

# **Seabird Predation on Butterfish in the Northeast, a Summary of Available Information**

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## **Background**

This information was compiled for the NOAA 2021 Butterfish stock assessment working group, research track (BSAWGRT), to address in part the requirements of the Additional Terms of Reference (A-TOR) number two:

“Evaluate consumptive removals of butterfish by its predators, including (if possible) marine mammals, seabirds, tunas, swordfish and sharks. If possible, integrate results into the stock assessment.”

This document summarizes the available information relevant to recent and on-going efforts to assess seabird predation on forage fish in the northeast, specifically butterfish.

## **Methods**

Various sources documenting seabird predation on butterfish were referenced including peer reviewed publications, research presentation files, and interviews with principal investigators responsible for historic and current studies assessing seabird predation on forage fish in the northeast, primarily the Gulf of Maine region. Information obtained was documented in a presentation provided during the BSAWGRT meeting held in December 2021. This presentation is archived in the BSAWGRT online folder coordinated by the National Marine Fisheries Service, Northeast Fisheries Science Center. The following represent the primary groups conducting seabird predation and diet studies in the northeast and Gulf of Maine region, and the sources of information for this document:

1. U.S. Fish and Wildlife Service and National Audubon Society Joint Seabird Restoration Program in the Gulf of Maine– Linda Welch (Audubon/USFWS)
2. Cornell Lab of Ornithology – Gemma Clucas(Cornell)
3. University of New Hampshire, Isle of Shoals Laboratory - Olivia Smith and Elizabeth Craig (UNH)
4. Atlantic Laboratory for Avian Research, University of New Brunswick - Lauren Scopel (UNB)

The primary focus of these groups is to assess diet and success rates for nesting seabird populations over time, with more recent accounting of climate impacts on fish species range and occurrence, and corresponding shifts in prey species composition and availability of prey species preferred by nesting seabirds. These studies focused primarily on two types of nesting bird species, terns (common, arctic, least, and roseate), Alcids (razorbills, and Atlantic puffins), which nest on islands in the Gulf of Maine and Long Island Sound area. The time periods for studies conducted by the groups listed above varied, with USFWS and Audubon collaborating on a study that has been ongoing for approximately 30 years; UNB 1995-2017; UNH 1999 to present; and more recently Cornell 2015 to present. The table below presents monitoring by site and year through 2017 for the USFWS and Audubon collaboration, although sampling has

continued through 2021 at these sites, and three additional sites (Petit Manan, Ship, and Metinic Islands) now have predation observation information in the Audubon/USFWS database.

Island	Island Code	Species	Time Series	No. Years of Data
Seal Island NWR	SINWR	Arctic Tern	1990 - 2017	28
		Common Tern	1992 – 1993, 1996, 2003 - 2017	18
Matinicus Rock	MR	Arctic Tern	1986 - 2017	32
		Common Tern	2003 - 2017	15
Eastern Egg Rock	EER	Arctic Tern	1990-1991, 1993-1995, 2002 - 2017	20
		Common Tern	1988 – 1992, 1994 - 2017	29
		Roseate Tern	1990 – 1995, 1999 - 2017	25
Pond Island NWR	PINWR	Common Tern	1999 – 2010, 2012 - 2017	18
Jenny Island	Jl	Common Tern	1991 - 2017	27
		Roseate Tern	2007, 2012, 2016 - 2017	4
Outer Green Island	OGI	Common Tern	2003 - 2017	15
		Roseate Tern	2005, 2007	2
Stratton Island	STI	Common Tern	1988 – 1992, 1994 - 2017	29
		Least Tern	2006 – 2014, 2016 - 2017	11
		Roseate Tern	1990, 1993, 1995, 1999 – 2002, 2004, 2006 - 2017	20
All Data			1986 - 2017	293

Table 1. Summary of Audubon and USFWS seabird predation monitoring in the Gulf of Maine by species, location and year. Source: Keenan Yakola, 2019.

## Results

Seabird predation on butterfish varies by site and year, yet observations suggest that seabird predation on butterfish in general has been low over time. Data from 2017-2018 in the Isle of Shoals Tern colonies shows a relatively high proportion of butterfish in the diets of tern adults and chicks in 2017, with a substantial decline in diet proportion in 2018 (Table 2.), while the contribution of butterfish to seabird diet over time in the Gulf of Maine is low compared to other prey species (Figures 1&2). The USFWS/Audubon long-term monitoring program concluded that in most years butterfish observed to be 1-5% of seabird diet on islands the Gulf of Maine.

Species/Age Class	FOO Butterfish
<b>2017</b>	
Common Tern Adults	35.7 %; n = 14
Common Tern Chicks	22.9 %; n = 35
Roseate Tern Chicks	7.3 %; n = 41
<b>2018</b>	
Common Tern Adults	1.8 %; n = 57
Common Tern Chicks	17.1 %; n = 41
Roseate Tern Chicks	2.1 %; n = 46

Table 2. Occurrence of Butterfish in seabird diets, Isle of Shoals, New Hampshire 2017-2018. Source: Gemma Clucas 2021.

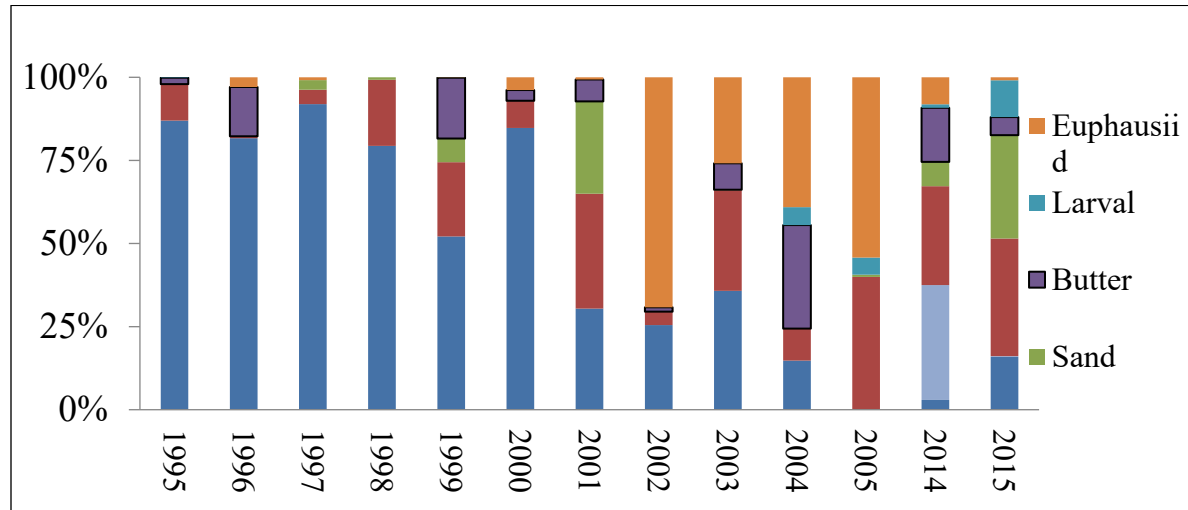


Figure 1. (Percent biomass for identified prey taxa in Arctic Tern (*Sterna paradisaea*) chick diets on MSI, 1995–2005, 2014–2015. Prey types in legend, from top, are euphausiid (northern krill (*Meganyctiphanes norvegica*)), larval fish, butterfish (*Poronotus triacanthus* = *Peprilus triacanthus*), sand lance (*Ammodytes* spp.), white hake (*Urophycis tenuis*), haddock (*Melanogrammus aeglefinus*), and Atlantic herring (*Clupea harengus*). Source: Scopel and Diamond 2018.

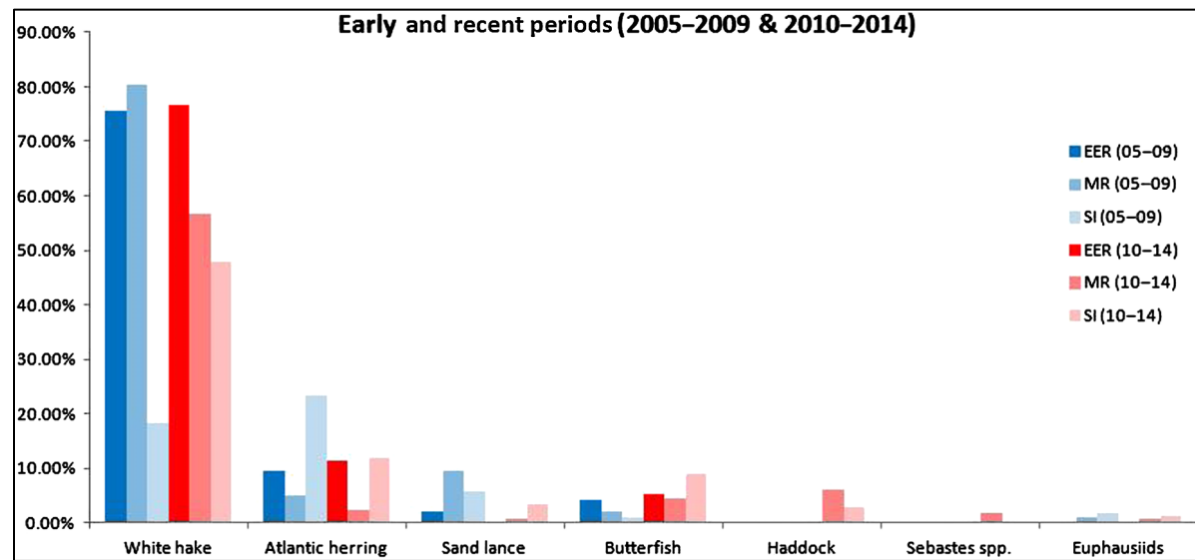


Figure 2. Median percentages of prey delivered to puffin chicks at Eastern Egg Rock (EER), Matinicus Rock (MR), and Seal Island (SI). White hake dominates the prey at all three islands, especially at EER and MR, increasing at SI in the recent half of the study. In the recent period, Atlantic herring has declined at Seal Island and Matinicus Rock, whereas butterfish, haddock, and Sebastes spp. have become more prevalent, though still less than 10% of chick diet. Source: Kress et al., 2016.

Shifts towards increasing seabird predation on butterfish are observed in more recent years in response to decreasing availability of preferred prey species (Tables 3, 4 & 5), but overall proportion of diet contribution by butterfish remains low.

Taxon	Time period	Mean (1995–2009)	Mean (2010–2017)	Change	% Contribution to group dissimilarity
Haddock/pollock	New	0.57	20.69	+20.12	9.83
Atlantic herring	Old	47.80	23.67	-24.14	8.09
Butterfish	Old	3.04	9.43	+6.39	8.08
Redfish	New	0.00	3.54	+3.54	7.95
Bluefish	New	0.01	2.02	+2.01	7.57
Rough scad	New	0.00	1.08	+1.08	7.53
Squid	New	0.16	0.88	+0.72	7.46
White hake	Old	33.18	21.79	-11.40	7.42
Atlantic saury	New	0.37	1.44	+1.06	7.37
Mackerel	New	0.00	0.52	+0.52	7.36
Euphausiids	Old	0.68	0.36	-0.33	7.17
Sand lance	Old	10.90	13.00	+2.10	7.11
Larval fish	Old	3.28	1.60	-1.68	7.06

Table 3. Relative changes in Atlantic puffin *Fratercula arctica* diets at colonies in the Gulf of Maine before and after 2010. Mean values are by percentage of total mass in the diet. Entries are ordered by their contribution to group dissimilarity. Source: Scopel et al., 2019.

Taxon	Mean (1995–2009)	Mean (2010–2017)	Change	% Contribution to group dissimilarity	Mean (MSI)	Mean (MR)	Difference
Larval fish	1.31	3.06	+1.76	21.03	3.15	0.21	2.94
Sand lance	12.60	21.04	+8.44	17.25	15.96	17.04	1.08
Atlantic herring	65.09	42.62	-22.46	15.23	63.97	39.42	24.54
Euphausiids	0.04	0.02	-0.02	13.61	0.01	0.06	0.05
Butterfish	1.48	8.75	+7.27	13.57	2.69	8.30	5.61
White hake	17.42	20.11	+2.70	10.15	13.30	28.02	14.72
Haddock/pollock	2.07	4.39	+2.32	9.16	0.92	6.95	6.03

Table 4. Relative changes in razorbill *Alca torda* diets at colonies in the Gulf of Maine (Machias Seal Island, MSI, and Matinicus Rock, MR) before and after 2010. Mean values are by percentage of total mass in the diet. Entries are ordered by their contribution to group dissimilarity. Source: Scopel et al., 2019.

Species	Eastern Egg Rock			Matinicus Rock			Seal Island		
	2005–2014	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014	2005–2014	2005–2009	2010–2014
White hake	(1) 76.64%	(1) 75.47%	(1) 76.64%	(1) 57.36%	(1) 80.38%	(1) 56.54%	(1) 38.58%	(2) 18.27%	(1) 47.88%
Atlantic herring	(2) 11.27%	(2) 9.55%	(2) 11.27%	(3) 4.01%	(3) 4.96%	2.40%	(2) 17.66%	(1) 23.44%	(2) 11.87%
Sand lance	0.29%	2.04%	0.29%	(2) 8.53%	(2) 9.47%	0.77%	(3) 4.63%	(3) 5.84%	3.41%
Butterfish	(3) 5.37%	(3) 4.20%	(3) 5.37%	2.71%	1.99%	(3) 4.44%	1.83%	0.98%	(3) 9.05%
Haddock	0.00%	0.00%	0.00%	1.03%	0.00%	(2) 6.08%	0.33%	0.00%	2.80%
<i>Sebastes</i> spp.	0.00%	0.00%	0.00%	0.00%	0.00%	1.74%	0.00%	0.00%	0.00%
Euphausiids	0.00%	0.30%	0.00%	0.74%	0.97%	0.71%	1.58%	1.88%	1.28%
Bluefish	0.29%	0.84%	0.29%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%
Atlantic mackerel	0.23%	0.19%	0.24%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Atlantic saury	0.15%	0.07%	0.26%	0.15%	0.59%	0.00%	0.00%	0.00%	0.62%
Atlantic pollock	0.32%	0.19%	0.36%	0.34%	0.34%	0.33%	0.17%	0.26%	0.10%

Table 5. Prey fed to puffin chicks at midcoast Maine colonies ranked as median percentage by number of items delivered to chicks. (#) represents rank from 1 to 3. Source: Kress et al., 2016.

Seabird adults and chick swallow their prey whole. Monitoring programs have observed that chicks are unable to consume butterfish due to the large size and shape that prevent the chicks from swallowing the fish. This results in chicks discarding the majority of butterfish delivered to nests. Therefore, seabird diet quality decreases with increased butterfish predation, relative to other prey species (Table 6).

Prey taxon	Atlantic puffin	Razorbill	Common murre	Time period	Fat content	Value
Atlantic herring	X	X	X	Old	High	Excellent
Sand lance	X	X	X	Old	High	Excellent
White hake	X	X	X	Old	Low	Moderate
Butterfish	X	X	X	Old	High	Poor
Euphausiids	X	X		Old	Low	Poor
Larval fish	X	X	X	Old	Low	Poor
Redfish	X			New	High	Excellent
Haddock/pollock	X	X	X	New	Low	Moderate
Rock gunnel			X	New	Low	Moderate
Bluefish	X			New	Low	Moderate
Atlantic saury	X			New	High?	Moderate
Rough scad	X			New	High?	Moderate
Mackerel	X			New	Low	Moderate
Squid	X		X	New	Low	Poor

Table 6. Occurrence and perceived value of prey taxa in alcid diets in the Gulf of Maine region. Value here is indicated by predicted effects on reproductive outcomes. Prey taxa that were observed throughout the time series are classified as ‘old’; taxa that first appeared or greatly increased in prominence in the diet after 2009 are considered ‘new’. Source: Scopel et al., 2019.

## Discussion

The studies reviewed for this document all had similar conclusions relative to seabird predation on butterfish in the Gulf of Maine and Northeast Region:

- Butterfish unsuitable prey for seabird chicks due to size and shape
- Adults appear to consume the same size butterfish as those they provide for chicks.
- Fecal DNA estimates may be underestimating mortality due to lack of actual consumption. Therefore, visual observations can provide more of a proxy for mortality, and fecal DNA can provide a proxy for actual diet contributions of butterfish to seabird diets
- Butterfish size estimated relative to bird bill size, which may enable biomass estimates from these data in the future, however biomass estimates are expected to be low based on proportion of diet and relevance to the total butterfish stock biomass
- All butterfish were estimated to be <10 cm in length
- Observed butterfish are a prey species for many seabirds in the Gulf of Maine, with high variability in predation among nesting colonies
- Butterfish increasing in seabird diets in Gulf of Maine, most notably since 2010
- Higher butterfish in diets correlates with higher chick mortality
- Observed low butterfish consumption and high discards due to size and inability of chicks to swallow whole butterfish
- Herring have been replaced in seabird diets by butterfish and other low quality prey species
- Climate effects on ocean temperatures decreasing preferred prey and increasing butterfish occurrence and the diet of Gulf of Maine seabirds, decreasing diet quality and increasing seabird mortality due to chicks inability to consume butterfish

## Conclusions

1. Seabird predation on butterfish is occurring in the northeast region
2. Seabird predation on butterfish in the northeast region is minimal relative to the larger butterfish population and is not a large impact on butterfish population mortality
3. Butterfish predation appears to fluctuate over time with few spikes and generally low contribution to seabird diet in Gulf of Maine seabird nest sites.
4. Butterfish is generally too large for chicks to swallow, so the fish are mostly discarded at the nest
5. Seabird predation on butterfish has increased in recent years due to reduced presence of preferred higher quality prey species in response to climate change.

## Literature Cited

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