

Supplemental materials for:

Evaluating growth dimorphism, maturation, and skip spawning of Atlantic halibut in the Gulf of Maine using a collaborative research approach

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Supplemental Materials Part 1: Sample sizes

Table S1. The number of female Atlantic halibut (*Hippoglossus hippoglossus*) processed for gonad histology and used in reproductive analyses, by sampling (A) source and gear and (B) month and year. Sources are the Cape Cod Commercial Fishermen's Alliance (CCCFA); Maine commercial fishery (Commercial_ME); Massachusetts Division of Marine Fisheries, Industry Based trawl survey (MA_IBS); Maine and New Hampshire inshore bottom trawl survey (ME_NH_Survey); Northeast Fisheries Science Center bottom trawl and bottom longline surveys (NEFSC_Survey); NEFSC Cooperative Research Branch, Study Fleet (NEFSC_SF).

(A)	Gear					
	Source	Trawl	Gillnet	Longline	Rod Reel	Total
	CCCFA	43	153	1	0	197
	Commercial_ME	0	0	2	0	2
	MA_IBS	12	0	0	0	12
	ME_NH_Survey	10	0	0	0	10
	NEFSC_Survey	48	0	40	0	88
	NEFSC_SF	5	0	0	1	6
	Total	118	153	43	1	315

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(B)		Year			
Month	2014	2015	2016	2017	2018
Jan	0	0	0	0	20
Feb	0	0	0	0	10
Apr	0	2	2	3	3
May	8	7	3	17	17
Jun	0	0	0	3	23
Jul	0	0	0	2	28
Aug	0	0	0	21	13
Sep	0	0	0	11	13
Oct	7	5	4	29	16
Nov	3	4	7	20	13
Dec	0	0	0	1	0
Total	18	18	16	107	156

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Table S2. The number of Atlantic halibut (*Hippoglossus hippoglossus*) processed for age & growth analyses, by sampling (A) source and gear and (B) month and year. The first number is females, the second number is males, and the third number is sex unknown. A dash indicates no samples of any sex category. Source abbreviations used are the same as in Table S1.

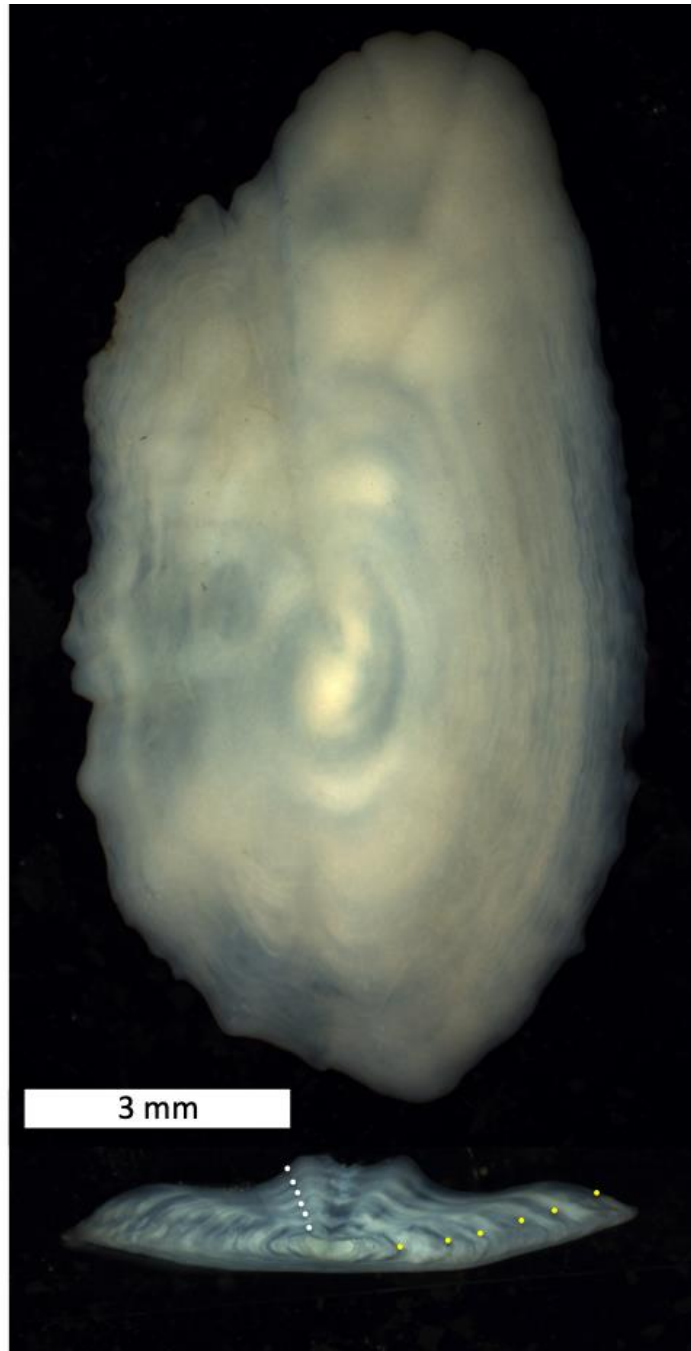
(A)	Gear					Total
	Source	Trawl	Gillnet	Longline	Rod Reel	
	CCCFA	42,2,2	150,24,5	1,0,1	0,0,2	229
	Commercial_ME	-	-	6,2,0	-	8
	MA_IBS	6,1,8	-	-	-	15
	ME_NH_Survey	28,23,0	-	-	-	51
	NEFSC_Survey	36,37,13	-	23,4,0	-	113
	NEFSC_SF	5,0,0	-	-	-	5
	Total	203	179	37	2	421

(B)		Year			
Month	2014	2015	2016	2017	2018
Jan	-	-	0,0,1	-	19,2,0
Feb	-	-	-	-	10,0,0
Apr	-	2,2,0	1,0,0	1,0,4	1,0,1
May	9,8,1	10,3,0	8,15,0	12,4,7	13,4,0
Jun	0,1,0	-	0,2,0	10,5,3	22,6,3
Jul	-	-	-	2,2,0	30,8,2
Aug	-	-	-	19,3,1	15,2,1
Sep	-	-	-	10,1,1	13,1,0
Oct	7,0,0	5,1,0	-	29,2,1	19,10,0
Nov	4,5,2	4,4,0	-	19,2,3	3,0,0
Total	37	31	27	141	185

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Supplemental Materials Part 2: Age & Growth

Image of a sagittal otolith whole (eyed side; in water [top]) and sectioned (blind side; bottom) from the same individual. This Atlantic halibut was an 81.5 cm male, determined as 6 years old, captured May 31, 2016. On the sectioned otolith image, two series of dots indicate different possible annuli counting axes. The scale bar is 3 mm for both images.



Supplemental Materials Part 3: Reproduction

Overview. This part regarding Atlantic halibut reproduction depicts several traits of six individuals in relation to the major maturity classes observed in this study (illustrated in Figure 9 of the main text). Each page depicts both macroscopic and microscopic images of an individual female, together with a plot of oocyte diameters from the same gonad.

In each legend, fish are identified with a unique name assigned in the field, as well as a cross-referenced name assigned for histology (i.e., HHSKxxx). The legend states the collection date and gear, and the fish size and age. It specifically refers to an individual's GSI, an acronym for gonad-somatic index (calculated as ovary weight / ovary-free body weight $\times 100$), as well as the gonad wall (tunica) thickness, as measured to the nearest micron (see Figure 4 of the main text for the entire sample of tunica measurements).

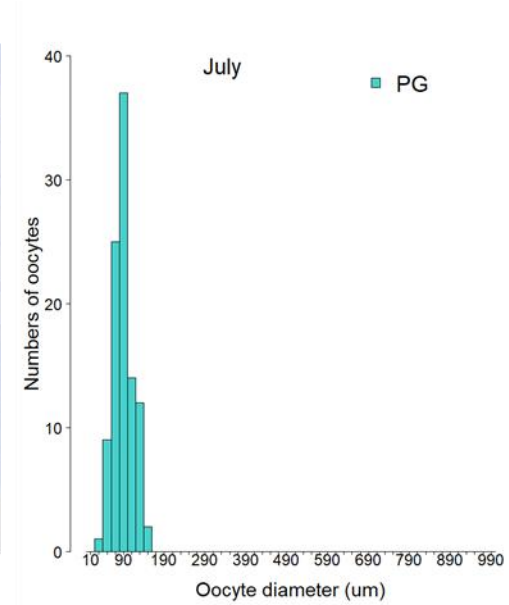
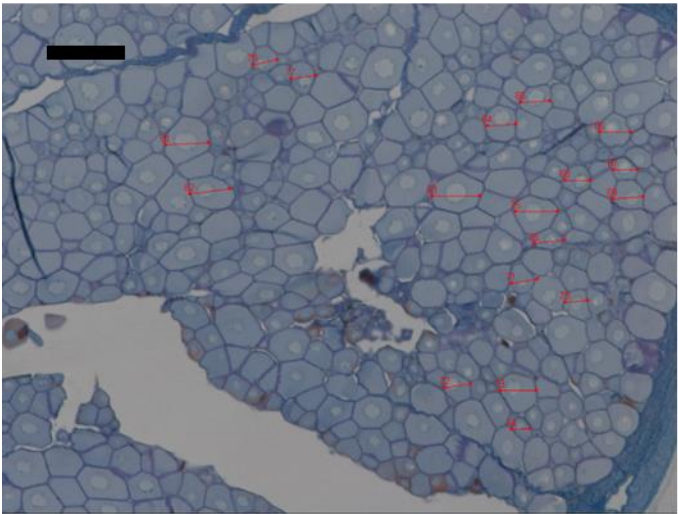
A macroscopic image of the whole gonad is presented against a blue grid (1×1 cm) background. The fish name in the image is the name assigned in the field.

A microscopic image is also presented, among those that were taken using a Nikon Coolscope under 4x magnification (black scale bar = 250 microns). In total, several images were taken across the entire section of ovarian tissue, resulting in non-overlapping images (9–32 images per fish), to plot a representative sample of oocyte diameters. In each image, stage-specific oocyte diameters were measured directly from histology slides using the image analysis software, ImageJ and ObjectJ (a plugin). The different stages were marked on the photomicrograph with different colors: primary growth (red), cortical aleolar (green), early vitellogenic (V1; black), and fully vitellogenic (V2; yellow). Only non-overlapping oocytes with the nucleus visible were measured, targeting 100 oocytes measured per female. Early cortical and late cortical were lumped together for this exercise, as they were difficult to distinguish at this magnification.

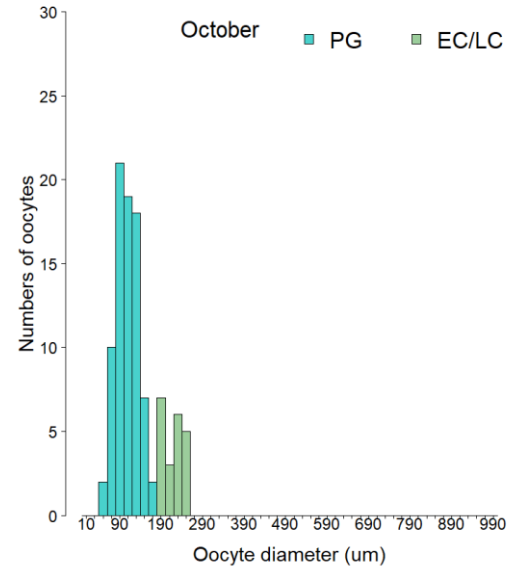
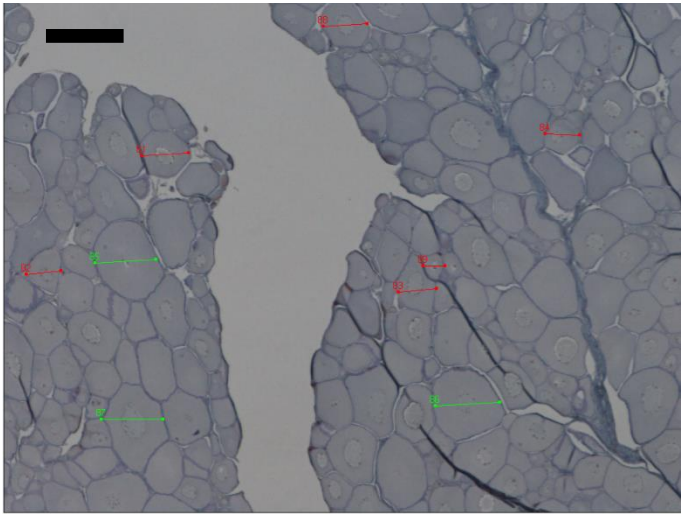
The stage-specific oocyte diameters were plotted as a histogram using analytical software (R Studio).

Fish samples depicted here were captured by participating members of the Cape Cod Commercial Fishermen's Alliance (CCCFA).

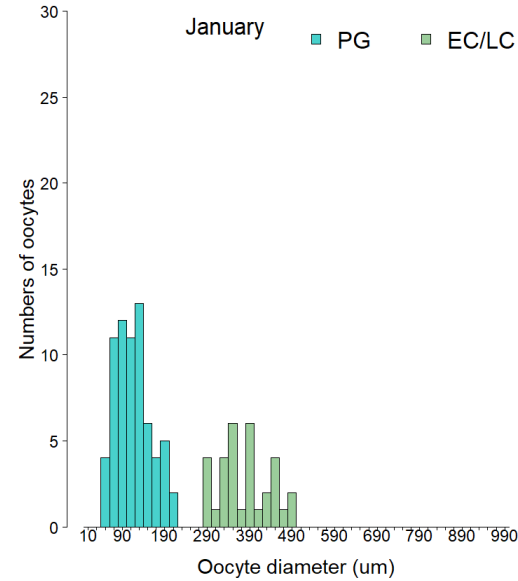
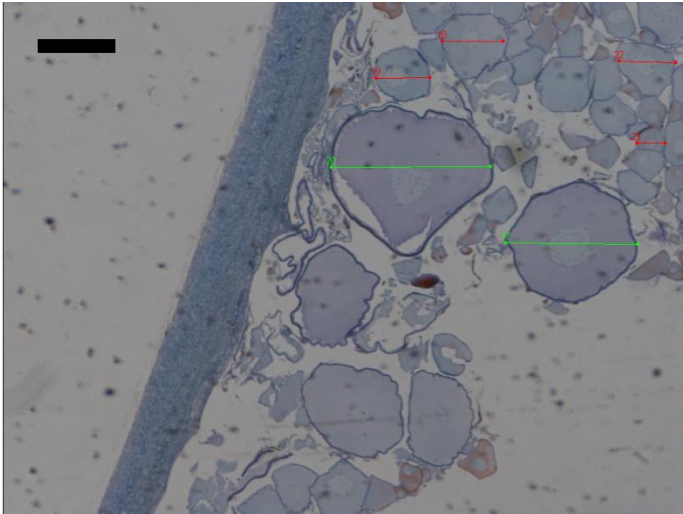
Fish HHSK07011804 (HHSK181) is an **immature** female (86 cm TL, 5 years) collected on July 1, 2018, by gillnet. It has a GSI = 0.28 (total weight, 6.8 kg; gonad weight 18.9 g). It has a most advanced oocyte stage of PG (primary growth), which measure < 0.20 mm in diameter, and gonad wall thickness = 0.14 mm.



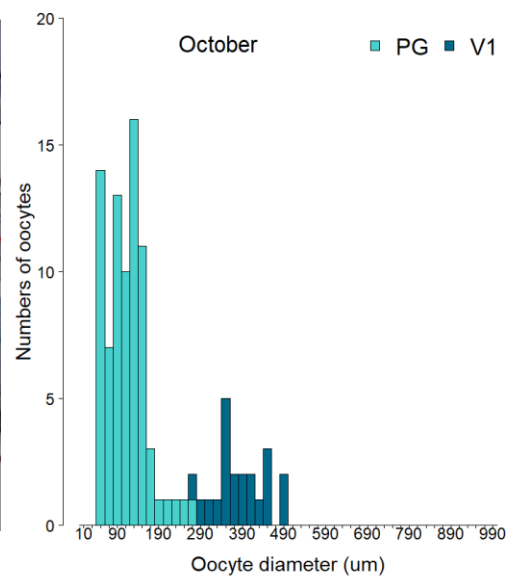
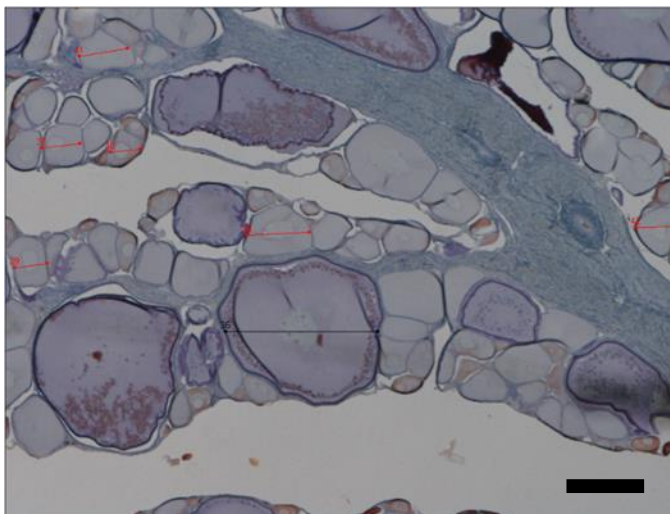
Fish HHSK10111701 (HHSK087) is an **immature, maturing** female (113 cm TL, 7 years) collected on October 11, 2017, by bottom trawl. It has a GSI = 0.43 (total weight, 15.4 kg; gonad weight, 65.6 g). It has a most advanced oocyte stage of EC (early cortical alveoli), which measure < 0.30 mm in diameter, and a gonad wall thickness = 0.16 mm.



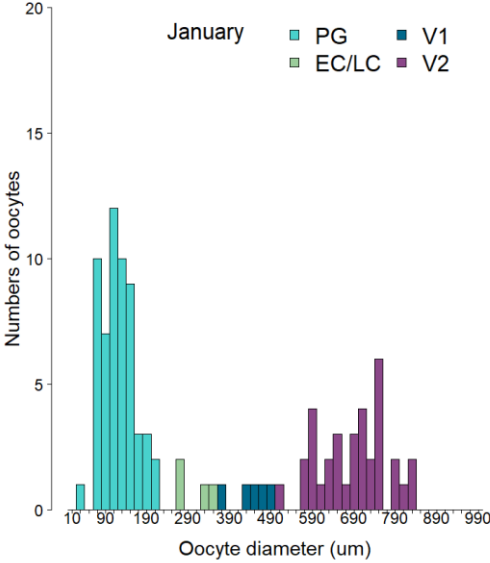
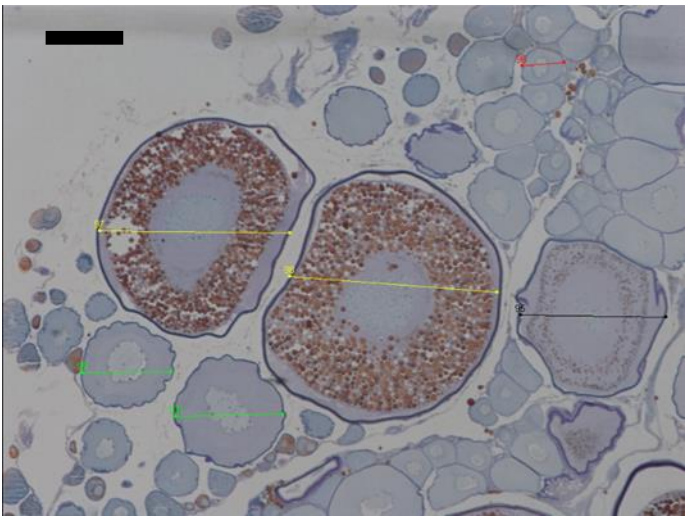
Fish HHSK01221802 (HHSK108) is an **immature, maturing** female (128 cm TL, 10 years) collected on January 22, 2018, by gillnet. It has a GSI = 0.57 (total weight, 22.7 kg; gonad weight, 128 g). It has a most advanced oocyte stage of LC (late cortical alveoli), which measure < 0.50 mm in diameter, and a gonad wall thickness = 0.23 mm.



Fish HHSK10191703 (HHSK085) is a **skip spawning** female (117 cm TL, 9 years) collected on October 19, 2017, by gillnet. It had a GSI = 0.95 (total weight 20.4 kg, gonad weight 191 g). It has a most advanced oocyte stage of V1 (early vitellogenesis), which measure < 0.50 mm in diameter, and a gonad wall thickness = 0.90 mm.



Fish HHSK01221801 (HHSK104) is a **developing** female (159 cm TL, 11 years) collected on January 22, 2018, by gillnet. It has a GSI = 1.6 (total weight, 40.8 kg; gonad weight, 643 g). It has a most advanced oocyte stage of V2 (late vitellogenesis), which measure < 0.90 mm in diameter, and a gonad wall thickness = 0.82 mm.



Fish HHSK06301802 (HHSK225) is a **developing** female (140 cm TL, 12 years) collected on June 30, 2018, by gillnet. It has a GSI = 2.9 (total weight, 39 kg; gonad weight, 1,115 g). It has a most advanced oocyte stage of V2 (late vitellogenesis), which measure < 1.0 mm in diameter, and a gonad wall = 0.93 mm.

