FROM INTRO

The ecosystem and species-level impacts of biomass declines of capelin in other North Atlantic  
regions (Iceland and Barents Sea) provide insight  
into what might have been expected in the NL marine environment. In the Iceland ecosystem, overfishing led to a dramatic decline of capelin biomass  
from 2 Mt in 1978 to 0.3 Mt (85% decrease) in 1982  
and, in response, the weight at age of Icelandic cod  
(ages 5-8 yr) declined by 25-30% (Vilhjálmsson  
2002). Similar responses were observed in the Barents Sea, where overfishing of capelin during the  
1980s resulted in a sudden 6 Mt collapse (Gjøsæteret al. 2009). This was followed by a 1-2 kg  
reduction in the average weight at age of 4-6 yr old  
cod (Mehl & Sunnanå 1991)

ADB notes:

1. From Mehl & Sunnanå 1991: cod’s secondary prey in the Barents Sea (pandalus borealis) stock was reduced by more than half when the reduced in weight aat age was observed
2. From Mehl & Sunnanå 1991: stock biomass of cod was virtually constant during the capelin collapse, if anything it was highest when capelin was lowest – therefore relative abundance of capelin saw a sharp decrease – as opposed to the case of the NL Shelf
3. From Mehl & Sunnanå 1991, figure 4: weights at age 1-7+. Why did Frank choose to mention ages 4-6? drop in weight at age did not reach 2 kg
   1. Age 4: about 500g
   2. Age 5: about 1 kg
   3. Age 6: a bit more than 1 kg (but NOT 2 kg)
4. Magnusson & Palsson (1989): cod in Iceland had
   1. Lower stomach contents - YES in nl (Morgan et al 2017)
   2. Smaller growth rate - YES in nl (Morgan et al 2017)
   3. Reduced feeding level - ? in NL

when capelin stock declined to low levels

1. From Lilly 1987: Predation by cod on capelin is not as seasonal in Div. 3L as it is to the north. Cod on the northern slopes of Grand Bank feed on capelin in winter (Templeman 1965; Turuk 1968; Minet and Perodou 1978; Lilly et ale 1984), and partial fullness indices can be very high (Lilly and Fleming 1981). Cod also feed on capelin in various parts of the Avalon Channel and the northern, western, and central Grand Bank in spring and summer (Popova 1962; Turuk 1968; Kovalyov and Kudrin 1973; Stanek 1975; Minet and Perodou 1~78; Lilly and Fleming 1981). Predation on capelin also occurs in autumn (Turuk 1968), but there has been less study at that season.

ECOREGIONS

Pepin et al 2010

In all runs, the Grand Banks remained its own class separate from the NL shelf and thesoutheast shoal.

Pepin et al 2012

link different features of the ecosystem, both physical and biological,  
to define areas with similar features

Grand Banks and NL Shelf  
still appear as distinct

Pepin et al 2014

Ecosystem Production Units (contain a reasonably well defined food web/production system ) - northeast Newfoundland Shelf  
(subareas 2J3K), the Grand Banks (subareas 3LNO)

Temporal dynamics of cod weight at ageand condition

Capelin are a major component of the diet of cod in NL, and the growth and condition of cod have been shown to be sensitive to variation in the abundance of capelin in the ecosystem (Rose & O’Driscoll 2002). Cod weights at age have been assessed annually in Div. 2J3KL from fall research bottom-trawl surveys beginning in 1978 (Fig. 9). We evaluated the coherence of the temporal variation in the 3-5 yr old cod weight at age time series through a PCA. The first 2 PCA modes effectively separated Div. 2J and 3K from 3L, captured 46 and 22% of the overall variance, respectively, and featured comparable loadings for all 6 series for Div. 2J and 3K (leading mode) and for all 3 series from Div. 3L (second mode; Figs. S3 & S4 in the Supplement). Weight at age of 3-5 yr old cod in Div. 2J and 3K declined to minimum values in the early 1990s, about the time of the reported capelin collapse in Div. 3L. Of the 12 time series of weight at age, 5 showed significant (p < 0.05) differences between the pre- and post-1991 periods: the weight at age of Div. 2J 5 yr and Div. 3K 4 yr old cod declined, whereas the weights of Div. 3L 3-4 yr old cod increased (Fig. 9; Table S2 in the Supplement). The increase of weight at age in Div. 3L is inconsistent with the reported capelin collapse. Krumsick & Rose (2012) determined the diets of cod collected between March and September in 1997-2003, 2008 and 2011 from Div. 2J, 3K, 3L and 3Ps. Over the entire region, capelin was the leading prey item at 31.6% by weight. On average, capelin constituted <7.4% of the cod diet from Div. 2J, but made a progressively larger contribution in Div. 3K (13.5%) and Div. 3L (61.3%). In Div. 3Ps, capelin contributed 33.5% to the total diet. However, we note that cod biomass had reached low values in the early 1990s, which were sustained, and therefore it is possible that capelin availability had not declined relative to the diminished cod biomass.

Rose & O’Driscoll (2002) reported a strong positive relationship (R2 = 0.73) between the ratio of liver to gutted body weight of 30-65 cm cod and a measure of the local (within a 40 km radius) availability of capelin, as assessed by acoustic surveys conducted during 1996-2001, independent of those run by DFO. We therefore examined temporal trends in the preand post-1991 liver condition index for 37 cm (immature) and 49 cm (mature) cod sampled in annual DFO research surveys (Taggart et al. 1994). Annual standardized anomalies of the index for 37 and 49 cm cod in Div. 2J and 49 cm cod in Div. 3K varied coherently, with peak values in 1986, decreasing to sustained low values in 1991, the time of the reported capelin collapse (Fig. 10; see also Figs. S5 & S6 in the Supplement). In Div. 3K (37 cm) and 3L, the opposite occurred. The differences of the pre- and post-1991 liver indexes were significant for all but the Div. 3K 49 cm cod (Table S3 in the Supplement). The index decreased for both size classes in Div. 2J and increased for both in Div. 3L as well as for Div. 3K 37 cm cod. The increased condition index in Div. 3L is inconsistent with the reported capelin collapse there.

In summary, both the analysis of cod weight at age and liver condition indicate that changes occurred in the cod-capelin trophic dynamics in the early 1990s, particularly in Div. 2J, that were roughly coherent with the dramatic decline in biomass estimates from the Div. 3L capelin acoustic surveys. However, this was not the case in the southern part of the region (Div. 3L), and mixed results were obtained in Div. 3K.













