

Tufted Puffin Monitoring Study at Haystack Rock, Cannon Beach, Oregon 2010-2021



Shawn W. Stephensen
U.S. Fish and Wildlife Service
Oregon Coast National Wildlife Refuge Complex
2127 SE Marine Science Drive
Newport, Oregon 97365

April 2022

Cite as: Stephensen, S.W. 2022. Tufted Puffin monitoring study at Haystack Rock, Cannon Beach, Oregon 2010-2021. U.S. Fish and Wildlife Service Unpublished Report, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon 97365. 30 pp.

“The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.”

EXECUTIVE SUMMARY

The Tufted Puffin (*Fratercula cirrhata*) is a medium-large pelagic seabird and member of the Auk family. The distribution of the Tufted Puffin is widespread in the North Pacific Ocean and nests on the coastline and offshore islands in California, Oregon, Washington, British Columbia, Alaska, Japan, and Russia. Tufted Puffin populations have generally declined throughout the southern portion of their range from British Columbia to northern California. The U.S. Fish and Wildlife Service conducted a Species Status Assessment for listing under the U.S. Endangered Species Act and concluded that listing the contiguous U.S. Distinct Population Segment of Tufted Puffin or the Tufted Puffin species as endangered or threatened is not warranted. Possible causes of puffin decline include factors related to conditions at breeding sites, at-sea mortality due to direct human impacts, and long-term changes in marine food webs.

The U.S. Fish and Wildlife Service conducted a burrow-nesting seabird survey that encompassed the entire coastline of Oregon in 2008 and 2021 and documented an order of magnitude decline in the puffin population since the official statewide survey in 1988. The purpose of this project was to conduct an intensive population status assessment of the Tufted Puffin at Haystack Rock (colony number 219-021), which is part of the Oregon Islands National Wildlife Refuge. The number of Tufted Puffin present at Haystack Rock was documented during 2010-2021 by conducting instantaneous counts of birds on the land, water, and in the air at 15-minute intervals. The daily mean counts were 42, 33, 13, 35, 22, 21, 23, 18, 26, 18, 15, and 17 birds during 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, and 2021 respectively. Burrow occupancy was determined and the annual breeding population estimate was calculated based on the number of viable occupied burrows times two. We estimated the Tufted Puffin breeding population (individual birds) at Haystack Rock to be 127 in 2010, 115 in 2011, 92 in 2012, 143 in 2013, 125 in 2014, 121 in 2015, 124 in 2016, 109 in 2017, 127 in 2018, 127 in 2019, 98 in 2020, and 98 in 2021. The breeding phenology of the Tufted Puffin at Haystack Rock was determined by bird behavior, bird abundance, and colony attendance patterns. Breeding phenology began with prospecting in early May and ended with fledging by late August. Current data suggest Haystack Rock supports the second largest puffin colony in Oregon due to declines at other sites along the coast. However, other historical Tufted Puffin nesting sites with large breeding populations have not been monitored to the extent as Haystack Rock.

Continued studies of the Tufted Puffin at Haystack Rock are necessary to support adaptive management decisions on the Oregon Islands National Wildlife Refuge as specific goals, objectives, and strategies are identified in the Oregon Islands National Wildlife Refuge Comprehensive Conservation Plan.

INTRODUCTION

The Tufted Puffin (*Fratercula cirrhata*) is a member of the Auk (Alcidae) family and is one of three puffin species that make up the *Fratercula* genus. It is a medium-large pelagic seabird that is approximately 40 cm in length and weighs 775 g. Breeding-plumage adults have black-brown bodies and a white face-mask with long golden head-plumes that drape down the neck. The laterally compressed triangular orange bill has variable number of grooves on the upper mandible and bright orange rictal rosettes at the base of gape. Legs and feet are bright yellowish-orange to reddish (Piatt and Kitaysky 2002). Its bright colors have earned the Tufted Puffin the nickname, “parrot of the sea,” and are highly favored among ornithologists and bird watchers.

The distribution of the Tufted Puffin is widespread in the North Pacific Ocean, from mid-transition zone (about 35° N) to the Beaufort Sea (Udvardy 1963). The Tufted Puffin has an extensive breeding range and nests on the coastline and offshore islands in California, Oregon, Washington, British Columbia, Alaska, Japan, and Russia. The total world population estimate is 2,970,000 breeding birds, of which 82% (2,440,000) breed in North America (Piatt and Kitaysky 2002, Hanson and Wiles 2015). Most of the North American breeding population occurs in Alaska at 693 colonies with 2,280,000 birds (USFWS 2013). The Oregon population was estimated at 4,600 individual birds (Naughton et al. 2007), however, in recent years the Tufted Puffin population has declined dramatically.

Tufted Puffin populations have generally declined throughout the southern portion of their range from British Columbia to northern California, during the past twenty years (Piatt and Kitaysky 2002). The Tufted Puffin was listed as Endangered in Japan in 1993 (Osa and Watanuki 2002). Environment Canada included Tufted Puffin as a Priority Species in the North Pacific Rainforest Bird Conservation Strategy in 2013 (Environment Canada 2013), and British Columbia increased the conservation status of breeding populations from Vulnerable to Imperiled/Vulnerable in 2015 (B.C. Conservation Data Center 2018). Possible causes of puffin decline include factors related to conditions at breeding sites, at-sea mortality due to direct human impacts such as net bycatch and oil spills, and long-term changes in marine food webs that affect reproductive success, winter survival, and distribution (Piatt and Kitaysky 2002, Gjerdrum et al. 2003). Basic information on puffin breeding status in the lower Columbia River coastal region is needed to fill a large data gap for this species in the Northeast Pacific Ocean California Current System.

The Tufted Puffin is listed as Endangered in Washington State, Sensitive in Oregon, and a Species of Special Concern in California (Pearson et al. 2018). In addition, it was petitioned for listing under the U.S. Endangered Species Act and the U.S. Fish and Wildlife Service (USFWS) found that the petition presented substantial information. As a result, a Species Status Assessment was completed (USFWS 2020). The Service concluded that listing the contiguous

U.S. Distinct Population Segment of Tufted Puffin or the Tufted Puffin species as endangered or threatened is not warranted (85 FR 78029). A detailed discussion of the basis for this finding can be found in the Tufted Puffin Species Status Assessment and other supporting documents.

The Oregon Islands and Three Arch Rocks National Wildlife Refuges, managed by the U.S. Fish and Wildlife Service, consist of 1,863 rocks, reefs, and islands and spans 320 miles (~88%) of the Oregon coast. Nesting seabird colonies are the most distinctive biological feature of the Oregon Islands providing nesting habitat for 1.3 million seabirds of 15 species (Naughton et al. 2007, Boone 1985). The Tufted Puffin is a diurnally active cavity nesting seabird species that raises its young on a few vegetated islands along the Oregon coast. The estimated Tufted Puffin breeding populations documented during the Oregon coast wide surveys in 1979, 1988, 2008, and 2021 were 6,632 individual birds at 38 colonies, 4,858 individual birds at 49 colonies, 142 individual birds at 15 colonies, and 553 individual birds at 17 colonies respectively (Stephensen 2022, Kocourek et al. 2009). Historically, Finley Rock at Three Arch Rocks National Wildlife Refuge was the largest Tufted Puffin colony on the Oregon Coast and supported 2,700 breeding birds (Naughton et al. 2007). Haystack Rock at Cannon Beach, one of the islands within the Oregon Islands National Wildlife Refuge, historically supported the second largest puffin breeding colony in Oregon with 612 individual birds (Naughton et al. 2007). However, an order of magnitude decline has been documented at these sites since the 1988 coast wide survey. Wildlife inventory and monitoring surveys are necessary to support adaptive management decisions on the Oregon Islands and Three Arch Rocks National Wildlife Refuges. Specific goals, objectives, and strategies are identified in the Comprehensive Conservation Plan to aid in the preservation of these islands and associated wildlife (USFWS 2009).

The purpose of this project was to conduct an intensive population status assessment of the Tufted Puffin at Haystack Rock, Cannon Beach. To quantify annual breeding population size, observations of puffins outside their burrows occurred throughout several annual breeding seasons. Total numbers of puffins attempting to nest were based on the number of active or occupied burrow sites used during an intensive census period in early spring and summer when puffins are most visible. All active burrow sites were mapped on photographic images of the island. This method provided a more accurate measure of population size than previous estimates that were largely based on instantaneous counts of individual birds. The “occupied burrow” method was used to refine population estimates at Castle Rock National Wildlife Refuge from shore (Jaques and Strong 2001) and is the standard methodology used to census puffins at Southeast Farallon Island National Wildlife Refuge (R. Bradley, PRBO Conservation Science, pers comm.). The occupied burrow count method to estimate the burrow nesting seabird breeding population is the preferred protocol used in many seabird management plans (USFWS 2005, Walsh et al. 1995, Williams et al. 2000, Nelson et al. 2009). Instantaneous counts of puffins on the island, repeated throughout the breeding season, were also completed to compare with previous census data.

Haystack Rock is connected to the mainland during low tides, therefore, observations necessary to evaluate puffin burrow occupancy, breeding phenology, and reproductive performance can be conducted by observing bird behavior outside their burrows from shore-based stations. Puffin monitoring at other breeding colonies on the west coast takes place by researchers working directly on the islands. In Oregon, there are no known puffin colonies where research can occur on-site without causing unacceptable levels of disturbance to other surface and burrow-nesting seabirds due to the small size of the rocks and islands. The type of information that can be collected during this project is critical to refining the recent puffin breeding population estimate at Haystack Rock. This project may also result in the development of a viable long-term monitoring program at the site, which would greatly facilitate understanding of the influence of various environmental factors, such as changes in the status of forage fishes and zooplankton guilds on Tufted Puffin population trends in northern Oregon.

This project was the first time that any puffin colony in northern Oregon was monitored throughout the breeding season and from shore. The project serves as a pilot study to determine if citizen science, in association with the Haystack Rock Awareness Program (HRAP) and Friends of Haystack Rock (FOHR), can be effectively utilized to assist in long-term monitoring of the species at the site. Monitoring was accomplished by recruiting volunteers to work with the primary observer during the multi-year study.

METHODS

Study Area

Haystack Rock is located on the north coast of Oregon at 45° 53' 4" North latitude and 123° 58' 6" West longitude, 2.4 km south of downtown Cannon Beach, but within the city limits, and approximately 130 km northwest of Portland (Figure 1). Haystack Rock is a 72 meter tall sea stack located near shore, (Figure 2) and has been assigned the seabird colony number 219-021 in the Catalog of Oregon Seabird Colonies (Naughton et al. 2007).

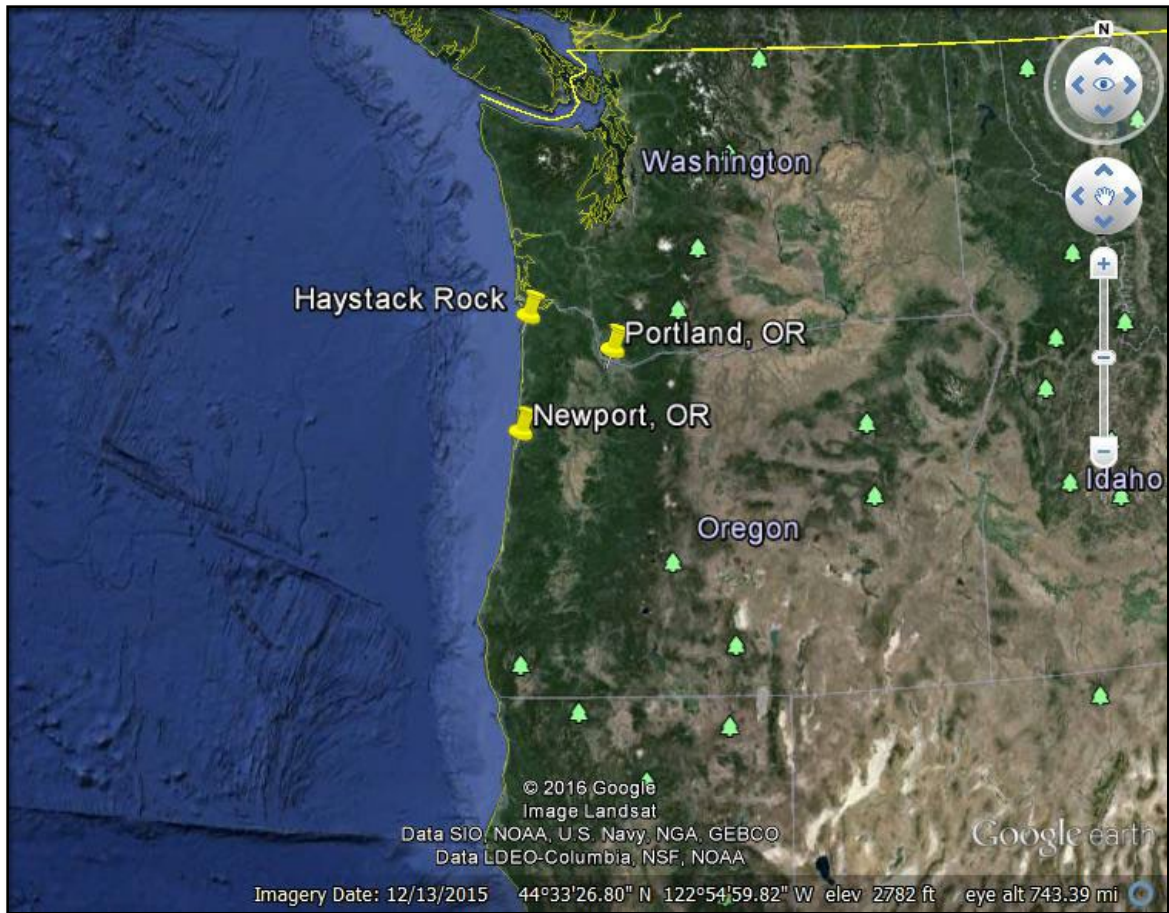


Figure 1. Map of the Oregon Coast showing the location of Haystack Rock at Cannon Beach.



Figure 2. Aerial photograph of Haystack Rock at Cannon Beach taken 03 June 2013.

Instantaneous Counts

The number of Tufted Puffins present at Haystack Rock was documented during the 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, and 2021 breeding seasons. Observers were positioned on shore approximately 100 meters northeast of Haystack Rock near the water's edge. Instantaneous counts of Tufted Puffins on the land, water, and in the air were conducted at 15-minute intervals. Counts were conducted opportunistically and usually occurred four days each week from mid-May to early September and during the morning hours when birds were most active (peak activity period). Canon 10x42 Image Stabilizer binoculars and a Swarovski Habicht ST80 HD 80mm 20-60X zoom spotting scope were used to identify individual birds. Miscellaneous notes including weather, general observation conditions, start and end times, tide, and disturbance events were recorded, but not included in this report. All observation data were recorded onto a datasheet (Appendix 1) during the survey and entered into an Excel spreadsheet or Survey123 App. The datasheets and Excel files are archived at the Oregon Coast National Wildlife Refuge Complex office in Newport, Oregon for future reference.

Burrow Occupancy

Haystack Rock was photographed with a Canon EOS 5D Mark II digital camera with a Canon Ultrasonic 20-35 mm lens from the instantaneous counts observation location in May 2010-2021. The series of digital photographs were merged using Adobe Photoshop CS4 software and a section grid was overlaid on the digital photograph (Figure 3). The section grid overlay was used to better define rock sections and to aid placement of identified burrows. A single digital photograph with no grid overlay was used in some years. A Canon 10x42 Image Stabilizer binoculars and a Swarovski Habicht ST80 HD 80mm 20-60X zoom spotting scope were used to identify individual burrows and associated birds. Tufted Puffin behavior was recorded and the burrows labeled as investigated (bird associated with burrow) or occupied (bird entered, exited, or sat in front of the burrow). Each investigated or occupied burrow was assigned an identification number that consisted of the grid section letter and a unique burrow number. When the grid overlay was not utilized, only a unique burrow number was used. All burrow occupancy data were recorded onto a datasheet (Appendix 2) during the survey and entered into an Excel spreadsheet or Survey123 App. The datasheets and Excel files are archived at the Oregon Coast National Wildlife Refuge Complex office in Newport, Oregon for future reference.

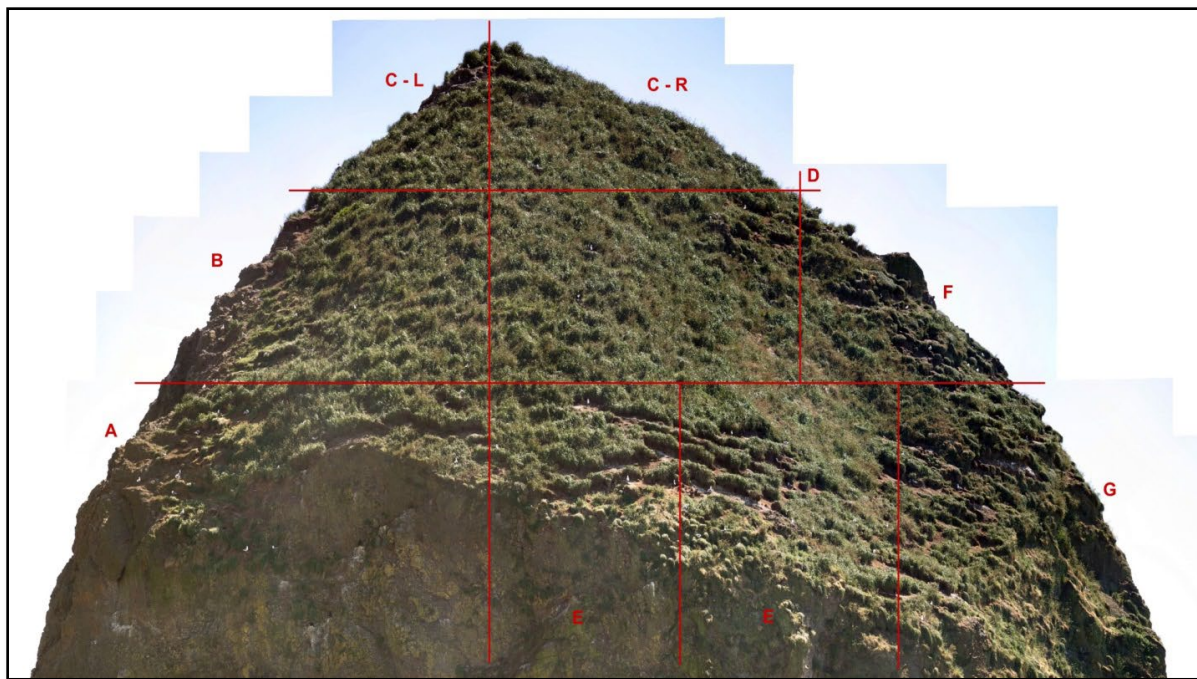


Figure 3. Digital photograph of Haystack Rock with section grid overlay.

Breeding Population Estimate

The annual individual bird breeding population estimate was calculated by multiplying the midpoint of the range of viable occupied burrows by two. A burrow had to be identified as “occupied” for a minimum of five weeks throughout the breeding season to be considered a viable breeding site for a puffin pair. The range of viable occupied burrows was equal to the number of burrows occupied for five and six weeks. The midpoint of the viable occupied burrow range (which represents breeding pairs) was multiplied by two to estimate the number of breeding individuals of each year.

The west side of Haystack Rock was not viewable from shore and was surveyed by boat in 2010, 2013, 2016, 2019, and 2021. The USFWS 26 ft. Boston Whaler was launched from Garibaldi Marina and traveled to Haystack Rock. The boat was positioned approximately 75 meters west of Haystack Rock and observers used binoculars to count occupied burrows and determine bird behavior.

Breeding Phenology

The breeding phenology of the Tufted Puffin was determined by bird behavior, bird abundance, and colony attendance patterns. Timing and duration of specific events (e.g. prospecting, egg-laying, incubation, hatching, or chick-rearing, and fledging) was determined by thorough literature review (Boone 1985; Piatt and Kitaysky 2002; Udvardy 1963) and compared to bird behavior and abundance at Haystack Rock.

Gaps in Data

In 2020, there is a gap in data. Between May 28 and June 11, observations were informal and gathered while the observer was volunteering at the tide pools. There is then a total gap in data until July 9, when consistent observations begin.

RESULTS

Instantaneous Counts

The weekly peak instantaneous counts (largest number of individual birds observed at once during a one-week period) were tallied (Table 1). The greatest difference in instantaneous counts was shown in 2010 when daily peak count ranged from 7 birds at the end of August to 99 birds mid-July. The largest mean peak instantaneous count occurred in 2010 with 42 birds and the lowest occurred in 2012 with 13 birds (Table 2).

Peak bird abundance was detected during the second through fourth week of July each year except 2014, 2017, 2018, and 2019, when peak bird abundance was detected during the first weeks of August (Figure 4; Table 1). These data suggest July and August is the chick-rearing period when both adults spend more time outside the burrow and are actively seeking prey to sustain themselves and their chicks. During peak colony attendance, large numbers of birds may gather on water and socialize before visiting breeding sites on land.

Table 1. Weekly peak instantaneous counts of Tufted Puffins at Haystack Rock each week during the 2010-2021 observation periods (USFWS unpublished data).

2010		2011		2012	
May 16-22	37	May 15-21	7		
May 23-29	36	May 22-28	18	May 20-26	4
May 30-June 05	32	May 29-June 04	28	May 27-June 02	9
June 06-12	24	June 05-11	31	June 03-09	2
June 13-19	29	June 12-18	19	June 10-16	9
June 20-26	19	June 19-25	36	June 17-23	
June 27-July 03	38	June 26-July 02	34	June 24-30	18
July 04-10	48	July 03-09		July 01-07	26
July 11-17	78	July 10-16	18	July 08-14	32
July 18-24	99	July 17-23	67	July 15-21	22
July 25-31	70	July 24-30	75	July 22-28	14
Aug 01-07	58	July 31-Aug 06	30	July 29-Aug 04	21
Aug 08-14	38	Aug 07-13	49	Aug 05-11	17
Aug 15-21	35	Aug 14-20	30	Aug 12-18	15
Aug 22-28	21	Aug 21-27	55	Aug 19-25	5
Aug 29-Sept 04	7	Aug 28-Sept 03	26	Aug 26-Sept 01	1
		Sept 04-10	3	Sept 02-08	1
Mean	42		33		13

Table 1 (cont.).

2013		2014		2015	
		May 04-10	30		
		May 11-17	25	May 10-16	11
		May 18-24	17	May 17-23	17
		May 25-31	15	May 24-30	23
June 02-08	25	June 01-07	16	May 31-June 06	No Data
June 09-15	38	June 08-14	21	June 07-13	14
June 16-22	30	June 15-21	25	June 14-20	7
June 23-29	37	June 22-28	13	June 21-27	5
June 30-July 06	47	June 29-July 05	No Data	June 28-July 04	20
July 07-13	27	July 06-12	26	July 05-11	17
July 14-20	34	July 13-19	16	July 12-18	44
July 21-27	56	July 20-26	20	July 19-25	33
July 28-Aug 03	28	July 27-Aug 02	40	July 26-Aug 01	25
Aug 04-10	40	Aug 03-09	43	Aug 02-08	41
Aug 11-17	45	Aug 10-16	10	Aug 09-15	32
Aug 18-24	No Data	Aug 17-23	16	Aug 16-22	26
Aug 25-31	35	Aug 24-30	No Data	Aug 23-29	2
Sept 01-07	7				
Mean	35		22		21

Table 1 (cont.).

2016		2017		2018	
May 15-21	6	May 14-20	17	May 13-19	14
May 22-28	13	May 21-27	8	May 20-26	8
May 29-June 04	8	May 28-June 3	12	May 27-June 02	9
June 05-11	11	June 4-10	8	June 3-9	12
June 12-18	24	June 11-17	19	June 10-16	9
June 19-25	8	June 18-24	6	June 17-23	17
June 26-July 02	25	June 25-July 1	14	June 24-30	23
July 03-09	29	July 2-8	25	July 01-07	27
July 10-16	33	July 9-15	25	July 08-14	30
July 17-23	32	July 16-22	23	July 15-21	33
July 24-30	46	July 23-29	33	July 22-28	20
July 31-Aug 06	34	July 30-Aug 5	36	July 29-Aug 04	25
Aug 07-13	29	Aug 6-12	No Data	Aug 05-11	64
Aug 14-20	45	Aug 13-19	36	Aug 12-18	60
Aug 21-27		Aug 20-26	9	Aug 19-25	47
Aug 28-Sept 03	0	Aug 27-Sept 2	3	Aug 26-Sept 01	34
Sept 04-10				Sept 02-08	8
Mean	23		18		26

Table 1 (cont.).

2019		2020		2021	
May 6-12	14				
May 13-19	19				
May 20-26	26				
May 27-June 2	18	May 25-31	9	May 23-29	11
June 3-9	10	June 1-7	10	May 30-June 5	10
June 10-16	16	June 8-14	2	June 6-12	12
June 17-23	14	June 15-21	No data	June 13-19	16
June 24-30	14	June 22-28	No data	June 20-26	8
July 1-7	27	June 29-July 5	No data	June 27-July 3	13
July 8-14	27	July 6-12	12	July 4-10	18
July 15-21	18	July 13-19	23	July 11-17	23
July 22-28	25	July 20-26	21	July 18-24	16
July 29-August 4	26	July 27-Aug 2	27	July 25-31	26
August 5-11	28	Aug 3-9	24	Aug 1-7	No Data
August 12-18	16	Aug 10-16	18	Aug 8-14	23
August 19-25	23	Aug 17-23	21	Aug 15-21	23
August 26-Sept 1	8	Aug 24-30	3	Aug 22-28	26
September 2-8	2			Aug 29-Sept 4	18
Mean	18		15		17

Table 2. Mean peak instantaneous counts for 2010-2021.

Year	Mean Peak Instantaneous Count
2010	42
2011	33
2012	13
2013	35
2014	22
2015	21
2016	23
2017	18
2018	26
2019	18
2020	15
2021	17

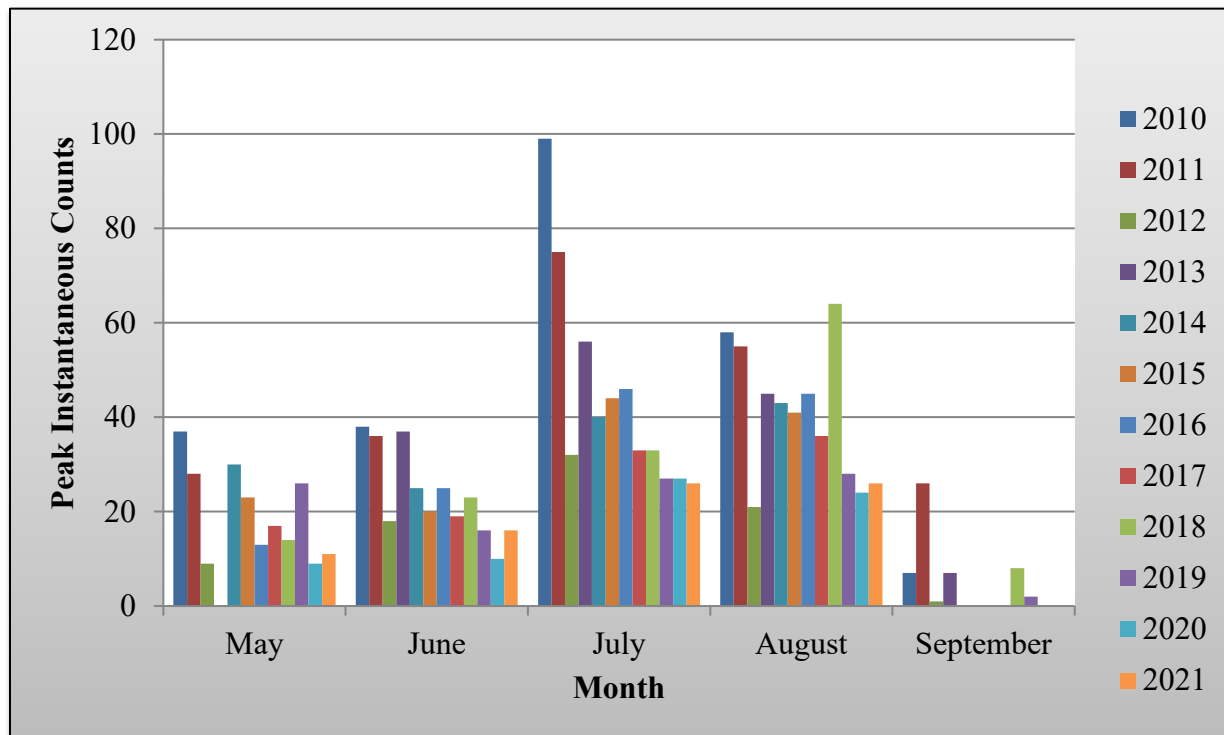


Figure 4. Highest monthly peak instantaneous counts of Tufted Puffins at Haystack Rock during 2010-2021 (USFWS unpublished data).

Burrow Occupancy

The total number of individual/different burrows labeled as occupied was 368, 171, 99, 160, 122, 108, 99, 90, 107, 108, 80, and 103 during 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, and 2021 respectively. The number of occupied burrows detected each week range from 4 to 165 during 2010, 2 to 91 during 2011, 4 to 58 during 2012, 13 to 87 during 2013, 6 to 67 during 2014, 4 to 62 during 2015, 0 to 71 during 2016, 8 to 57 during 2017, 11 to 63 during 2018, 2 to 61 during 2019, 2 to 53 during 2020, and 6 to 55 during 2021 (Table 3). Note: these data do not include the burrows observed on the west side of Haystack Rock during the boat surveys.

The number of detected occupied burrows exhibited a similar trend throughout each year with exception to the first part of 2010 (Figure 5). However, the 2010 burrow occupancy data are of low quality because of bird behavior identification inconsistencies and occupied burrow identification by the observer. The peak numbers of occupied burrows occurred during the fourth week of July during 2011, 2013, 2016, and 2020 and first week of August in 2012, 2014, and 2015 and second week of August in 2017, 2018, and 2019 (Table 3).

Table 3. Occupied burrow tally by week and total number of individual occupied burrows at Haystack Rock during 2010-2021 (USFWS unpublished data).

2010		2011		2012	
Dates	# Occupied	Dates	# Occupied	Dates	# Occupied
May 16-22	12	May 15-21	2	May 20-26	4
May 23-29	38	May 22-28	7	May 27-June 02	16
May 30-June 05	50	May 29-June 04	8	June 03-09	9
June 06-12	165	June 05-11	17	June 10-16	28
June 13-19	157	June 12-18	16	June 17-23	
June 20-26	139	June 19-25	11	June 24-30	25
June 27-July 03	85	June 26-July 02	32	July 01-07	42
July 04-10	116	July 03-09	32	July 08-14	52
July 11-17	125	July 10-16	43	July 15-21	42
July 18-24	70	July 17-23	85	July 22-28	45
July 25-31	83	July 24-30	91	July 29-Aug 04	58
Aug 01-07	69	July 31-Aug 06	59	Aug 05-11	44
Aug 08-14	65	Aug 07-13	66	Aug 12-18	36
Aug 15-21	55	Aug 14-20	66	Aug 19-25	31
Aug 22-28	33	Aug 21-27	38	Aug 26-Sept 01	11
Aug 29-Sept 04	4	Aug 28-Sept 03	50	Sept 02-08	6
		Sept 04-10	5		
Total Occupied Burrows	368		171		99

Table 3 (cont.).

2013		2014		2015	
Dates	# Occupied	Dates	# Occupied	Dates	# Occupied
		May 04-10	11		
		May 11-17	29	May 10-16	17
		May 18-24	34	May 17-23	25
		May 25-31	44	May 24-30	49
June 02-08	38	June 01-07	34	May 31-June 06	
June 09-15	46	June 08-14	52	June 07-13	40
June 16-22	41	June 15-21	52	June 14-20	28
June 23-29	45	June 22-28	61	June 21-27	31
June 30-July 06	56	June 29-July 05		June 28-July 04	49
July 07-13	79	July 06-12	56	July 05-11	41
July 14-20	76	July 13-19	51	July 12-18	51
July 21-27	87	July 20-26	44	July 19-25	54
July 28-Aug 03	61	July 27-Aug 02	67	July 26-Aug 01	51
Aug 04-10	85	Aug 03-09	65	Aug 02-08	62
Aug 11-17	78	Aug 10-16	44	Aug 09-15	54
Aug 18-24		Aug 17-23	42	Aug 16-22	40
Aug 25-31	53	Aug 24-30	6	Aug 23-29	4
Sept 01-07	13				
Total Occupied Burrows	160		122		108

Table 3 (cont.).

2016		2017		2018	
Dates	# Occupied	Dates	# Occupied	Dates	# Occupied
May 15-21	6	May 14-20	22	May 13-19	22
May 22-28	12	May 21-27	14	May 20-26	27
May 29-June 04	12	May 28-June 3	24	May 27-June 02	16
June 05-11	14	June 4-10	13	June 3-9	35
June 12-18	32	June 11-17	31	June 10-16	26
June 19-25	41	June 18-24	14	June 17-23	32
June 26-July 02	54	June 25-July 1	42	June 24-30	43
July 03-09	48	July 2-8	48	July 01-07	52
July 10-16	65	July 9-15	55	July 08-14	48
July 17-23	65	July 16-22	51	July 15-21	63
July 24-30	71	July 23-29	54	July 22-28	45
July 31-Aug 06	51	July 30-Aug 5	53	July 29-Aug 04	54
Aug 07-13	53	Aug 6-12		Aug 05-11	61
Aug 14-20	57	Aug 13-19	57	Aug 12-18	63
Aug 21-27		Aug 20-26	27	Aug 19-25	62
Aug 28-Sept 03	0	Aug 27-Sept 2	8	Aug 26-Sept 01	56
Sept 04-10	1			Sept 02-08	11
Total Occupied Burrows	99		90		107

Table 3 (cont.)

2019		2020		2021	
Dates	# Occupied	Dates	# Occupied	Dates	# Occupied
May 6-12	21				
May 13-19	43				
May 20-26	52				
May 27-June 2	48	May 25-31	9	May 23-29	28
June 3-9	38	June 1-7	18	May 30-June 5	39
June 10-16	45	June 8-14	12	June 6-12	27
June 17-23	55	June 15-21	No data	June 13-19	38
June 24-30	37	June 22-28	No data	June 20-26	52
July 1-7	60	June 29-July 5	No data	June 27-July 3	36
July 8-14	57	July 6-12	39	July 4-10	41
July 15-21	58	July 13-19	51	July 11-17	43
July 22-28	59	July 20-26	51	July 18-24	48
July 29-August 4	52	July 27-Aug 2	53	July 25-31	52
August 5-11	61	Aug 3-9	49	Aug 1-7	55
August 12-18	46	Aug 10-16	50	Aug 8-14	52
August 19-25	32	Aug 17-23	39	Aug 15-21	46
August 26-Sept 1	12	Aug 24-30	7	Aug 22-28	36
Sept 2-8	2			Aug 29-Sept 4	6
Total Occupied Burrows	108		80		103

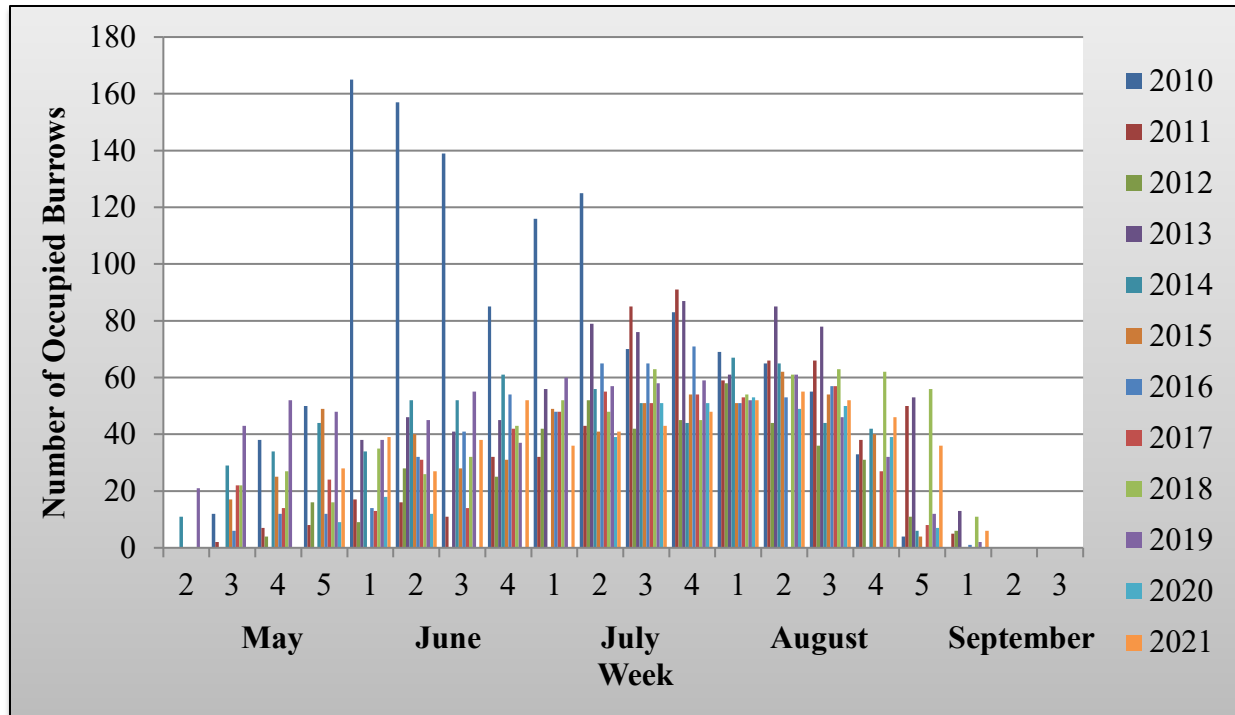


Figure 5. Number of occupied burrows during May to September 2010-2021 (USFWS unpublished data).

Burrows were located in the vegetated area on the upper portion of the rock (Figure 6). The burrows were most dense along the perimeter rather than the central portion of the vegetated area. Very few burrows were located on the steep un-vegetated slopes or cliffs, as there is insufficient soil available for burrow excavation.

The 2010, 2013, 2016, 2019, and 2021 boat survey documented 9, 8, 6, 7, and 4 burrows respectively in the vegetated area on the west side of the rock. Surveys of the west side of Haystack Rock with the boat are not conducted every year. Equipment availability, personnel schedules, and logistics often conflict which prevent survey efforts from being completed.

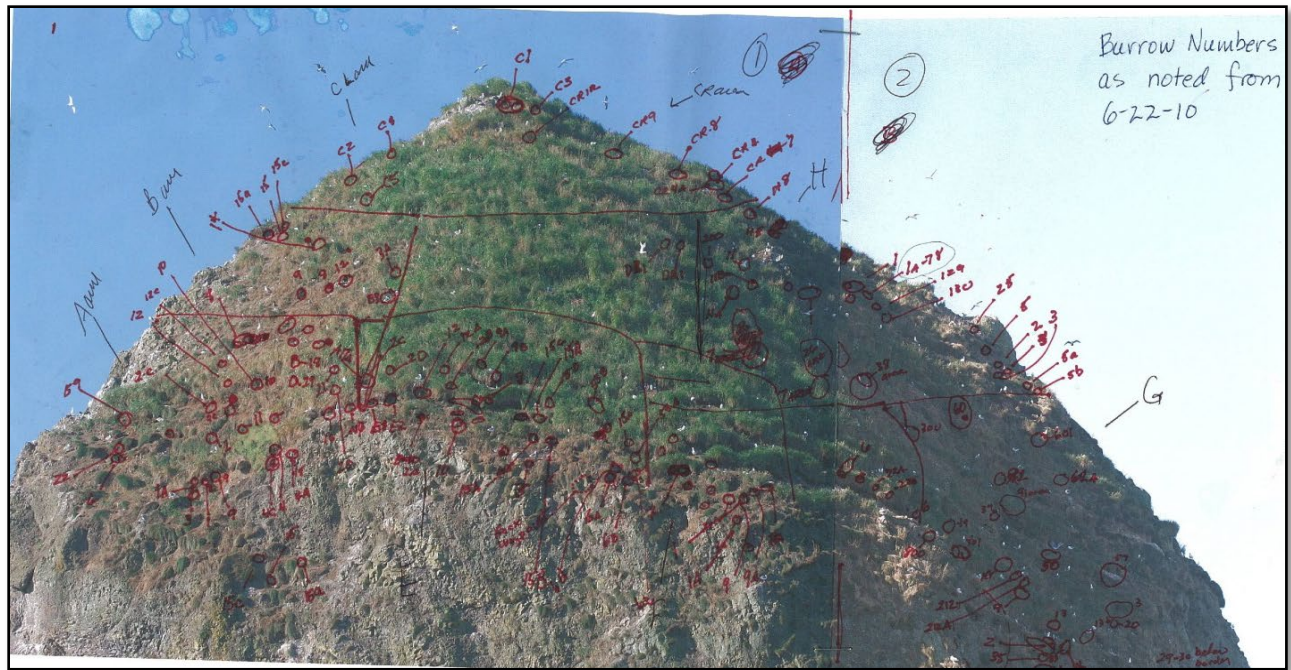


Figure 6. Occupied burrows numbered on digital photograph of Haystack Rock during 2010.

Breeding Population Estimates

The 2010 data indicated a total of 368 individual burrows were occupied, with 63 and 46 occupied for at least 5 to 6 weeks. The midpoint of the range of viable occupied burrows was 54.5, multiplied by 2 (2 adults per burrow) for an estimate of 109 birds. The boat survey of the west side of Haystack Rock was conducted on 04 August 2010. We documented 9 occupied burrows near the top of the Rock. Thus, 18 were added to 109 for an estimate of 127 individual breeding birds during 2010. In 2011, 171 total occupied burrows were identified and 38 to 59 were viable burrows occupied at least 5 to 6 weeks. The midpoint of the range of viable occupied burrows (48.5) multiplied by 2 and added to the 18 individuals from the 2010 boat survey results in a population estimate of 115. During 2012, 30 to 44 burrows were identified as viable occupied 5 to 6 weeks with a midpoint of the range of 37. Therefore, 37 pairs or 74 individuals added to the 18 individuals from the 2010 boat survey shows that an estimated 92 individual birds bred in 2012. The largest estimate of breeding birds at Haystack Rock since this study began occurred in 2013 with a total of 143 individual birds. Occupied burrows for 5-6 weeks totaled 58 to 69, which indicated 63.5 pairs or 127 individual breeding birds were documented on the east side of Haystack Rock. In addition, the west side of Haystack Rock was surveyed by boat on 19 August 2013 and 8 occupied burrows (or 16 individual birds) were documented (Table 4, Figure 7). During 2014, 49 to 60 burrows were occupied for 5 to 6 weeks which calculates a midpoint of 54.5 for a total estimate of 109 birds. After adding the estimated 8 burrows from the 2013 boat survey, the breeding population estimate for 2014 is 125 birds.

During 2015, 50 to 55 burrows were occupied 5 to 6 weeks, with a midpoint of 52.5 burrows or about 105 individuals. 105 individual birds plus the 16 from the west side (8 burrows found in 2013) equals a breeding population of 121 individual birds for the year 2015. In 2016, 57 burrows were occupied ≥ 5 weeks and 55 were occupied ≥ 6 weeks, providing a midpoint of 56 burrows or 112 breeding adults. 6 burrows were found during a survey of the west side of Haystack Rock on 03 August 2016, which adds 12 individuals for a total population estimate of 124 Tufted Puffins for the year 2016. In 2017, 52 burrows were occupied ≥ 5 weeks and 54 were occupied ≥ 6 weeks, providing a midpoint of 48.5 burrows or 97 breeding adults. We were unable to survey the west side of Haystack Rock in 2017, so we used 2016 estimate, which adds 12 individuals for a total population estimate of 109 Tufted Puffins in 2017. The 2018 breeding population was estimated at 127 individual birds. Occupied burrows for 5-6 weeks totaled 56 to 59 (midpoint 57.5) and an additional 6 burrows documented during the 2016 boat survey was used to calculate the 2018 estimate. In 2019, 58 burrows were occupied ≥ 5 weeks, and 55 burrows were occupied ≥ 6 weeks, with a midpoint of 56.5 burrows or 113 breeding adults. An additional 7 burrows found on the west side of Haystack Rock during a boat survey added 14 more breeding adults, bringing the total breeding population estimate to 127 (Table 4, Figure 7). In 2020, 45 burrows were occupied ≥ 5 weeks, and 39 burrows were occupied ≥ 6 weeks, with a midpoint of 42 burrows or 84 breeding birds. While there was no boat survey in 2020, we used the 7 burrows found on the west side in 2019 to add an estimated 14 breeding birds, for a total breeding population estimate of 98. In 2021, 46 burrows were occupied ≥ 5 weeks, and 44 burrows were occupied ≥ 6 weeks, with a midpoint of 45 burrows or 90 breeding birds. An additional 4 burrows found on the west side of Haystack Rock during a boat survey on 14 July 2021 added 8 more breeding adults, bringing the total breeding population estimate to 98 (Table 4, Figure 7).

The 1988 breeding population of 612 birds is the largest estimate ever recorded at Haystack Rock and a steep decline is detected when compared to the 2010-2021 estimates. However, when all estimates are compared since 1960, a slight decline is noted (Figure 7). Note: the population estimates are highly variable between years and this is likely due to varying methods of data collection used in previous years. The breeding population appears to be stable when using only the data collected during 2010-2021 and no trend is detected.

Table 4. Number of burrows occupied in relation to week (USFWS unpublished data) during 2010-2021.

Weeks	2010		2011		2012	
	NBONW ¹	NBO _≥ NW ²	NBONW	NBO _≥ NW	NBONW	NBO _≥ NW
1	166	368	38	171	18	99
2	61	202	27	133	14	81
3	48	141	21	106	14	67
4	30	93	26	85	9	53
5	17	63	21	59	14	44
6	13	46	16	38	4	30
7	12	33	12	22	8	26
8	5	21	7	10	5	18
9	5	16	2	3	5	13
10	5	11	1	1	2	8
11	5	6			2	6
12	1	1			4	4
13						
14						

Weeks	2013		2014		2015	
	NBONW ¹	NBO _≥ NW ²	NBONW	NBO _≥ NW	NBONW	NBO _≥ NW
1	39	160	32	122	32	108
2	27	121	13	90	11	76
3	13	94	8	77	7	65
4	12	81	9	69	3	58
5	11	69	11	60	5	55
6	10	58	4	49	4	50
7	7	48	5	45	6	46
8	9	41	4	40	6	40
9	8	32	3	36	7	34
10	9	24	8	33	6	27
11	8	15	2	25	12	21
12	5	7	10	23	3	9
13	2	2	6	13	5	6
14			4	7	1	1
15			3	3		

¹NBONW = Number of burrows occupied for n week

²NBO_≥NW = Number of burrows occupied ≥ n week

Table 4 (cont.).

Weeks	2016		2017		2018	
	NBONW ¹	NBO _≥ NW ²	NBONW	NBO _≥ NW	NBONW	NBO _≥ NW
1	24	99	26	90	28	107
2	8	75	4	64	12	79
3	5	67	7	60	4	67
4	5	62	1	53	4	63
5	2	57	7	52	3	59
6	7	55	5	45	3	56
7	4	48	4	40	3	53
8	11	44	11	36	9	50
9	11	33	5	25	6	41
10	7	22	6	10	2	35
11	11	15	7	14	7	33
12	4	4	3	7	6	26
13			1	4	6	20
14			3	3	5	14
15					6	9
16					2	3
17					1	1

Table 4 (cont.).

Weeks	2019		2020		2021	
	NBONW ¹	NBO _≥ NW ²	NBONW	NBO _≥ NW	NBONW	NBO _≥ NW
1	31	108	22	80	34	103
2	10	77	6	58	15	69
3	5	67	3	52	3	54
4	4	62	4	49	5	51
5	3	58	6	45	2	46
6	2	55	11	39	3	44
7	4	53	14	28	2	41
8	1	49	12	14	1	39
9	5	48	1	2	3	38
10	4	43	1	1	4	35
11	4	39			5	31
12	3	35			10	26
13	6	32			11	16
14	11	26			4	5
15	9	15			1	1
16	2	6				
17	3	4				
18	1	1				

¹NBONW = Number of burrows occupied for n week²NBO_≥NW = Number of burrows occupied _≥ n week

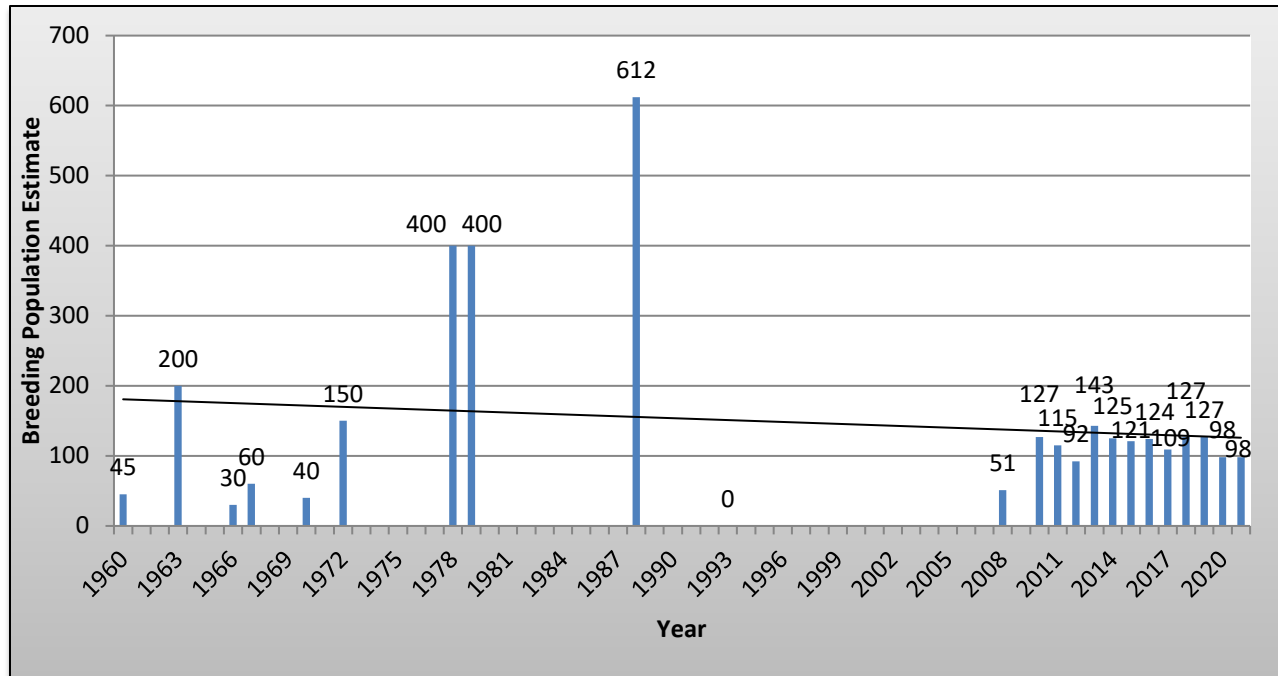


Figure 7. Tufted Puffin breeding population estimates 1960 – 2021 with linear trendline (Naughton et al. 2007, USFWS unpublished data).

Breeding Phenology

The breeding phenology of the Tufted Puffin at Haystack Rock was determined by examining colony attendance patterns and bird abundance in relation to time (Figure 4). Prospecting usually lasts 21 – 28 days which began second week of April and ended last week of May. Breeding adults started to lay eggs during the second week of May until early July. Incubation lasts 41 – 54 days from mid-May to mid-July. The hatching and chick-rearing period began late June and ended late August. Fledging takes 38 to 59 days. Some chicks were observed departing the colony late July through second week of September. Some adults were still caring for chicks at the end of the observation period and is estimated those chicks fledged late September (Table 5).

Table 5. Tufted Puffin breeding phenology chart for Haystack Rock (Piatt and Kitaysky 2002, USFWS unpublished data).

Activity	Month					
	April	May	June	July	August	September
Prospecting	← 21 - 28 days →					
Egg Laying		← Period →				
Incubation		← 41 - 54 days →				
Hatching				← Period →		
Fledging					← 38 - 59 days →	

CONCLUSION

The Tufted Puffin population has declined in Oregon over the past 20 years and scientific studies need to be conducted for further investigation. Haystack Rock is an important nesting site for Tufted Puffins and current data suggest Haystack Rock supports the second largest puffin colony in Oregon due to declines at other sites along the coast. A monitoring study of Tufted Puffins at Haystack Rock during 2010-2021 included instantaneous counts and burrow occupancy protocol. These puffins can be monitored from shore and citizen science can be effectively utilized to assist in long-term monitoring of the species at this site. This study concluded peak bird counts occurred in late July and early August during the hatching or chick rearing period. Many burrows were found to be occupied and are a good estimator of the breeding population. The 2021 population estimate indicates 98 individual Tufted Puffins breed at Haystack Rock.

ACKNOWLEDGEMENTS

Richard Messenger and Mike Brownle were volunteer observers during 2010 and 2011 respectively and Tim Halloran during 2012 - 2021. These volunteers spent hundreds of hours on this project, sometimes in extreme weather conditions without complaint. Without dedicated volunteers, this project could not have been completed. The Haystack Rock Awareness Program (HRAP) and Friends of Haystack Rock (FOHR) personnel contributed many hours assisting with the project and supporting volunteer observers. HRAP is a stewardship and environmental educational program whose mission is to protect, through education, the intertidal and bird ecology of the Marine Garden and Oregon Islands National Wildlife Refuge at Haystack Rock. The Friends of Haystack Rock (FOHR) provides financial support and enables education, restoration, and advocacy for the ecosystem at Haystack Rock so that a thriving natural environment remains intact for future generations.

LITERATURE CITED

- B.C. Conservation Data Centre. 2018. B.C. Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available: <http://a100.gov.bc.ca/pub/eswp/> (accessed Jan 24, 2018).
- Boone, D.L. 1985. Breeding biology and early life history of the Tufted Puffin (*Fratercula cirrhata*). A Master of Science Thesis submitted to Oregon State University.
- Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 5: Northern Pacific Rainforest. Canadian Wildlife Service, Environment Canada. Delta, British Columbia. 128 pp. + appendices.
- Gjerdrum, C., A.M.J. Vallee, C. Cassaday St. Clair, D.F. Bertram, J.L. Ryder, and G.S. Blackburn. 2003. Tufted Puffin reproduction reveals ocean climate variability. PNAS 100 (16):9377-9382.
- Hanson, T. and G.J. Wiles. 2015. Washington state status report for the Tufted Puffin. Washington Department of Fish and Wildlife, Olympia, Washington. 66 pp.
- Jaques, D.L. and C.S. Strong. 2001. Seabird status at Castle Rock National Wildlife Refuge, 1997-1999. Fin. Rep. to U.S. Fish and Wildl. Serv., Humboldt Bay NWR, Loleta, CA.
- Kocourek, A.L., S.W. Stephensen, K.J. So, A.J. Gladics, and J. Ziegler. 2009. Burrow-nesting seabird census of the Oregon Coast National Wildlife Refuge Complex, June – August 2008. U.S. Fish and Wildlife Service Report. Oregon Coast National Wildlife Refuge Complex, Newport, Oregon. 63pp.
- Naughton, M.B., D.S. Pitkin, R.W. Lowe, K.J. So, and C.S. Strong. 2007. Catalog of Oregon seabird colonies. U.S. Department of Interior; Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R1009-2007.
- Nelson, K.S., M. Naughton, D.D. Roby, and A.E. Gall. 2009. Seabird inventory and monitoring manual for the California Current System (final draft). U.S. Geological Survey Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Corvallis, Oregon and U.S. Fish and Wildlife Service, Migratory Bird and Habitat Programs, Pacific Region, Portland, Oregon.
- Osa, Y., and Y. Watanuki. 2002. Status of seabirds breeding in Hokkaido. Journal of the Yamashina Institute for Ornithology 33:107-141.

- Pearson, S., I. Keren, P. Hodum, and others. 2018. Ecosystem-level changes in the North American Tufted Puffin breeding population (in Review).
- Piatt, J.F., and A.S. Kitaysky. 2002. Tufted Puffin (*Fratercula cirrhata*). In The Birds of North America, No. 708 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.
- Stephensen, S.W. 2022. Oregon Coast Wide Tufted Puffin Survey 2021. U.S. Fish and Wildlife Service Unpublished Report, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon 97365. 36pp.
- Udvardy, M.D.F. 1963. Zoogeographical study of the Pacific Alcidae. Proc. Pac. Sci. 10: 85-111.
- U.S. Fish and Wildlife Service (USFWS). 2005. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Bird and Habitat Programs, Pacific Region, Portland, Oregon.
- U.S. Fish and Wildlife Service (USFWS). 2009. Oregon Islands, Three Arch Rocks, and Cape Meares National Wildlife Refuges Comprehensive Conservation Plan and Wilderness Stewardship Plan. U.S. Fish and Wildlife Service, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon.
- U.S. Fish and Wildlife Service (USFWS). 2013. North Pacific Seabird Colony Database – computer database and Colony Status Record archives. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska 99503.
- U.S. Fish and Wildlife Service (USFWS). 2020. Species Status Assessment Report for the Tufted Puffin (*Fratercula cirrhata*), Version 1.0. Anchorage Fish and Wildlife Office, Anchorage, Alaska.
- Walsh, P.M., D.J. Halley, M.P. Harris, A. del Nevo, I.M.W. Sim, and M.L. Tasker. 1995. Seabird monitoring handbook for Britain and Ireland. JNCC / RSPB / ITE / Seabird Group, Peterborough.
- Williams, J.C., L. Scharf, and G.V. Byrd. 2000. Ecological monitoring methods of the Aleutian Islands Unit, Alaska Maritime National Wildlife Refuge. U.S. Fish and Wildlife Service Report AMNWR 00/01. Adak, Alaska. 351 pp.

Appendix 1. Tufted Puffin instantaneous counts datasheet.

TUFTED PUFFIN INSTANTANEOUS COUNTS – HAYSTACK ROCK 2021

Observer(s):				
Date	Start Time	End Time	Tide	Visibility
Sky	Precipitation	Temperature	Wind Direction	Wind Speed
General Observation Conditions (glare, heatwaves, fog, blowing sand, etc.):				

Time		Number of Puffins			
Start	End	On Rock	On Water	Flying	Total per Scan
Scan 1 Notes (disturbance, double-counting, etc.):					
Scan 2 Notes:					
Scan 3 Notes:					
Scan 4 Notes:					

Additional Notes:					

Appendix 2. Tufted Puffin burrow occupancy datasheet.

TUFTED PUFFIN BURROW OCCUPANCY – HAYSTACK ROCK 2021

Observer(s):				
Date	Start Time	End Time	Tide	Visibility
Sky	Precipitation	Temperature	Wind Direction	Wind Speed
General Observation Conditions (glare, heatwaves, fog, blowing sand, etc.):				

Sighting No.	Time	Burrow			Activity at Burrow			Pair or Single
		ID No.	Occupied	Investigated	Courthouse	Fish Deliver	Interference or Disturbance	

Additional Notes (specific details concerning monitoring period or each burrow):	
Sighting No.	