APPENDIX 1

MARINE HEATWAVES

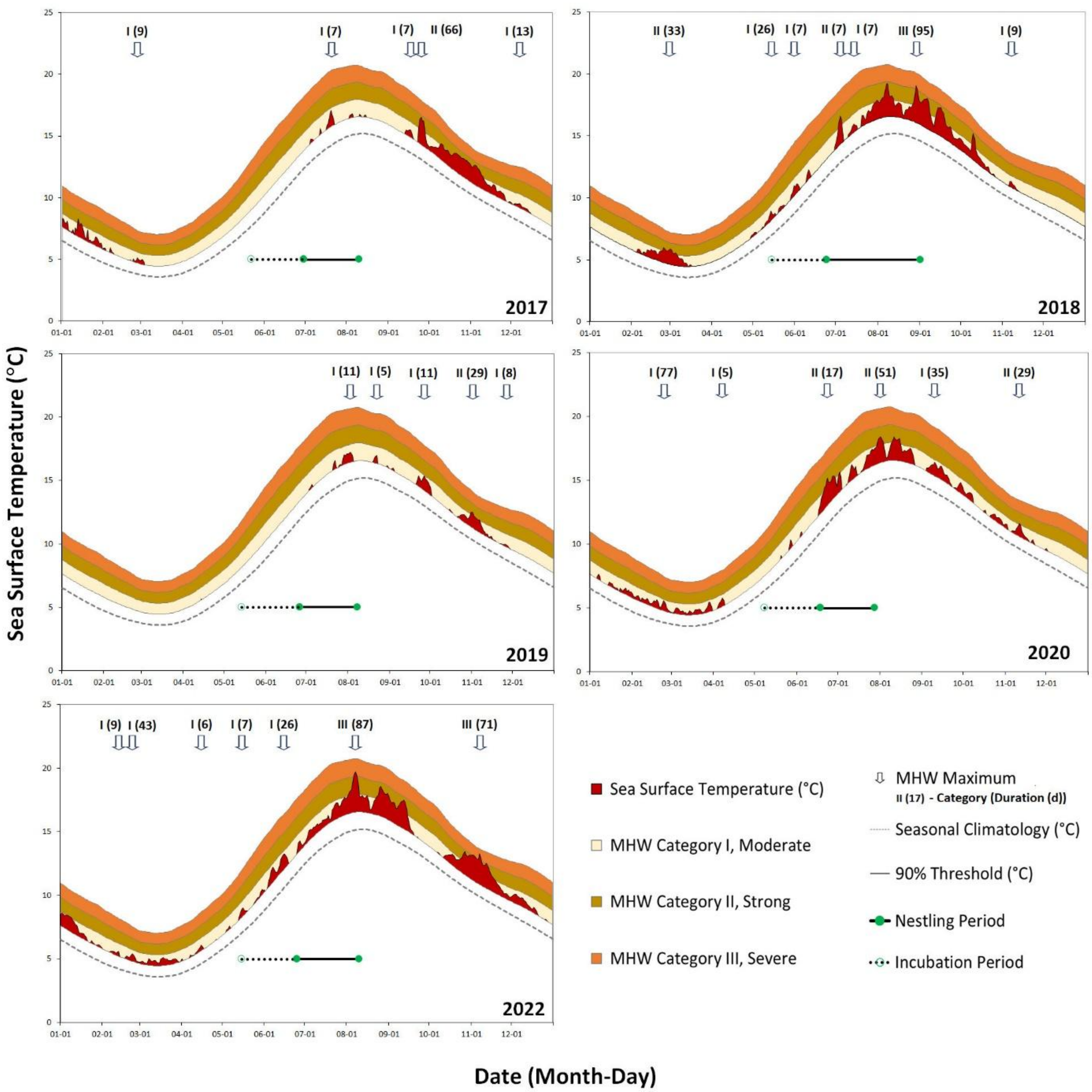

Fig. A1. Marine heatwaves (MHW) in the study years 2017-2020 and 2022, with categories indicated. For each year, incubation and nestling periods are displayed to show the temporal overlap with MHWs. The 30-year temperature climatology is based on the period 1982-2011.

Methods

The development of the OISST.V2.1 data product is explained in Reynolds et al. (2007) and Banzon et al. (2022). Extracting MHW data is explained in Schlegel and Smit (2018).

Output metrics for MHWs include: the start, end and peak dates, duration (d), mean intensity (average SST anomaly over the duration of the MHW; °C), and maximum intensity (highest SST anomaly of the MHW; °C).

Marine heatwave categories

MHWs are classified into four categories, based on maximum observed intensity (Hobday et al., 2018; Schlegel & Smit, 2018).

C = 30-year climatology (°C)
T = 90th percentile threshold (°C)
$\Delta t = T\text{-}C$ (°C)
I = Maximum intensity of MHW (°C)

TABLE A1-1. MARINE HEATWAVE CATEGORIES AND DESCRIPTIONS

Category	Temperature range of daily maximum intensity (*I*)	Description[a]
I Moderate	Between T and $(T + \Delta t)$	Common and have the least impact
II Strong	Between $(T + \Delta t)$ and $(T + 2\Delta t)$	Not uncommon. Causes biological or ecological damage, but impact may not be long-term
III Severe	Between $(T + 2\Delta t)$ and $(T + 3\Delta t)$	Relatively uncommon and linked to damaging events
IV Extreme	Between $(T + 3\Delta t)$ and $(T + 4\Delta t)$	Rare, but can cause widespread and lasting ecological damage

[a] Source: https://robwschlegel.github.io/heatwaveR/articles/event_categories.html

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QUANTIFYING PREY BIOMASS

We quantified prey biomass throughout the nestling period using the length-weight relationship for fish (Keys, 1928).

The relationship is defined by:

$$\ln W = \ln a + b \ln L$$

where W = weight (kg), L = length (cm), a and b are pre-determined parameters specific to individual species.

Parameters a and b for most prey were retrieved from Wigley *et al*. (2003). Other sources for species not included in Wigley *et al*. (2003) were: Sandlance *Ammodytes* spp. from Winters (1989); Atlantic Saury *Scomberesox saurus* from Dudnik et al. (1981); Squid, assumed to be Shortfin Squid *Illex illecebrosus*, from Lange and Johnson (1981). Unidentified species were assigned the parameters of the most common prey, hake, assumed to be White Hake *Urophycis tenuis* (Kress et al., 2016).

We estimated the length of each prey item from screen captures of each fish delivery (n=245), by comparing the length of the fish to the length of the adult puffin bill, assumed to be three centimeters (Barrett et al., 1985; Harris, 1979). We estimated a value for L and thence, the value of W.

Species	**ln a**	**b**	**Other formulae**
Hake *Urophycis tenuis*	-12.95	3.2903	
Haddock *Melanogrammus aeglefinus*	-11.8062	3.0766	
Butterfish *Peprilus triacanthus*	-11.6824	3.293	
Shortfin Squid *Illex illecebrosus*	-3.85026	2.98298	
Sandlance *Ammodytes americanus*			W (g) = 0.0000015 ($L(mm)^{3.13}$)
Saury *Scomberesox saurus*			W (g) = 0.003328 ($L(cm)^{3.0045}$)

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