Trawl Sampling in the Norwegian Sea

Oceanography at Sea: An introduction to Practical Aspects of Oceanography

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Introduction

The Norwegian Sea is home to more than 250 species of fish and serves as an important societal resource, both in terms of economics through fisheries and as a food source. Amongst the most important commercial species are herring (*Claupea harengus*), mackerel (*Scomber scombrus*) and blue whiting (*Micromesistius poutassou*). These stocks are highly dependent on food availability and climate variability. *Calanus sp*. is the major food source of most of the pelagic fish species, with the dominant prey species being *Calanus finmachius*, especially important for younger fish life stages. Besides the biological properties, the hydrodynamics of the Norwegian Sea also serve as an important variable, as it is dominated by warm and saline Atlantic water that is carried along the Norwegian continental shelf break. The species living and breeding in the Norwegian sea are highly adapted to the area specific hydrodynamics. For example, herring spawns along the coast from February to March and the larvae are then transported by currents to the nursing grounds along the coast to the Barents Sea.

Figure 1. Map of Norwegian coast and the three trawl sampling stations (haul 1 – pink, haul 2 – green, haul 3 – red).

	Atlantic Herring	Blue Whiting	Mackerel
Scientific name	*Clupea harengus*	*Micromesistius poutassou*	*Scomber scombrus*
Length	Common: 30 cm Max: 45 cm	Common: 22 cm Max: 50 cm	Common: 30 cm Max: 60 cm
Distribution	Temperate 0-364 m Pelagic	Warm boreal waters 150-3000 m Continental margins, bathypelagic	Temperate 0-1000m Pelagic
Preys on	Copepods, krill and small fish		Zooplankton, molluscs and small fish
Predators	Seals, whales, cod and other larger fish		
Spawning	Norwegian coast (58° to 70°N) February to March	Winter - west of the British Isles Norwegian sea (nursery and feeding)	West of the British Isles and Bay of Biscay
Stock	650 000 tons (since 1950)	Over 1 million tonnes from 1998 to 2008	360 000 to 930 000 tonnes
Quota	619 000 tonnes (2013)	1.2 million tonnes (2015)	600 000 tonnes – disputed (2014)

Table 1. Characteristics of target species

	Muller's Pearlside	Lanternfish	Sharpchin barracudina
Scientific name	*Maurolicus muelleri*	*Notoscopelus sp.*	*Paralepis coregonoides*
Length	Common: 4 cm Max: 8 cm	2 to 30 cm	Max: 50 cm
Distribution	0 - 1524 m Worldwide Bathypelagic	300 - 1,500 m Circumglobal Mesopelagic	50-1032 m Eastern Atlantic Ocean Bathypelagic
Preys on	Copepods and euphausiids	Zooplankton	Fishes, crustaceans and shrimp
Predators	Fish	Whales, dolphins, salmon, tuna, sharks, grenadiers, other deep-sea fish, pinnipeds, sea birds, and squid	Atlantic salmon and Cod
Spawning	March to September	February to March	March to September
Stock / Quota	Not significant		

Table 2. Characteristics of bycatch species in haul 2

	Grey Gurnard	Lumpfish
Scientific Name	*Eutrigla gurnardus*	*Cyclopterus lumpus*
Length	Common: 30 cm Max: 60cm	Max: 61 cm (male), 42.9 cm (female)
Distribution	10-340 m; Eastern Atlantic Marine and brackish waters	0-868 m Atlantic Ocean Benthopelagic
Preys on	Crustaceans and fishes	Ctenophores, crustaceans, polychaetes, jellyfish and fish
Spawning	January to June	Move into fjords
Stock / Quota	Catch and keep	Catch and keep

Table 3. Characteristics of bycatch species in haul 3

Figure 2. Krill from haul 2

Aims

- To examine the composition of pelagic trawl catches in the Norwegian Sea
- To establish length-weight, length-age and length-maturity ratio of predominant species
- To discuss the gathered information, taking into consideration existing data

Methods

Station data

Prior to every trawl, the vertical profile of the water column was analysed with a CTD (Figure 8) and corresponding water samples were taken. Plankton nets were deployed at measured chlorophyll peaks to analyse the plankton composition.

Fishing

An echo-sounder (SIMRAD EK60 : 18, 38, & 120 kHz) was used to locate potential schools of fish. After a suitable location was found, a mid-water pelagic trawl net was deployed. After towing the net, the catch was brought on board.

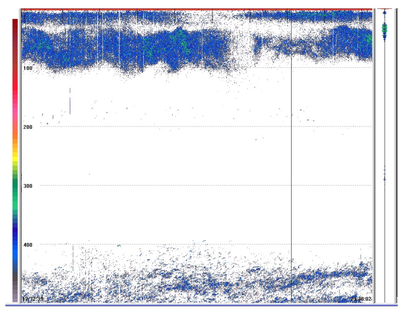


Figure 3. Echogram for haul 1

On board processing and sampling

Firstly, a total haul weight was taken, the haul was then sorted into species, total number of species and weight to determine the haul composition. Biological data were taken on species of interest. Including, length (n = 320), weight (n = 180), sex (n = 180), maturity (n = 180) and otoliths (n = 180).

Post sampling analysis

Using excel, a length to weight ratio was established. Lengths were plotted to determine potential cohorts in the catch. This was then applied to all non-weighed fish. Maturity data were compared to length data to establish a length to maturity relationship. A known age-length ratio was applied to determine age of caught fish to determine approximate ages.

Species	Number	Weight (kg)
Mackerel	2	0.588
Total	**2**	**0.588**

Table 5. Species composition for haul 1

Figure 4. Mackerel from haul 1

Species	Number	Weight (kg)
Blue Whiting	322	21.82
Mackerel	2	0.492
Blindside	51	0.046
Lanternfish	7	0.138
Barracudina	2	0.022
Krill	-	0.414
Jellyfish	-	0.09
Total	**384**	**23.022**

Table 6. Species composition for haul 2

Figure 5. Blue whiting from haul 2

Species	Number	Weight (kg)
Herring	5	0.807
Gunard	1	0.275
Lumpfish	2	0.143
Total	**8**	**1.225**

Table 7. Species composition for haul 3

Figure 6. Herring from haul 3

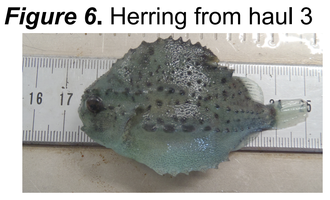
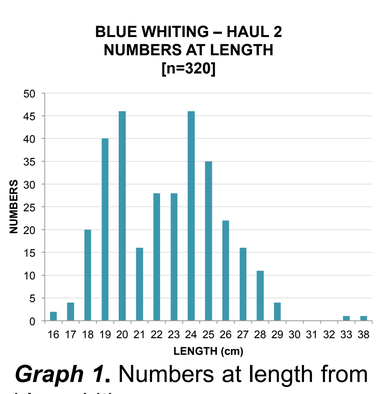
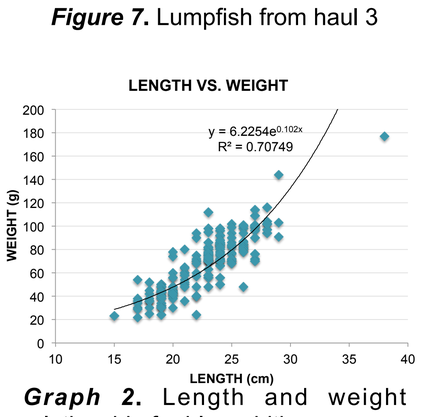


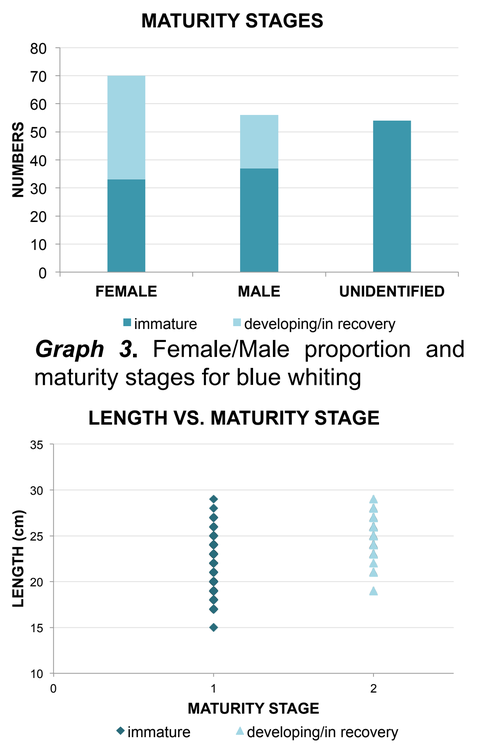
Figure 7. Lumpfish from haul 3



Graph 1. Numbers at length from blue whiting



Graph 2. Length and weight relationship for blue whiting



Graph 3. Female/Male proportion and maturity stages for blue whiting

Graph 4. Length and maturity stage relationship for blue whiting

Total Observed Weight	21.82
Total Expected Weight	20.99
Difference	0.83

Table 8. Blue whiting weight (kg)

Age (years)	Count
0	6
1	106
2	72
3	103
4	31
5	1
8	1

Table 9. Blue whiting age

Results and Discussion

From the echograms, figure 3, different levels of biomass were observed, with the majority in the photic zone. Based on the observed biomass concentrations from the echogram, the composition of catch was assessed to be of predominantly consisting of phyto- or zooplankton. The plankton net catches showed the zooplankton community was commonly or predominantly *Calanus sp.,* as well as other common fish prey, such as krill (Figure 2). This provides good feeding grounds for fish. However, the echogram did not show large biomasses, which would be expected with fish schools or large fish, this was reflected by the small haul size.

The species composition of the catch were composed mainly of commercial and abundant species, e.g. herring, mackerel and blue whiting. The analysis of blue whiting was the primary focus. The frequency at different lengths, show two peaks, which could indicate two different cohorts were present within the total catch. (Graph 1). In graph 3, we see the female and male proportions and well as their respective maturity proportions. The unidentified fish are assumed to be undeveloped because the fish is likely too small to be examine accurately. Based on a subsample, a length-weight relationship was derived and used to calculate weight of individual length classes for the whole sample (Graph 2). Only a slight difference of 830 g was observed between the calculated and measured, which could be explained by small sample size or inaccurate weight measurement due to ship motion.

The maturity analysis show that all the individuals where either immature or had already spawned, which was expected in this location at this time of year. There was a slight size to maturity trend, more mature fish were slightly heavier and longer (Graph 4), but there is some overlap in the data.

Using a Von Bertalanffy growth curve taken from Ybema (2015) the age of all fish were estimated based upon their length. (Table 9) This shows that we have members from seven separate cohorts, with three predominant cohorts. This is different than the previous discussed pair of cohorts visible on the length graph (Graph 1). This could be because the Von Bertalanffy curve is based upon accurate otolith ring measurements and not just simple length class abundance.

Work like this is conducted to perform stock assessments, estimate age, sex and maturity of fish caught, thus allowing us to manage fisheries to maintain healthy stocks.

Haul	Date	Gear Depth (m)	Bottom Depth (m)	Deployment Time (UTC)	Deployment Lat	Deployment Long	Retrieval Time (UTC)	Retrieval Lat	Retrieval Long	Total Time
1	25.05.2015	50	577.10	12:51:32	67°18.968' N	008°47.776' E	13:51:49	67°16.100' N	008°42.919' E	01:00:17
2	26.05.2015	350	725.2	11:38:52	64°00.747' N	005°33.835' E	12:38:47	63°57.827' N	005°31.082' E	00:59:55
3	27.05.2015	5	299.2	11:18:24	60°36.801' N	004°02.932' E	11:44:48	60°35.559' N	004°04.116' E	00:26:24

Table 4. Haul data (haul 1 – pink, haul 2 – green, haul 3 – red)

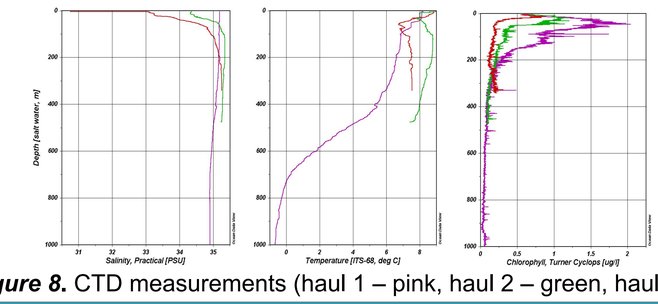


Figure 8. CTD measurements (haul 1 – pink, haul 2 – green, haul 3 – red)

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