareas 1, 2, and 5, and in divisions 4.a and 14.a, Norwegian spring-spawning herring (the Northeast Atlantic and Arctic Ocean). In Report of the ICES Advisory Committee, 2019 ICES Advice 2019, her271-24a514a <https://doi.org/10.17895/icesadvice4882>
- ICES (2019c) ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP). ICES Scientific Reports 1_72 193 pp <http://doi.org/10.17895/icespub5617>
- ICES (2019d) Working Group on the Integrated Assessments of the Barents Sea (WGIBAR). ICES Scientific Reports 1:42 <http://doi.org/10.17895/ices.pub.15536>
- ICES (2019e) Working Group on Widely Distributed Stocks (WGWIDE). ICES Scientific Reports 1:36 948 pp <http://doi.org/10.17895/icespub5574>
- ICES (2020a) Working group on North Atlantic Salmon (WGNAS). ICES Scientific Reports 2:21
- ICES (2020b) Working Group on the integrated Assessment of the Barents Sea (WGIBAR). ICES Scientific Reports 2:30 (<http://doi.org/10.17895/icespub5998>)
- Ikeda T, Skjoldal HR (1989) Metabolism and elemental composition of zooplankton from the Barents Sea during early Arctic summer. Marine Biology 100:173-183
- Isaksen B, Valdemarsen J, Larsen R, Karlsen L (1992) Reduction of fish by-catch in shrimp trawl using a rigid separator grid in the aft belly. Fisheries Research 13:335-352
- Iversen KR, Seuthe L (2011) Seasonal microbial processes in a high-latitude fjord (Kongsfjorden, Svalbard): I. Heterotrophic bacteria, picoplankton and nanoflagellates. Polar biology 34:731-749
- Iversen M, Aars J, Haug T, Alsos IG, Lydersen C, Bachmann L, Kovacs KM (2013) The diet of polar bears (*Ursus maritimus*) from Svalbard, Norway, inferred from scat analysis. Polar Biology 36:561-571
- Jakobsen T (1987) Coastal cod in Northern Norway. Fisheries Research 5:223-234
- Jakubas D, Iliszko LM, Strøm H, Darecki M, Jerstad K, Stempniewicz L (2016) Foraging behavior of a high-Arctic zooplanktivorous alcid, the little auk, at the southern edge of its breeding range. Journal of Experimental Marine Biology and Ecology 475:89-99
- Jansen OE, Leopold MF, Meesters E, Smeenk C (2010) Are white-beaked dolphins *Lagenorhynchus albirostris* food specialists? Their diet in the southern North Sea. Journal of the Marine Biological Association of the United Kingdom 90:1501-1508
- Jeong HJ, Du Yoo Y, Kim JS, Seong KA, Kang NS, Kim TH (2010) Growth, feeding and ecological roles of the mixotrophic and heterotrophic dinoflagellates in marine planktonic food webs. Ocean science journal 45:65-91
- Jiang W (1992) Food of haddock (*Melanogrammus aeglefinus*) in the Barents Sea from 1984 to 1991. Master thesis, University of Bergen, Bergen
- Jiang W, Jørgensen T (1996) The diet of haddock (*Melanogrammus aeglefinus* L.) in the Barents Sea during the period 1984-1991. ICES Journal of Marine Science 53:11-21
- Johannesen E, Ingvaldsen RB, Bogstad B, Dalpadado P, Eriksen E, Gjøsæter H, Knutsen T, Skern-Mauritzen M, Stiansen JE (2012a) Changes in Barents Sea ecosystem state, 1970-2009: climate fluctuations, human impact, and trophic interactions. ICES Journal of Marine Science 69:880-889
- Johannesen E, Ingvaldsen RB, Bogstad B, Dalpadado P, Eriksen E, Gjøsæter H, Knutsen T, Skern-Mauritzen M, Stiansen JE (2012b) Changes in Barents Sea ecosystem state, 1970-2009: climate fluctuations, human impact, and trophic interactions. ICES Journal of Marine Science 69:880-889

- Johansen R (1998) Foraging behaviour of cormorants wintering in North Norway, and their role as fish predators. Cand. scient. thesis, University of Tromsø, Tromsø
- Johansen R, Pedersen T, Barrett R (1999a) Cormorants *Phalacrocorax carbo carbo* as predators in a cod *Gadus morhua* enhancement area in North Norway. In: Howell BR, Moksness E, Svåsand T (eds) Stock Enhancement and Sea Ranching. Fishing News Books, Oxford
- Johansen R, Pedersen T, Barrett RT (1999b) Cormorants (*Phalacrocorax carbo carbo*) as predators in a cod (*Gadus morhua* L.) enhancement area in North Norway. Stock Enhancement and Sea Ranching:334-349
- Jonsgård Å (1966) Biology of the North Atlantic fin whale *Balaenoptera physalus* (L.). Taxonomy, distribution, migration and food. Hvalrådets Skrifter 49:1-62
- Jonsgård Å, Lyshøel PB (1969) A contribution to the knowledge of the biology of the killer whale (*Orcinus orca*). ICES CM 1969 N:6
- Jonsson N, Jonsson B, Hansen L (1997) Changes in proximate composition and estimates of energetic costs during upstream migration and spawning in Atlantic salmon *Salmo salar*. Journal of Animal Ecology 66:425-436
- Jourdain E, Vongraven D, Bisther A, Karoliussen R (2017) First longitudinal study of seal-feeding killer whales (*Orcinus orca*) in Norwegian coastal waters. PLoS One 12:e0180099
- Jumars PA, Dorgan KM, M LS (2015) Diet of worms emended: An update of Polyhaete feeding guilds. Annu Rev Mar Sci 7:497-520
- Jørgensen LL, Ljubin P, Skjoldal HR, Ingvaldsen RB, Anisimova N, Manushin I (2015a) Distribution of benthic megafauna in the Barents Sea: baseline for an ecosystem approach to management. ICES Journal of Marine Science 72:595-613
- Jørgensen LL, Planque B, Thangstad TH, Certain G (2015b) Vulnerability of megabenthic species to trawling in the Barents Sea. ICES Journal of Marine Science 73:i84-i97
- Jørgensen S (1992) Næringsøkologiske studier av sild (*Clupea harengus* L.) i noen utvalgte fjorder. Master thesis, University of Tromsø, Tromsø
- Kach DJ, Ward JE (2008) The role of marine aggregates in the ingestion of picoplankton-size particles by suspension-feeding molluscs. Marine Biology 153:797-805
- Kanapathipillai P, Berg E, Santos J, Gulliksen B, Pedersen T (1994) The food consumption of cod (*Gadus morhua* L.), in a high-latitude enhancement area. Aquaculture and Fisheries Management 25:(Suppl. 1):65-76
- Kay D, Brafield A (1973) The energy relations of the polychaete *Neanthes* (= *Nereis*) *virens* (Sars). The Journal of Animal Ecology 42:673-692
- Kędra M, Renaud PE, Andrade H, Goszczko I, Ambrose Jr WG (2013) Benthic community structure, diversity, and productivity in the shallow Barents Sea bank (Svalbard Bank). Marine biology 160:805-819
- Kharlamenko VI, Brandt A, Kiyashko SI, Würzberg L (2013) Trophic relationship of benthic invertebrate fauna from the continental slope of the Sea of Japan. Deep Sea Research Part II: Topical Studies in Oceanography 86:34-42
- Kideys AE (1998) Physiological energetics of *Buccinum undatum* L.(Gastropoda) off Douglas, Isle of Man (the Irish Sea). Turk J Zool 22:49-62
- Kitchell JA, Boggs CH, Kitchell JF, Rice JA (1981) Prey selection by naticid gastropods: experimental tests and application to application to the fossil record. Paleobiology 7:533-552
- Kivimäe C, Bellerby RG, Fransson A, Reigstad M, Johannessen T (2010) A carbon budget for the Barents Sea. Deep Sea Research Part I: Oceanographic Research Papers 57:1532-1542
- Kleiber M (1961) The fire of life. An introduction to animal energetics. John Wiley & Sons, London
- Kolsum I (2011) Diett og posisjoner i næringsnettet til torskefisk i Ullsfjord. Master, University of Tromsø, Tromsø, Norway
- Korsun S, Hald M, Panteleeva N, Tarasov G, Båmstedt U (1998) Biomass of foraminifera in the St. Anna Trough, Russian Arctic continental margin. Sarsia 83:419-431

- Korsun S, Pogodina I, Tarasov G, Matishov G (1994) Foraminifera of the Barents Sea (Hydrobiology and Paleoecology). Kola Sci. Center Publication, Apatity, Russia (in Russian with English Abstract)
- Koszteyn J, Timofeev S, Węśławski J, Malinga B (1995) Size structure of *Themisto abyssorum* Boeck and *Themisto libellula* (Mandt) populations in European Arctic seas. *Polar Biology* 15:85-92
- Kotwicki L, Grzelak K, Opaliński K, Węśławski JM (2018) Total benthic oxygen uptake in two Arctic fjords (Spitsbergen) with different hydrological regimes. *Oceanologia* 60:107-113
- Kovacs KM, Haug T, Lydersen C (2009) Chapt. 18. Marine mammals of the Barents Sea. *Ecosystem Barents Sea*. Tapir Academic Press, Trondheim, Norway
- Kovacs KM, Aars J, Lydersen C (2014) Walruses recovering after 60+ years of protection in Svalbard, Norway. *Polar Research* 33:26034
- Kraft A, Berge J, Varpe Ø, Falk-Petersen S (2013) Feeding in Arctic darkness: mid-winter diet of the pelagic amphipods *Themisto abyssorum* and *T. libellula*. *Marine biology* 160:241-248
- Kristoffersen JB, Salvanes AGV (1998) Life history of *Maurollicus muelleri* in fjordic and oceanic environments. *Journal of Fish Biology* 53:1324-1341
- Krivosheya P, Bogstad B (2015) Monitoring the demersal fish community. In: Eriksen E (ed) Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October 2014 IMR/PINRO Joint Report Series No 1/2015
- Krumhansl KA, Scheibling RE (2012) Production and fate of kelp detritus. *Marine Ecology Progress Series* 467:281-302
- Kuningas S, Similä T, Hammond PS (2014) Population size, survival and reproductive rates of northern Norwegian killer whales (*Orcinus orca*) in 1986–2003. *Journal of the Marine Biological Association of the United Kingdom* 94:1277-1291
- Labansen AL, Lydersen C, Haug T, Kovacs KM (2007) Spring diet of ringed seals (*Phoca hispida*) from northwestern Spitsbergen, Norway. *ICES Journal of Marine Science* 64:1246-1256
- Laidre KL, Heide-Jørgensen MP, Nielsen TG (2007) Role of the bowhead whale as a predator in West Greenland. *Marine Ecology Progress Series* 346:285-297
- Laidre KL, Heide-Jørgensen M (2005) Winter feeding intensity of narwhals (*Monodon monoceros*). *Marine Mammal Science* 21:45-57
- Langøy H, Nøttestad L, Skaret G, Broms C, Fernö A (2012) Overlap in distribution and diets of Atlantic mackerel (*Scomber scombrus*), Norwegian spring-spawning herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou*) in the Norwegian Sea during late summer. *Marine biology research* 8:442-460
- Larsen T (1986) Population biology of the polar bear (*Ursus maritimus*) in the Svalbard area. *Nor Polarinst Skr* 184:1-55
- Larson RJ (1986) Water content, organic content and carbon and nitrogen composition of medusae from the northeast Pacific. *Journal of Experimental Marine Biology and Ecology* 99:107-120
- Lawrence JM (1985) The energetic echinoderm. *Echinodermata*. Balkema, Rotterdam
- Lawson JW, Magalhaes AM, Miller EH (1998) Important prey species of marine vertebrate predators in the northwest Atlantic: proximate composition and energy density. *Marine Ecology Progress Series* 164:13-20
- Leclerc L-ME, Lydersen C, Haug T, Bachmann L, Fisk AT, Kovacs KM (2012) A missing piece in the Arctic food web puzzle? Stomach contents of Greenland sharks sampled in Svalbard, Norway. *Polar Biology* 35:1197-1208
- Leonard D, Øien N (2020a) Estimated abundances of Cetacean species in the Northeast Atlantic from two multiyear surveys conducted by Norwegian vessels between 2002–2013. *NAMMCO Scientific Publications* 11:<https://doi.org/10.7557/7553.4695>
- Leonard D, Øien NI (2020b) Estimated abundances of Cetacean species in the Northeast Atlantic from Norwegian shipboard surveys conducted in 2014-2018 *NAMMCO Sci Publ* 11:<https://doi.org/10.7557/7553.4694>

- Leu E, Søreide J, Hessen D, Falk-Petersen S, Berge J (2011) Consequences of changing sea-ice cover for primary and secondary producers in the European Arctic shelf seas: timing, quantity, and quality. *Progress in Oceanography* 90:18-32
- Levinsen H, Nielsen TG, Hansen BW (1999) Plankton community structure and carbon cycling on the western coast of Greenland during the stratified summer situation. II. Heterotrophic dinoflagellates and ciliates. *Aquatic Microbial Ecology* 16:217-232
- Lie U (1961) On the growth and food of 0-group coalfish, *Pollachius virens* (L.) in norwegian waters. *Sarsia* 3:1-35
- Lindley JA (1980) Population dynamics and production of Euphausiids. II. *Thysanoessa inermis* and *T. raschii* in the North Sea and American coastal waters. *Marine Biology* 59:225-233
- Lindstrøm U, Harbitz A, Haug T, Nilssen K (1998) Do harp seals *Phoca groenlandica* exhibit particular prey preferences? *ICES Journal of Marine Science* 55:941-953
- Lindstrøm U, Nilssen KT, Pettersen LM, Haug T (2013) Harp seal foraging behaviour during summer around Svalbard in the northern Barents Sea: diet composition and the selection of prey. *Polar Biology* 36:305-320
- Linke P, Altenbach A, Graf G, Heeger T (1995) Response of deep-sea benthic foraminifera to a simulated sedimentation event. *J Foraminifer Res* 25:75-82
- Lockyer C (2003) Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: Biological parameters. *NAMMCO Scientific Publications* 5:71-89
- Lockyer C (2007) All creatures great and smaller: a study in cetacean life history energetics. *Journal of the Marine Biological Association of the United Kingdom* 87:1035-1045
- Loo L-O, Rosenberg R (1996) Production and energy budget in marine suspension feeding populations: *Mytilus edulis*, *Cerastoderma edule*, *Mya arenaria* and *Amphiura filiformis*. *Journal of Sea Research* 35:199-207
- Lowe CG, Goldman KJ (2001) Thermal and bioenergetics of elasmobranchs: bridging the gap. *Environmental Biology of Fishes* 60:251-266
- Lowry LF, Sheffield G, George JC (2004) Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach contents analyses. *J Cetacean Res Manage* 6:215-223
- Luksenburg JA, Pedersen T (2002) Sexual and geographical variation in life history parameters of the shorthorn sculpin. *Journal of Fish Biology* 61:1453-1464
- Lundberg M, Hop H, Eiane K, Gulliksen B, Falk-Petersen S (2006) Population structure and accumulation of lipids in the ctenophore *Mertensia ovum*. *Marine biology* 149:1345-1353
- Lydersen C (1998) Status and biology of ringed seals (*Phoca hispida*) in Svalbard. *NAMMCO Scientific Publication* 1:46-62
- Lydersen C, Angantyr LA, Wiig Ø, Øritsland T (1991) Feeding habits of Northeast Atlantic harp seals (*Phoca groenlandica*) along the summer ice edge of the Barents Sea. *Canadian Journal of Fisheries and Aquatic Sciences* 48:2180-2183
- Lydersen C, Chernook VI, Glazov DM, Trukhanova IS, Kovacs KM (2012) Aerial survey of Atlantic walrus (*Odobenus rosmarus rosmarus*) in the Pechora Sea, August 2011. *Polar Biology* 35:1555-1562
- Lydersen C, Fisk AT, Kovacs KM (2016) A review of Greenland shark (*Somniosus microcephalus*) studies in the Kongsfjorden area, Svalbard Norway. *Polar Biology* 39:2169-2178
- Lydersen C, Gjertz I (1987) Population parameters of ringed seals (*Phoca hispida* Schreber, 1775) in the Svalbard area. *Canadian Journal of Zoology* 65:1021-1027
- Lydersen C, Gjertz I, Weslawski JM (1989) Stomach contents of autumn-feeding marine vertebrates from Hornsund, Svalbard. *Polar Rec* 25:107-114
- Lydersen C, Kovacs KM (2005) Growth and population parameters of the world's northernmost harbour seals *Phoca vitulina* residing in Svalbard, Norway. *Polar Biology* 28:156-163
- Lydersen C, Kovacs KM (2014) Walrus *Odobenus rosmarus* research in Svalbard, Norway, 2000-2010. *NAMMCO Scientific Publications* 9:175-190

- Lydersen C, Martin A, Kovacs K, Gjertz I (2001) Summer and autumn movements of white whales *Delphinapterus leucas* in Svalbard, Norway. Marine Ecology Progress Series 219:265-274
- Lydersen C, Aars J, Kovacs KM (2008) Estimating the number of walruses in Svalbard from aerial surveys and behavioural data from satellite telemetry. Arctic 61:119-128
- Lønø O (1970) The polar bear (*Ursus maritimus* Phipps) in the Svalbard area. Nor Polarinst Skr 149:1-103
- Macdonald JS, Waiwood KG, Green RH (1982) Rates of digestion of different prey in Atlantic cod (*Gadus morhua*), ocean pout (*Macrozoarces americanus*), winter flounder (*Pseudopleuronectes americanus*), and American plaice (*Hippoglossoides platessoides*). Canadian Journal of Fisheries and Aquatic sciences 39:651-659
- Macdonald TA (2010) Taxonomic and feeding guild classification for the marine benthic macroinvertebrates of the Strait of Georgia, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 2874: iv + 63 p. Fisheries and Oceans Canada, Ocean Sciences Division
- MacKinnon J (1972) Summer storage of energy and its use for winter metabolism and gonad maturation in American plaice (*Hippoglossoides platessoides*). Journal of the Fisheries Board of Canada 29:1749-1759
- MacNeil M, McMeans B, Hussey N, Vecsei P, Svavarsson J, Kovacs K, Lydersen C, Treble M, Skomal G, Ramsey M (2012) Biology of the Greenland shark *Somniosus microcephalus*. Journal of fish biology 80:991-1018
- Majaneva S, Berge J, Renaud P, Vader A, Stübner E, Rao A, Sparre Ø, Lehtiniemi M (2013) Aggregations of predators and prey affect predation impact of the Arctic ctenophore *Mertensia ovum*. Marine Ecology Progress Series 476:87-100
- Markowska M, Janecki T, Kidawa A (2008) Field observations of the spider crab, *Hyas araneus* (L., 1758): feeding behaviour in an Arctic fjord. Crustaceana 81:1211-1217
- Martinussen MB, Båmstedt U (1995) Diet, estimated daily food ration and predator impact by the scyphozoan jellyfishes *Aurelia aurita* and *Cyanea capillata* In: Skjoldal HR, Hopkins C, Erikstad KE, Leinaas HP (eds) Ecology of Fjords and Coastal Waters. Elsevier Science, Amsterdam
- McBride MM, Hansen JR, Korneev O, Titov OMM, Hansen JR, Korneev O, Titov O (2016) (Eds.) Stiansen, J.E., Tchernova, J., Filin, A., Ovsyannikov A. (Co-eds.) Joint Norwegian - Russian environmental status 2013. Report on the Barents Sea Ecosystem. Part II - Complete report. IMR/PINRO Joint Report Series, 2016 (2), 359pp. ISSN 1502-8828.
- McClatchie S (1985) Feeding behaviour in *Meganctiphanes norvegica* (M. Sars)(Crustacea: Euphausiacea). Journal of Experimental Marine Biology and Ecology 86:271-284
- McMeans BC, Svavarsson J, Dennard S, Fisk AT (2010) Diet and resource use among Greenland sharks (*Somniosus microcephalus*) and teleosts sampled in Icelandic waters, using delta C-13, delta N-15, and mercury. Canadian Journal of Fisheries and Aquatic Sciences 67:1428-1438
- Mehl S (2005) Stomach analysis of northeast Arctic saithe sampled during the saithe survey Varanger-Møre 1998-2003: preliminary results. Working Document No 7 to the Arctic Fisheries Working Group 19 – 28 April 2005
- Mehlum F (2001) Crustaceans in the diet of adult common and Brünnich's guillemots *Uria aalge* and *U. lomvia* in the Barents Sea during the breeding period. Marine Ornithology 29:19-22
- Mehlum F, Gabrielsen G (1993a) The diet of high-arctic seabirds in coastal and ice-covered, pelagic areas near the Svalbard archipelago. Polar research 12:1-20
- Mehlum F, Gabrielsen GW (1993b) The diet of high-arctic sea-birds in coastal and ice-covered, pelagic areas near the Svalbard archipelago. Polar Research 12:1-20
- Meier S, Falk-Petersen S, Aage Gade-Sørensen L, Greenacre M, Haug T, Lindstrøm U (2016) Fatty acids in common minke whale (*Balaenoptera acutorostrata*) blubber reflect the feeding area and food selection, but also high endogenous metabolism. Marine Biology Research 12:221-238
- Michalsen K, Nedreaas KH, Båmstedt U (1998) Food and feeding of Greenland halibut (*Reinhardtius hippoglossoides*, Walbaum) in the Barents Sea and East Greenland waters. Sarsia 83:401-407

- Misund OA, Heggland K, Skogseth R, Falck E, Gjøsæter H, Sundet J, Watne J, Lønne OJ (2016) Norwegian fisheries in the Svalbard zone since 1980. Regulations, profitability and warming waters affect landings. *Polar Science* 10:312-322
- Molnár PK, Klanjscek T, Derocher AE, Obbard ME, Lewis MA (2009) A body composition model to estimate mammalian energy stores and metabolic rates from body mass and body length, with application to polar bears. *Journal of Experimental Biology* 212:2313-2323
- Mortensen E (2007) Er det variasjon i diett og lengde ved alder hos torsk (*Gadus morhua*) nord for 64°N? Master thesis, University of Tromsø, Tromsø (in Norwegian)
- Myrseth B (1971) Fekunditet, vekst, levevis og ernæring hos *Cyclopterus lumpus* L. Master thesis, University of Bergen, Bergen (in Norwegian)
- Møller EF, Thor P, Nielsen TG (2003) Production of DOC by *Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus* through sloppy feeding and leakage from fecal pellets. *Marine Ecology Progress Series* 262:185-191
- Møller LF, Canon JM, Tiselius P (2010) Bioenergetics and growth in the ctenophore *Pleurobrachia pileus*. *Jellyfish Blooms: New Problems and Solutions*. Springer
- Møller LF, Riisgård HU (2007) Feeding, bioenergetics and growth in the common jellyfish *Aurelia aurita* and two hydromedusae, *Sarsia tubulosa* and *Aequorea vitrina*. *Marine Ecology Progress Series* 346:167-177
- Mårtensson P-E, Nordøy E, Blix A (1994) Digestibility of krill (*Euphausia superba* and *Thysanoessa* sp.) in minke whales (*Balaenoptera acutorostrata*) and crabeater seals (*Lobodon carcinophagus*). *Brit J Nutr* 72:713-716
- Mårtensson PE, Gotaas AL, Norddy E, Blix A (1996) Seasonal changes in energy density of prey of northeast Atlantic seals and whales. *Marine Mammal Science* 12:635-640
- Nakken O (1998) Past, present and future exploitation and management of marine resources in the Barents Sea and adjacent areas. *Fisheries Research* 37:23-35
- NAMMCO (2016) Report of the NAMMCO Working Group on Coastal Seals 2016, 1-4 March 2016, Reykjavik, Iceland. SC/23/CSWG/Report NAMMCO
- Nejstgaard JC, Tang KW, Steinke M, Dutz J, Koski M, Antajan E, Long JD (2007) Zooplankton grazing on *Phaeocystis*: a quantitative review and future challenges. *Biogeochemistry* 83:147-172
- Nielsen A, Berg CW (2014) Estimation of time-varying selectivity in stock assessments using state-space models. *Fisheries Research* 158:96-101
- Nielsen C (1974) Observations on *Buccinum undatum* L. attacking bivalves and on prey responses, with a short review on attack methods of other prosobranchs. *Ophelia* 13:87-108
- Nielsen J, Hedeholm RB, Heinemeier J, Bushnell PG, Christiansen JS, Olsen J, Ramsey CB, Brill RW, Simon M, Steffensen KF (2016) Eye lens radiocarbon reveals centuries of longevity in the Greenland shark (*Somniosus microcephalus*). *Science* 353:702-704
- Nilsen M, Pedersen T, Nilssen EM (2006) Macrobenthic biomass, productivity (P/B) and production in a high-latitude ecosystem, North Norway. *Marine Ecology-Progress Series* 321:67-77
- Nilsen R, Gutvik OK, Nilssen EM, Hopkins CCE (1991) Population parameters of the witch flounder, *Clyptocephalus cynoglossus* (L.) (Pisces: Pleuronectidae), from Malangen, northern Norway. *Fisheries Research* 12:259-278
- Nilssen KT, Bjørge A (2015) Status for kystsel-anbefaling av jaktkvoter 2016. Møte i Sjøpattedyrutvalget, Tromsø, 28 - 29 oktober 2015, Tromsø (in Norwegian)
- Nilssen KT, Haug T, Potelov V, Stasenkova VA, Timoshenko YK (1995a) Food habits of harp seals (*Phoca groenlandica*) during lactation and moult in March-May in the southern Barents Sea and White Sea. *ICES Journal of Marine Science* 52:33-41
- Nilssen KT, Haug T, Potelov V, Timoshenko YK (1995b) Feeding habits of harp seals (*Phoca groenlandica*) during early summer and autumn in the northern Barents Sea. *Polar Biology* 15:485-493

- Nilssen KT, Lindstrøm U, Westgaard JI, Lindblom L, Blencke T-R, Haug T (2019) Diet and prey consumption of grey seals (*Halichoerus grypus*) in Norway. *Marine Biology Research* 15:137-149
- Nilssen KT, Pedersen OP, Folkow L, Haug T (2000) Food consumption estimates of Barents Sea harp seals. *Nammco Sci Publ* 2:9-27
- Nilssen KT, Skavberg N-E, Poltermann M, Haug T, Härkönen T, Henriksen G (2010) Status of harbour seals (*Phoca vitulina*) in mainland Norway. *NAMMCO Scientific Publications* 8:61-69
- Nomaki H, Heinz P, Nakatsuka T, Shimanaga M, Ohkouchi N, Ogawa NO, Kogure K, Ikemoto E, Kitazato H (2006) Different ingestion patterns of ¹³C-labeled bacteria and algae by deep-sea benthic foraminifera. *Marine Ecology Progress Series* 310:95-108
- Nordøy ES, Folkow LP, Potelov V, Prischemikhin V, Blix AS (2008) Seasonal distribution and dive behaviour of harp seals (*Pagophilus groenlandicus*) of the White Sea–Barents Sea stock. *Polar Biology* 31:1119
- Noyon M, Gasparini S, Mayzaud P (2009) Feeding of *Themisto libellula* (Amphipoda Crustacea) on natural copepods assemblages in an Arctic fjord (Kongsfjorden, Svalbard). *Polar biology* 32:1559-1570
- Nøstvik F, Pedersen T (1999) Movement patterns and growth of wild cod (*Gadus morhua* L.) and hatchery-reared cod released as 1-group. In: Howell B, Moksness E, Svåsand TS (eds) *Stock Enhancement and Sea Ranching*. Fishing News Books, Oxford
- Nøttestad L, Sivle LD, Krafft BA, Langård L, Anthonypillai V, Bernasconi M, Langøy H, Fernö A (2014) Prey selection of offshore killer whales *Orcinus orca* in the Northeast Atlantic in late summer: spatial associations with mackerel. *Marine Ecology Progress Series* 499:275-283
- Ofstad LH (2013) Anglerfish *Lophius piscatorius* L. in Faroese waters. Life history, ecological importance and stock status. PhD thesis, University of Tromsø, Tromsø, Norway
- Orlov YI, Ivanov B (1978) On the introduction of the Kamchatka king crab *Paralithodes camtschatica* (Decapoda: Anomura: Lithodidae) into the Barents Sea. *Marine Biology* 48:373-375
- Orlova EL, Dolgov AV, Renaud PE, Greenacre M, Halsband C, Ivshin VA (2015) Climatic and ecological drivers of euphausiid community structure vary spatially in the Barents Sea: relationships from a long time series (1952–2009). *Frontiers in Marine Science* 1 (Article 74):1-13
- Orlova EL, Dolgov AV, Rudneva GB, Oganin IA, Konstantinova LL (2009) Trophic relations of capelin *Mallotus villosus* and polar cod *Boreogadus saida* in the Barents Sea as a factor of impact on the ecosystem. *Deep-Sea Res Pt II* 56:2054-2067
- Ottesen CAM, Hop H, Falk-Petersen S, Christiansen JS (2014) Growth of daubed shanny (Teleostei: *Leptoclinus maculatus*) in Svalbard waters. *Polar Biology* 37:809-815
- Ozerov M, Vähä J-P, Wennevik V, Niemelä E, Svenning M-A, Prusov S, Diaz Fernandez R, Unneland L, Vasemägi A, Falkegård M (2017) Comprehensive microsatellite baseline for genetic stock identification of Atlantic salmon (*Salmo salar* L.) in northernmost Europe. *ICES Journal of Marine Science* 74:2159-2169
- Pagano AM, Durner GM, Rode KD, Atwood TC, Atkinson SN, Peacock E, Costa DP, Owen MA, Williams TM (2018) High-energy, high-fat lifestyle challenges an Arctic apex predator, the polar bear. *Science* 359:568-572
- Pasternak A, Driks A, Flint M (2017) Feeding, egg production, and respiration rate of pteropods *Limacina* in Arctic seas. *Oceanology* 57:122-129
- Paul A, Fuji A (1989) Bioenergetics of the Alaskan crab *Chionoecetes bairdi* (Decapoda: majidae). *Journal of Crustacean Biology* 9:25-36
- Paul A, Paul J (1996) A note on energy costs of molting and egg production for female red king crab (*Paralithodes camtschaticus*). *High latitude crabs: biology, management and economics* University of Alaska Sea Grant Report:96-02
- Paulsen ML, Seuthe L, Reigstad M, Larsen A, Cape MR, Vernet M (2018) Asynchronous accumulation of organic carbon and nitrogen in the Atlantic gateway to the Arctic Ocean. *Frontiers in Marine Science* 5:Article 416

- Pauly D (1980) On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *Journal du Conseil international pour l'Exploration de la Mer* 39:195-212
- Pauly D, Christensen V, Haggan N (1996) Mass-balance models of northeastern Pacific ecosystems. *Fisheries Centre Research Reports* 1996 vol. 4 no 1
- Pauly D, Trites A, Capuli E, Christensen V (1998) Diet composition and trophic levels of marine mammals. *ICES Journal of Marine Science* 55:467-481
- Pedersen HC, Follestad A, Gjershaug JO, Nilsen EB (2016a) Statusoversikt for jaktbart småvilt. NINA Rapport 1178 (in Norwegian)
- Pedersen J, Hislop JRG (2001) Seasonal variations in the energy density of fishes in the North Sea. *Journal of Fish Biology* 59:380-389
- Pedersen T, Fossheim M (2007) Diet of 0-group stages of capelin (*Mallotus villosus*), herring (*Clupea harengus*) and cod (*Gadus morhua*) during spring and summer in the Barents Sea. *Marine Biology* 153:1037-1046
- Pedersen T, Fuhrmann MM, Lindstrøm U, Nilssen EM, Ivarjord T, Ramasco V, Jørgensen LL, Sundet JH, Sivertsen K, Källgren E, Hjelset AM, Michaelsen C, Systad G, Norrbin F, Svenning M-A, Bjørge A, Steen H, Nilssen K (2018) Effects of the invasive red king crab on food web structure and ecosystem properties in an Atlantic fjord. *Marine Ecology Progress Series* 596:13-31
- Pedersen T, Nilsen M, Nilssen EM, Berg E, Reigstad M (2008) Trophic model of a lightly exploited cod-dominated ecosystem. *Ecological Modelling* 214:95-111
- Pedersen T, Pope JG (2003a) How may feeding data be integrated into a model for a Norwegian fjord population of cod (*Gadus morhua* L.). *Scientia Marina* 67(Suppl. 1):155-169
- Pedersen T, Pope JG (2003b) Sampling and a mortality model of a Norwegian fjord cod (*Gadus morhua* L.) population. *Fisheries Research* 63:1-20
- Pedersen T, Ramsvatn S, Nilssen EM, Nilsen M, Morissette L, Ivarjord T, Systad GH, Kolsum I, Fause H (2016b) Species diversity affects ecosystem structure and mass flows in fjords. *Regional Studies in Marine Science* 3:205-215
- Pedersen T, Strand HK, Christie H, Moy F (2020) Predation mortality from ambush and cruising predators on newly-settled 0-group gadoids *Journal of Experimental Marine Biology and Ecology* 529:151396
- Percy J (1993) Reproduction and growth of the Arctic hyperiid amphipod *Themisto libellula* Mandt. *Polar Biology* 13:131-139
- Percy JA, Fife FJ (1981) The biochemical composition and energy content of Arctic marine macroplankton. *Arctic* 34:307-313
- Perez MA, McAlister WB, Mooney EE (1990) Estimated feeding rate relationship for marine mammals based on captive animal data.
- Petersen JK, Schou O, Thor P (1995) Growth and energetics in the ascidian *Ciona intestinalis*. *Mar Ecol Prog Ser* 120:175-184
- Pfannkuche O, Thiel H (1987) Meiobenthic stocks and benthic activity on the NE-Svalbard Shelf and in the Nansen Basin. *Polar Biology* 7:253-266
- Piepenburg D, Blackburn TH, Vondorrien CF, Gutt J, Hall POJ, Hulth S, Kendall MA, Opalinski KW, Rachor E, Schmid MK (1995) Partitioning of benthic community respiration in the Arctic (Northwestern Barents Sea). *Marine Ecology-Progress Series* 118:199-213
- Piepenburg D, Chernova NV, vonDorrien CF, Gutt J, Neyelov AV, Rachor E, Saldanha L, Schmid MK (1996) Megabenthic communities in the waters around Svalbard. *Polar Biology* 16:431-446
- Pihl L, Rosenberg R (1984) Food selection and consumption of the shrimp *Crangon crangon* in some shallow marine areas in western Sweden. *Marine Ecology-Progress Series* 15:159-168
- Pike DG, Víkingsson GA, Gunnlaugsson T, Øien N (2009) A note on the distribution and abundance of blue whales (*Balaenoptera musculus*) in the Central and Northeast North Atlantic. *NAMMCO Scientific Publications* 7:19-29

- Planque B, Kristinsson K, Astakhov A, Bernreuther M, Bethke E, Drevetnyak K, Nedreaas K, Reinert J, Rolskiy A, Sigurðsson T (2013) Monitoring beaked redfish (*Sebastes mentella*) in the North Atlantic, current challenges and future prospects. *Aquatic Living Resources* 26:293-306
- Poltermann M (2000) Growth, production and productivity of the Arctic sympagic amphipod *Gammarus wilkitzkii*. *Marine Ecology Progress Series* 193:109-116
- Poltermann M (2001) Arctic sea ice as feeding ground for amphipods—food sources and strategies. *Polar Biology* 24:89-96
- Pons J-M, Migot P (1995) Life-history strategy of the herring gull: changes in survival and fecundity in a population subjected to various feeding conditions. *Journal of Animal Ecology*:592-599
- Prokopchuk I (2009) Feeding of the Norwegian spring spawning herring *Clupea harengus* (Linne) at the different stages of its life cycle. *Deep Sea Research Part II: Topical Studies in Oceanography* 56:2044-2053
- Prokopchuk I, Sentyabov E (2006) Diets of herring, mackerel, and blue whiting in the Norwegian Sea in relation to *Calanus finmarchicus* distribution and temperature conditions. *ICES Journal of Marine Science* 63:117-127
- Prozorkevich D, Sunnanå K (2016) Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October 2015. IMR/PINRO Joint Report Series, No 1/2016 ISSN 1502-8828
- Prozorkevich D, Sunnanå K (2017) Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October 2016. IMR/PINRO Joint Report Series, No 2/2017 ISSN 1502-8828
- Qasim S, Easterson D (1974) Energy conversion in the shrimp, *Metapenaeus monoceros* (Fabricius), fed on detritus. *Indian J Mar Sci* 3:131-134
- Rafter E, Nilssen E, Sundet J (1996) Stomach content, life history, maturation and morphometric parameters of red king crab, *Paralithodes camtschaticus*, from Varangerfjord area, North Norway. *ICES CM* 1996/K:10
- Ramp C, Bérubé M, Hagen W, Sears R (2006) Survival of adult blue whales *Balaenoptera musculus* in the Gulf of St. Lawrence, Canada. *Marine Ecology-Progress Series* 319:287-295
- Rasmussen M (2012) Diett hos Atlantisk laks *Salmo salar* langs kysten av Finnmark. Master's thesis University of Tromsø, Tromsø (in Norwegian)
- Reigstad M, Carroll J, Slagstad D, Ellingsen I, Wassmann P (2011) Intra-regional comparison of productivity, carbon flux and ecosystem composition within the northern Barents Sea. *Progress in Oceanography* 90:33-46
- Reigstad M, Riser CW, Wassmann P, Ratkova T (2008) Vertical export of particulate organic carbon: Attenuation, composition and loss rates in the northern Barents Sea. *Deep-Sea Research Part II-Topological Studies in Oceanography* 55:2308-2319
- Reigstad M, Wassmann P, Riser CW, Øygarden S, Rey F (2002) Variations in hydrography, nutrients and chlorophyll a in the marginal ice-zone and the central Barents Sea. *Journal of Marine Systems* 38:9-29
- Renaud PE, Berge J, Varpe Ø, Lønne OJ, Nahrgang J, Ottesen C, Hallanger I (2012) Is the poleward expansion by Atlantic cod and haddock threatening native polar cod, *Boreogadus saida*? *Polar biology* 35:401-412
- Ricciardi A, Bourget E (1998) Weight-to-weight conversion factors for marine benthic macroinvertebrates. *Marine Ecology Progress Series* 163:245-251
- Richman SE, Lovvorn JR (2003) Effects of clam species dominance on nutrient and energy acquisition by spectacled eiders in the Bering Sea. *Marine Ecology Progress Series* 261:283-297
- Riisgård HU, Larsen PS (2010) Particle capture mechanisms in suspension-feeding invertebrates. *Marine Ecology Progress Series* 418:255-293
- Riser CW, Wassmann P, Reigstad M, Seuthe L (2008) Vertical flux regulation by zooplankton in the northern Barents Sea during Arctic spring. *Deep-Sea Research Part II - Topological Studies in Oceanography* 55:2320-2329

- Rumohr H, Brey T, Ankar S (1987) A compilation of biometric factors for benthic invertebrates of the Baltic sea. Baltic Marine Biologist Publication 9:1-56
- Rusyaev S, Orlov A (2013) Bycatches of the Greenland shark *Somniosus microcephalus* (Squaliformes, Chondrichthyes) in the Barents Sea and the adjacent waters under bottom trawling data. Journal of Ichthyology 53:111-115
- Saier B (2001) Direct and indirect effects of seastars *Asterias rubens* on mussel beds (*Mytilus edulis*) in the Wadden Sea. Journal of Sea Research 46:29-42
- Sakshaug E (1997) Biomass and productivity distributions and their variability in the Barents Sea. ICES Journal of Marine Science 54:341-350
- Sakshaug E, Bjørge A, Gulliksen B, Loeng H, Mehlum F (1994) Structure, biomass distribution, and energetics of the pelagic ecosystem in the Barents Sea: A synopsis. Polar Biology 14:405-411
- Sameoto D (1972) Yearly respiration rate and estimated energy budget for *Sagitta elegans*. Journal of the Fisheries Board of Canada 29:987-996
- Sampei M, Forest A, Sasaki H, Hattori H, Makabe R, Fukuchi M, Fortier L (2009) Attenuation of the vertical flux of copepod fecal pellets under Arctic sea ice: evidence for an active detrital food web in winter. Polar biology 32:225-232
- Sandneseng E (2006) Variation in abundance, diet, otolith zone patterns and black spot disease (*Cryptocotyle lingua*) of 0-group coastal cod (*Gadus morhua* L.) in northern Norway. Master thesis, University of Tromsø, Tromsø, Norway
- Sandvik H, Erikstad KE, Barrett RT, Yoccoz NG (2005) The effect of climate on adult survival in five species of North Atlantic seabirds. Journal of Animal Ecology 74:817-831
- Santos MB, Pierce GJ (2003) The diet of harbour porpoise (*Phocoena phocoena*) in the northeast Atlantic. Oceanography and Marine Biology 41:355-390
- Schoening T, Bergmann M, Ontrup J, Taylor J, Dannheim J, Gutt J, Purser A, Nattkemper TW (2012) Semi-automated image analysis for the assessment of megafaunal densities at the Arctic deep-sea observatory HAUSGARTEN. PLoS One 7:e38179
- Scott CL, Falk-Petersen S, Sargent JR, Hop H, Lonne OJ, Poltermann M (1999) Lipids and trophic interactions of ice fauna and pelagic zooplankton in the marginal ice zone of the Barents Sea. Polar Biology 21:65-70
- Sennikov A, Mukhin S, Bliznichenko T (1989) Distribution and trophic importance of juvenile squid (*Gonatus fabricii* Lichtenstein) in the Norwegian and Barents seas in 1986–1988. ICES CM 1989/K: 15
- Seuthe L, Iversen KR, Narcy F (2011) Microbial processes in a high-latitude fjord (Kongsfjorden, Svalbard): II. Ciliates and dinoflagellates. Polar Biology 34:751-766
- Sherr EB, Sherr BF (2007) Heterotrophic dinoflagellates: a significant component of microzooplankton biomass and major grazers of diatoms in the sea. Marine Ecology Progress Series 352:187-197
- Shick JM, Edwards KC, Dearborn JH (1981) Physiological ecology of the deposit-feeding sea star *Ctenodiscus crispatus*: ciliated surfaces and animal-sediment interactions. Marine Ecology-Progress Series 5:165-184
- Shirley T, Stickle W (1982) Responses of *Leptasterias hexactis* (Echinodermata: Asteroidea) to low salinity. Marine Biology 69:155-163
- Sigurjonsson J, Vikingsson GA (1997) Seasonal abundance of and estimated food consumption by cetaceans in Icelandic and adjacent waters. Journal of Northwest Atlantic Fishery Science 22:271-287
- Siikavuopio SI, James P (2015) Effects of temperature on feed intake, growth and oxygen consumption in adult male king crab *Paralithodes camtschaticus* held in captivity and fed manufactured diets. Aquaculture Research 46:602-608
- Simacheva I, Glukhov A (1985) Feeding of long rough dab in the Barents Sea. ICES CM 1985/G:9

- Similä T, Holst JC, Christensen I (1996) Occurrence and diet of killer whales in northern Norway: seasonal patterns relative to the distribution and abundance of Norwegian spring-spawning herring. *Canadian Journal of Fisheries and Aquatic Sciences* 53:769-779
- Skaret G, Bachiller E, Langøy H, Stenevik EK (2015) Mackerel predation on herring larvae during summer feeding in the Norwegian Sea. *ICES Journal of Marine Science* 72:2313-2321
- Skaret G, Pitcher TJ (2016) An Ecopath with Ecosim model of the Norwegian Sea and Barents Sea validated against time series of abundance. *Fisken og Havet* nr. 7-2016
- Skaug HJ, Øien N, Schweder T, Bøthun G (2004) Abundance of minke whales (*Balaenoptera acutorostrata*) in the Northeast Atlantic: variability in time and space. *Canadian Journal of Fisheries and Aquatic Sciences* 61:870-886
- Skern-Mauritzen M, Johannesen E, Bjørge A, Øien N (2011) Baleen whale distributions and prey associations in the Barents Sea. *Marine Ecology-Progress Series* 426:289-301
- Skogen MD, Hjøllø SS, Sandø AB, Tjiputra J (2018) Future ecosystem changes in the Northeast Atlantic: a comparison between a global and a regional model system. *ICES Journal of Marine Science* 75:2355-2369
- Skoglund EG, Lydersen C, Grahl-Nielsen O, Haug T, Kovacs KM (2010) Fatty acid composition of the blubber and dermis of adult male Atlantic walrus (*Odobenus rosmarus rosmarus*) in Svalbard, and their potential prey. *Marine Biology Research* 6:239-250
- Skreslet S, Albrigtsen I, Andersen AP, Kolbeinshavn A, Pedersen T, Unstad K, Howell B (1999) Migration, growth and survival in stocked and wild cod (*Gadus morhua* L.) in the Vestfjord region, north Norway. *Stock Enhancement and Sea Ranching*. Fishing News Books, Oxford
- Slagstad D, Ellingsen IH, Wassmann P (2011) Evaluating primary and secondary production in an Arctic Ocean void of summer sea ice: An experimental simulation approach. *Progress in Oceanography* 90:117-131
- Slagstad D, Tande KS, Wassmann P (1999) Modelled carbon fluxes as validated by field data on the north Norwegian shelf during the productive period in 1994. *Sarsia* 84:303-317
- Slotte A, Mikkelsen N, Gjørseter H (2006) Egg cannibalism in the Barents Sea in relation to a narrow spawning distribution. *Journal of Fish Biology* 69:187-202
- Solov'ev K, Kosobokova K (2003) Feeding of the chaetognaths *Parasagitta elegans* Verrill (Chaetognatha) in the White Sea. *Oceanology* 43:524-531
- Solvang HK, Skaug HJ, Øien N (2015) Abundance estimates of common minke whales in the Northeast Atlantic based on survey data collected over the period 2008-2013. SC/66a/RMP/8; Paper submitted to the IWC Scientific Committee 66a, San Diego, May 2015
- Soot-Ryen T (1941) Undersøkelser over erfuglens næring. *Tromsø Museums Årshefter* 59:1-42
- Southward A (1955) Feeding of barnacles. *Nature* 175:1124
- Spitz J, Mourocq E, Schoen V, Ridoux V (2010) Proximate composition and energy content of forage species from the Bay of Biscay: high-or low-quality food? *ICES Journal of Marine Science* 67:909-915
- Steimle FW, Terranova RJ (1985) Energy equivalents of marine organisms from the continental shelf of the temperate Northwest Atlantic. *Journal of Northwest Atlantic Fishery Science* 6:117-124
- Stempniewicz L (1993) The polar bear *Ursus maritimus* feeding in a seabird colony in Frans Josef Land. *Polar Research* 12:33-36
- Sternberg R, Aagaard K, Cacchione D, Wheatcroft R, Beach R, Roach A, Marsden M (2001) Long-term near-bed observations of velocity and hydrographic properties in the northwest Barents Sea with implications for sediment transport. *Continental Shelf Research* 21:509-529
- Stirling I, McEwan EH (1975) The caloric value of whole ringed seals (*Phoca hispida*) in relation to polar bear (*Ursus maritimus*) ecology and hunting behavior. *Canadian Journal of Zoology* 53:1021-1027

- Stirling I, Øritsland NA (1995) Relationships between estimates of ringed seal (*Phoca hispida*) and polar bear (*Ursus maritimus*) populations in the Canadian Arctic. *Canadian Journal of Fisheries and Aquatic Sciences* 52:2594-2612
- Sturluson M, Nielsen TG, Wassmann P (2008) Bacterial abundance, biomass and production during spring blooms in the northern Barents Sea. *Deep Sea Research Part II: Topical Studies in Oceanography* 55:2186-2198
- Sundet J, Rafter E, Nilssen E (2000) Sex and seasonal variation in the stomach content of the red king crab, *Paralithodes camtschaticus* in the southern Barents Sea. In: Klein JCvV, Schram FR (eds) *The Biodiversity Crisis and Crustacea: Proceedings of the fourth International Crustacean Congress, Amsterdam, The Netherlands, July 20-24, 1998, Book 12*. A.A. Balkema, Rotterdam/Brookfield
- Sundström LF, Gruber SH (1998) Using speed-sensing transmitters to construct a bioenergetics model for subadult lemon sharks, *Negaprion brevirostris* (Poey), in the field. *Hydrobiologia* 371:241-247
- Svenning MA, Borgstrøm R, Dehli TO, Moen G, Barrett RT, Pedersen T, Vader W (2005a) The impact of marine fish predation on Atlantic salmon smolts (*Salmo salar*) in the Tana estuary, North Norway, in the presence of an alternative prey, lesser sandeel (*Ammodytes marinus*). *Fisheries Research* 74:466-474
- Svenning MA, Fagermo SE, Barrett RT, Borgstrøm R, Vader W, Pedersen T, Sandring S (2005b) Goosander predation and its potential impact on Atlantic salmon smolts in the River Tana estuary, northern Norway. *Journal of Fish Biology* 66:924-937
- Swanberg N, Bamstedt U (1991) Ctenophora in the Arctic - The abundance, distribution and predatory impact of the Cyppid Ctenophore *Mertensia ovum* (Fabricius) in the Barents Sea. *Polar Research* 10:507-524
- Søreide JE, Hop H, Falk-Petersen S, Gulliksen B, Hansen E (2003) Macrozooplankton communities and environmental variables in the Barents Sea marginal ice zone in late winter and spring. *Marine Ecology Progress Series* 263:43-64
- Tande K, Hassel A, Slagstad D (1985) Gonad maturation and possible life cycle strategies in *Calanus finmarchicus* and *Calanus glacialis* in the northwestern part of the Barents Sea. *Marine biology of polar regions and effects of stress on marine organisms* Wiley, Chichester
- Tarling G, Burrows M, Matthews J, Saborowski R, Buchholz F, Bedo A, Mayzaud P (2000) An optimisation model of the diel vertical migration of northern krill (*Meganyctiphanes norvegica*) in the Clyde Sea and the Kattegat. *Canadian Journal of Fisheries and Aquatic Sciences* 57:38-50
- Taylor BL, Chivers SJ, Larese J, Perrin WF (2007) Generation length and percent mature estimates for IUCN assessments of cetaceans. NOAA, NMFS, Southwest Fisheries Science Center Administrative Report LJ-07-01 21
- Taylor JD (1978) The diet of *Buccinum undatum* and *Neptunea antiqua* (Gastropoda: Buccinidae). *Journal of Conchology* 29:309-318
- Teigsmark G (1983) Population of the deep-sea shrimp (*Pandalus borealis* Kroeyer) in the Barents Sea. *Fiskeridirektoratets Skrifter Serie Havundersøkelser* 17:377-430
- Tenore KR, Gopalan U (1974) Feeding efficiencies of the polychaete *Nereis virens* cultured on hard-clam tissue and oyster detritus. *Journal of the Fisheries Board of Canada* 31:1675-1678
- Thangstad T, Dyb JE, Jónsson E, Laurenson C, Ofstad LH, Reeves SA (2002) Anglerfish (*Lophius* spp.) in Nordic and European Waters: Status of current knowledge and ongoing research. Report, Institute of Marine Research, Bergen, Norway
- Thiel M, Kruse I (2001) Status of the Nemertea as predators in marine ecosystems. *Hydrobiologia* 456:21-32
- Toresen R, Østvedt OJ (2000) Variation in abundance of Norwegian spring-spawning herring (*Clupea harengus*, Clupeidae) throughout the 20th century and the influence of climatic fluctuations. *Fish and Fisheries* 1:231-256

- Vacquié-Garcia J, Lydersen C, Marques T, Aars J, Ahonen H, Skern-Mauritzen M, Øien N, Kovacs K (2017) Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endangered Species Research* 32:59-70
- Vadas S, Robert L, Wright WA, Beal BF (2004) Biomass and productivity of intertidal rockweeds (*Ascophyllum nodosum* LeJolis) in Cobscook Bay. *Northeastern Naturalist* 11:123-142
- Vahl O (1973) Efficiency of particle retention in *Chlamys islandica*. *Astarte* 6:21-25
- Vahl O (1980) Seasonal variations in seston and in the growth rate of the iceland scallop, *Chlamys islandica* (O.F. Müller) from Balsfjord, 70°N. *Journal of Experimental Marine Biology and Ecology* 48:195-204
- Vaqué D, Guadayol O, Peters F, Felipe J, Angel-Ripoll L, Terrado R, Lovejoy C, Pedrós-Alioó C (2008) Seasonal changes in planktonic bacterivory rates under the ice-covered coastal Arctic Ocean. *Limnology and Oceanography* 53:2427-2438
- Verity PG, Redalje DG, Lohrenz SR, Flagg C, Hristov R (2002) Coupling between primary production and pelagic consumption in temperate ocean margin pelagic ecosystems. *Deep Sea Research II-Topological Studies in Oceanography* 49:4553-4569
- Vetrov AA, Romankevich EA (2004) Carbon cycle in the russian Arctic Seas. Springer, Berlin, Heidelberg
- Víkingsson GA (1995) Body condition of fin whales during summer off Iceland. *Dev Mar Bio*:361-369
- Víkingsson GA (1997) Feeding of fin whales (*Balaenoptera physalus*) off Iceland—diurnal and seasonal variation and possible rates. *Journal of Northwest Atlantic Fishery Science* 22:77-89
- Vollen T, Albert OT, Nilssen EM (2004) Diet composition and feeding behaviour of juvenile Greenland halibut (*Reinhardtius hippoglossoides*) in the Svalbard area. *Journal of Sea Research* 51:251-259
- Vongraven D, Bisther A (2014) Prey switching by killer whales in the north-east Atlantic: observational evidence and experimental insights. *Journal of the Marine Biological Association of the United Kingdom* 94:1357-1365
- Våge S, Bratbak G, Egge J, Heldal M, Larsen A, Norland S, Lund Paulsen M, Pree B, Sandaa RA, Skjoldal EF (2018) Simple models combining competition, defence and resource availability have broad implications in pelagic microbial food webs. *Ecology letters* 21:1440-1452
- Walkusz W, Kwasniewski S, Petersen SF, Hop H, Tverberg V, Wieczorek P, Weslawski JM (2009) Seasonal and spatial changes in the zooplankton community of Kongsfjorden, Svalbard. *Polar Research* 28:254-281
- Walsh SJ (1996) Life history and ecology of long rough dab *Hippoglossoides platessoides* (F) in the Barents Sea. *Journal of Sea Research* 36:285-310
- Ward JE, Shumway SE (2004) Separating the grain from the chaff: particle selection in suspension- and deposit-feeding bivalves. *Journal of Experimental Marine Biology and Ecology* 300:83-130
- Wassmann P, Reigstad M, Haug T, Rudels B, Carroll ML, Hop H, Gabrielsen GW, Falk-Petersen S, Denisenko SG, Arashkevich E, Slagstad D, Pavlova O (2006a) Food webs and carbon flux in the Barents Sea. *Progress in Oceanography* 71:232-287
- Wassmann P, Slagstad D, Riser CW, Reigstad M (2006b) Modelling the ecosystem dynamics of the Barents Sea including the marginal ice zone II. Carbon flux and interannual variability. *Journal of Marine Systems* 59:1-24
- Wathne JA, Haug T, Lydersen C (2000) Prey preference and niche overlap of ringed seals *Phoca hispida* and harp seals *P. groenlandica* in the Barents Sea. *Marine Ecology Progress Series* 194:233-239
- Welch HE (1968) Relationships between assimilation efficiencies and growth efficiencies for aquatic consumers. *Ecology* 49:755-759
- Welch HE, Bergmann MA, Siferd TD, Martin KA, Curtis MF, Crawford RE, Conover RJ, Hop H (1992) Energy flow through the marine ecosystem of the Lancaster Sound Region, Arctic Canada. *Arctic* 45:343-357

- Weslawski J, Hacquebord L, Stempniewicz L, Malinga M (2000a) Greenland whales and walrus in the Svalbard food web before and after exploitation. *Oceanologia* 42:37-56
- Weslawski JM, Pedersen G, Falk-Petersen S, Porazinski K (2000b) Entrapment of macroplankton in an Arctic fjord basin, Kongsfjorden, Svalbard. *Oceanologia* 42:57-69
- Weslawski JM, Ryg M, Smith TG, Oritsland NA (1994a) Diet of ringed seals (*Phoca hispida*) in a fjord of West Svalbard. *Arctic* 47:109-114
- Weslawski JM, Stempniewicz L, Galaktionov K (1994b) Summer diet of seabirds from the Frans Josef Land archipelago, Russian Arctic. *Polar Res* 13:173-181
- Wetherbee BM, Cortes E (2004) Food consumption and feeding habits. In: Carrier JC, Musick JA, Heithaus MR (eds) *Biology of sharks and their relatives*. CRC Press, Boca Raton
- Wetherbee BM, Gruber SH (1993) Absorption efficiency of the lemon shark *Negaprion brevirostris* at varying rates of energy intake. *Copeia*:416-425
- Whitehouse GA, Aydin K, Essington T, Hunt GLJ (2014) A trophic mass balance model for the eastern Chukchi Sea with comparisons to other high-latitude systems. *Polar Biology* 33:911-939
- Wiborg KF (1960) Investigations on pelagic fry of cod and haddock in coastal and off-shore areas of northern Norway in July-August. *Fiskeridirektoratets Skrifter Serie Havundersøkelser* 12:1-18
- Wiborg KF (1980) Undersøkelser av *Gonatus fabricii* (Lichtenstein) i Norskehavet og det vestlige Barentshavet i juni-september 1979. *Fisken og Havet* 1980(1):1-7 (In Norwegian)
- Wiborg KF (1982) Undersøkelser av *Gonatus fabricii* (Lichtenstein) i Norskehavet og det vestlige Barentshavet i februar-september 1980 og juli-september 1981. *Fisken og Havet* 1982(2):13-25 (In Norwegian)
- Wiborg KF, Hansen K, Olsen HE (1974) Haneskjell (*Chlamys islandica* Müller) ved Spitsbergen og Bjørnøya-Undersøkelser i 1973.
- Wienerroither R, Johannesen E, Dolgov AV, Byrkjedal I, Bjelland O, Drevetnyak K, Eriksen KB, Høines ÅS, Langhelle G, Langøy H (2013) Atlas of the Barents Sea Fishes based on the winter survey. IMR/PINRO Joint Rep Ser 2-2013
- Wienerroither R, Johannesen E, Langøy H, Dolgov A, Byrkjedal I, Bjelland O, Drevetnyak K, Eriksen K, Høines Å, Langhelle G (2011) Atlas of the Barents Sea fishes. IMR-PINRO Joint Report Series 1-2011:1-272
- Wiig Ø (1998) Survival and reproductive rates for polar bears at Svalbard. *Ursus* 10:25-32
- Wiig Ø, Bachmann L, Kovacs KM, Swift R, Lydersen C (2010a) Survey of bowhead whales (*Balaena mysticetus*) in the Northeast Atlantic in 2010. International Whaling Commission SC/62/BRG20
- Wiig Ø, Bachmann L, Øien N, Kovacs KM, Lydersen C (2010b) Observations of bowhead whales (*Balaena mysticetus*) in the Svalbard area 1940–2009. *Polar biology* 33:979-984
- Windsland K (2015) Total and natural mortality of red king crab (*Paralithodes camtschaticus*) in Norwegian waters: catch–curve analysis and indirect estimation methods. *ICES Journal of Marine Science: Journal du Conseil* 72:642-650
- Windsland K, Hvingel C, Nilssen EM, Sundet JH (2014) Dispersal of the introduced red king crab (*Paralithodes camtschaticus*) in Norwegian waters: a tag-recapture study. *ICES Journal of Marine Science*
- Windsland K, Lindstrøm U, Nilssen KT, Haug T (2007) Relative abundance and size composition of prey in the common minke whale diet in selected areas of the northeastern Atlantic during 2000-04. *J Cetacean Res Manage* 9:167-178
- Witting L, Born EW (2005) An assessment of Greenland walrus populations. *ICES Journal of Marine Science* 62:266-284
- Wu R, Levings C (1978) An energy budget for individual barnacles (*Balanus glandula*). *Marine Biology* 45:225-235
- Yamada Y, Ikeda T (2006) Production, metabolism and trophic importance of four pelagic amphipods in the Oyashio region, western subarctic Pacific. *Marine Ecology Progress Series* 308:155-163

- Yasui W, Gaskin D (1986) Energy budget of a small cetacean, the harbour porpoise, *Phocoena phocoena* (L.). *Ophelia* 25:183-197
- Ye L, Jiang S, Zhu X, Yang Q, Wen W, Wu K (2009) Effects of salinity on growth and energy budget of juvenile *Penaeus monodon*. *Aquaculture* 290:140-144
- Yoccoz N, Erikstad KE, Bustnes JO, Hanssen SA, Tveraa T (2002) Costs of reproduction in common eiders (*Somateria mollissima*): an assessment of relationships between reproductive effort and future survival and reproduction based on observational studies. *Journal of Applied Statistics* 29:57-64
- Yuan X, Yang H, Zhou Y, Mao Y, Zhang T, Liu Y (2006) The influence of diets containing dried bivalve feces and/or powdered algae on growth and energy distribution in sea cucumber *Apostichopus japonicus* (Selenka)(Echinodermata: Holothuroidea). *Aquaculture* 256:457-467
- Zaborska A, Włodarska-Kowalczyk M, Legeżyńska J, Jankowska E, Winogradow A, Deja K (2016) Sedimentary organic matter sources, benthic consumption and burial in west Spitsbergen fjords—signs of maturing of Arctic fjordic systems? *Journal of Marine Systems* 180:112-123
- Zakharov DV, Manushin IE, Nosova TB, Strelkova NA, Pavlov VA (2020) Diet of snow crab in the Barents Sea and macrozoobenthic communities in its area of distribution. *ICES Journal of Marine Science*
- Zamarro J (1992) Feeding behaviour of the American plaice (*Hippoglossoides platessoides*) on the southern Grand Bank of Newfoundland. *Netherlands Journal of Sea Research* 29:229-238
- Zenkevitch L (1963) *Biology of the Seas of the U.S.S.R.* George Allen & Unwin Ltd, London
- Zimina O, Lyubin P, Jorgensen L, Zakharov D, Lyubina O (2015) Decapod crustaceans of the Barents Sea and adjacent waters: species composition and peculiarities of distribution. *Arthropoda Selecta* 24:417-428
- Ziryanov SV, Mishin VL (2007) Grey seals on the Murman coast, Russia: status and present knowledge. *NAMMCO Scientific Publications* 6:13-21
- Øien N (1988) The distribution of killer whales (*Orcinus orca*) in the North Atlantic based on Norwegian catches, 1938-1981, and incidental sightings, 1967-1987. *Rit Fiskideildar* 11:65-78
- Øien N (1996) *Lagenorhynchus* species in Norwegian waters as revealed from incidental observations and recent sighting surveys. International Whaling Commission, Scientific Committee Document SC/48/SM15, Cambridge, UK
- Øien N (2009) Distribution and abundance of large whales in Norwegian and adjacent waters based on ship surveys 1995-2001. *NAMMCO Scientific Publications* 7:31-47
- Øigård TA, Frie AK, Nilssen KT, Hammill MO (2012) Modelling the abundance of grey seals (*Halichoerus grypus*) along the Norwegian coast. *ICES Journal of Marine Science* 69:1436-1447
- Østvedt OJ (1963) On the life history of the spotted catfish (*Anarhichas minor* Olafsen). *Fisk Dir Skr Ser Havunders* 13:54-72
- Aarefjord H, Bjørge AJ (1995) Diet of the Harbour Porpoise (*Phocoena phocoena*) in Scandinavian Waters. *Biology of the Phocoenids*. The International Whaling Commission, Cambridge
- Aarflot JM, Skjoldal HR, Dalpadado P, Skern-Mauritzen M (2017) Contribution of *Calanus* species to the mesozooplankton biomass in the Barents Sea. *ICES Journal of Marine Science* 75:2342-2354
- Aars J, Marques TA, Buckland ST, Andersen M, Belikov S, Boltunov A, Wiig O (2009) Estimating the Barents Sea polar bear subpopulation size. *Marine Mammal Science* 25:35-52
- Aars J, Marques TA, Lone K, Andersen M, Wiig Ø, Bardalen Fløystad IM, Hagen SB, Buckland ST (2017) The number and distribution of polar bears in the western Barents Sea. *Polar Research* 36:1374125
- Aas C (2007) The predation impact of juvenile saithe (*Pollachius virens* L.) on juvenile coastal cod (*Gadus morhua* L.) and other juvenile fishes. Master thesis, University of Tromsø, Tromsø