Abiotic Drivers of Catches of Nearshore Fishes in a Changing Arctic

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Introduction

- Nearshore fishes are ecologically and socioeconomically vital in the Arctic
- Warming, ocean acidification (OA), freshening, and de-oxygenation are occurring
- Findings of the Beaufort Sea Nearshore Fish Monitoring Study suggests fish communities are changing [5]
- Information on impacts of climate change, especially OA on Arctic fishes is limited
- Little data exists on the *in-situ* habitat preferences of nearshore Arctic fishes

Our main objectives were to 1) characterize the habitat preference ranges of nearshore fishes with an emphasis on pH, and 2) understand how the nearshore environment influences daily fish catches.

Methods

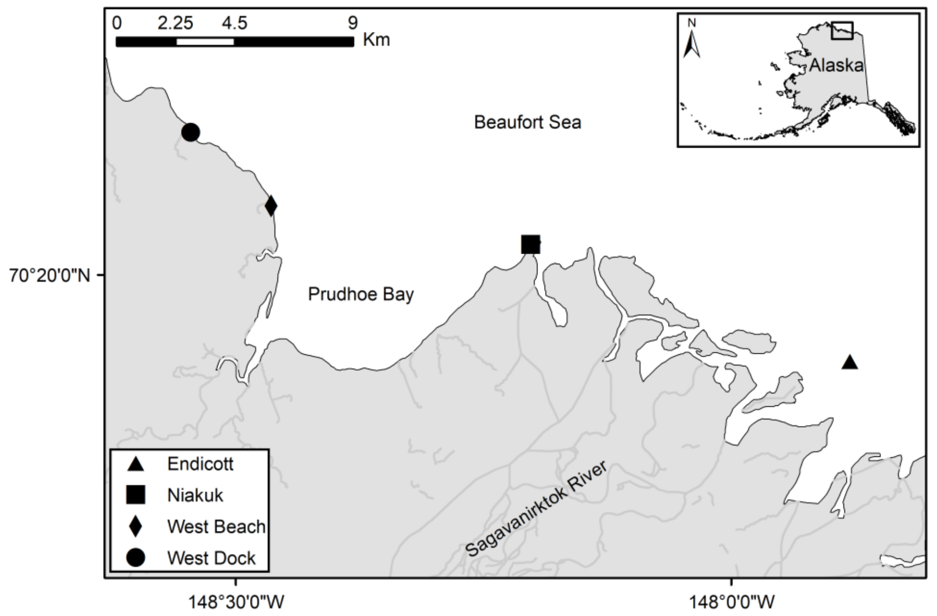

Figure 1. Overview map of Beaufort Sea Nearshore Fish Monitoring Study sites in the Beaufort Sea, Alaska.

Sites

- Endicott (brackish) and West Dock (marine) selected for study

Oceanographic sampling

- Oceanographic sensors moored to fyke nets (Figure 2)
  - SeaFET™ pH sensor (pH and temperature)
  - Onset HOBO conductivity logger (salinity)
  - PME miniDOT optical oxygen logger (oxygen)
  - Hourly samples between 2 July 2019 and 21 August 2019
- Data analyzed according to best practices in chemical oceanography, and standard operating procedures [1,2,3]

Fish sampling

- Fish were sampled (Figure 2) at each site daily using side-by-side fyke nets
- Blocker nets (Figure 2) directed fish swimming bi-directionally into the openings

Data analysis

- Generalized linear models (GLM)
  - Binomial error family and logit link
  - Response variable: daily fish presence/absence
  - Predictor variables: daily average pH, temperature, salinity, DO, and site (as factor)
- Backwards elimination was used to arrive at final models ($\alpha = 0.05$)

Figure 2. Kyle Gatt and Jerrod Lepper sampling fish (left), blocker net orientation (middle), and oceanographic mooring installation (right).

Results

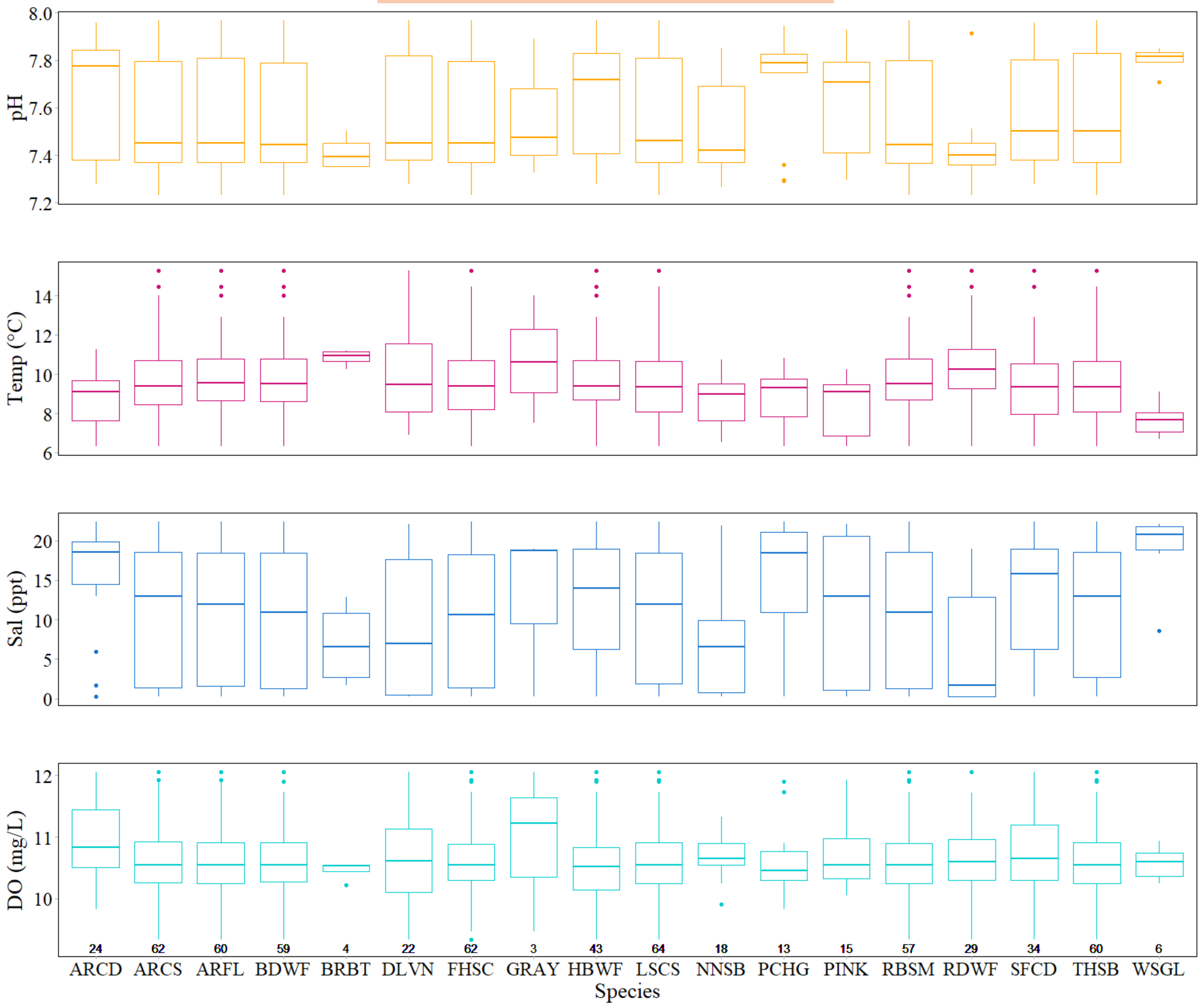

Figure 3. Boxplots summarizing the environmental conditions at which each species identified was present. Solid bars represent the median, while the upper and lower margins of the boxes represents the interquartile range (25th to 75th percentile). Whiskers represent values outside of the interquartile range and dots represent outliers. Sample sizes on the lower margins of the figure denote the number of days a given species was observed present over the study period. Species codes given in Table 4.

Table 1. Species codes used in Figure 3.

Common Name	Code	Common Name	Code
Arctic cod	ARCD	Least cisco	LSCS
Arctic cisco	ARCS	Ninespine stickleback	NNSB
Arctic flounder	ARFL	Pacific herring	PCHG
Arctic grayling	GRAY	Pink salmon	PINK
Broad whitefish	BDWF	Rainbow smelt	RBSM
Burbot	BRBT	Round whitefish	RDWF
Dolly varden	DLVN	Saffron cod	SFCD
Fourhorn sculpin	FHSC	Threespine stickleback	THSB
Humpback whitefish	HBWF	Whitespotted greenling	WSGL

Table 2. GLM model results for species with significant covariates.

Species	Covariate	Coefficient ± S.E.	*P*	Deviance Explained
Arctic cod	Salinity	0.17 ± 0.05	0.00	33.5
	Dissolved Oxygen	1.84 ± 0.78	0.02	
Arctic flounder	Temperature	2.39 ± 0.87	0.01	55.8
Broad whitefish	Temperature	0.76 ± 0.34	0.03	17.4
Humpback whitefish	Temperature	0.44 ± 0.19	0.02	15.1
	Site (West Dock)	2.22 ± 0.74	0.00	
Ninespine stickleback	Salinity	-0.15 ± 0.05	0.00	21.8
	Temperature	-0.62 ± 0.21	0.00	
Pacific herring	pH	-9.94 ± 5.08	0.05	18.5
	Site (West Dock)	6.47 ± 2.54	0.01	
Pink salmon	Temperature	-0.51 ± 0.20	0.01	11.3
Rainbow smelt	pH	50.97 ± 24.20	0.04	61.7
	Salinity	0.92 ± 0.41	0.02	
	Site (West Dock)	-37.60 ± 16.66	0.02	
Round whitefish	Site (West Dock)	-4.43 ± 1.09	0.00	44.4
Saffron cod	Temperature	0.69 ± 0.26	0.01	15.0
	Dissolved Oxygen	2.68 ± 0.99	0.01	
	Site (West Dock)	1.71 ± 0.75	0.02	
Whitespotted greenling	Temperature	-1.22 ± 0.45	0.01	28.6

Table 3. Summary statistics for hourly measurements of environmental variables taken during the study period.

	Endicott			West Dock		
	Mean ± SD	Median	Range	Mean ± SD	Median	Range
pH	7.37 ± 0.11	7.4	6.92 - 7.63	7.84 ± 0.09	7.83	7.5 - 8.14
Temp (ºC)	9.94 ± 2.22	9.75	5.85 - 17.18	8.69 ± 1.7	8.68	1.21 - 13.29
Sal	6.63 ± 7.99	1.73	0.2 - 25.8	15.14 ± 6.72	17.14	0.69 - 30.64
DO (mg/L)	10.65 ± 0.67	10.62	8.96 - 13.98	10.51 ± 0.58	10.42	9.2 - 13.37
pH Uncert.	0.17			0.27		

Results cont. & Discussion

- Habitat preference is highly variable between species
- All covariates were associated with daily presence of at least one species
- Results are consistent with the literature, such as Pacific herring sensitivity to low pH [4]
- Generalist fishes, such as saffron cod may be resilient to future conditions
- Future work should emphasize a holistic approach to understanding species responses to climate change, such as including pH

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Citations

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