

Tufted Puffin Monitoring Study at Haystack Rock, Cannon Beach, Oregon 2010-2013



Photo credit USFWS

By

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

January 2014

Cite as: Stephensen, S.W. 2014. Tufted Puffin monitoring study at Haystack Rock, Cannon Beach, Oregon 2010-2013. U.S. Fish and Wildlife Service Unpublished Report, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon 97365. 16 pp.

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. 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 documented an order of magnitude decline in the puffin population since the previous 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. Haystack Rock is a 72 meter tall sea stack, located on the north coast of Oregon at Cannon Beach. The number of Tufted Puffins present at Haystack Rock was documented during 2010-13 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, and 35 birds during 2010, 2011, 2012, and 2013 respectively. Burrow occupancy was determined and the annual breeding population estimate was calculated based on the number of viable occupied burrows. We estimated the Tufted Puffin breeding population (individual birds) at Haystack Rock to be 127 in 2010, 97 in 2011, 74 in 2012, and 143 in 2013. 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 April and ended with fledging by late September. Current data suggest Haystack Rock supports the 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 2014). 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). 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 a diurnally active cavity nesting seabird species that raises its young on a few vegetated islands along the Oregon coast. The U. S. Fish and Wildlife Service (USFWS) conducted a burrow-nesting seabird survey that encompassed the entire coastline of Oregon in 2008 and detected an order of magnitude decline in the puffin population since the previous official statewide survey in 1988 (USFWS unpublished data). Only 142 Tufted Puffins were documented along the entire Oregon coastline (Kocourek et al. 2009). With the tremendous decline in the Oregon breeding population, anthropogenic-caused mortality of even a few birds will negatively affect the Oregon population.

The Oregon Islands and Three Arch Rocks National Wildlife Refuges, managed by the U.S. Fish and Wildlife Service, consists of 1,854 rocks, reefs, and islands and spans 320 miles 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 13 species (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, Kocourek et al. counted only 51 birds at Haystack Rock during the 2008 census. Current data suggest Haystack Rock supports the largest puffin colony in Oregon due to declines at other sites along the coast. 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). The Tufted Puffin population at Finley Rock has not been monitored to the extent as Haystack Rock. 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. 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 was 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.). 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), 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 southeast of Portland (Figure 1). Haystack Rock is a 72 meter tall sea stack located nearshore, (Figure 2) and has been assigned the seabird colony number 219-021 in the Catalog of Oregon Seabird Colonies (Naughton et al. 2007).

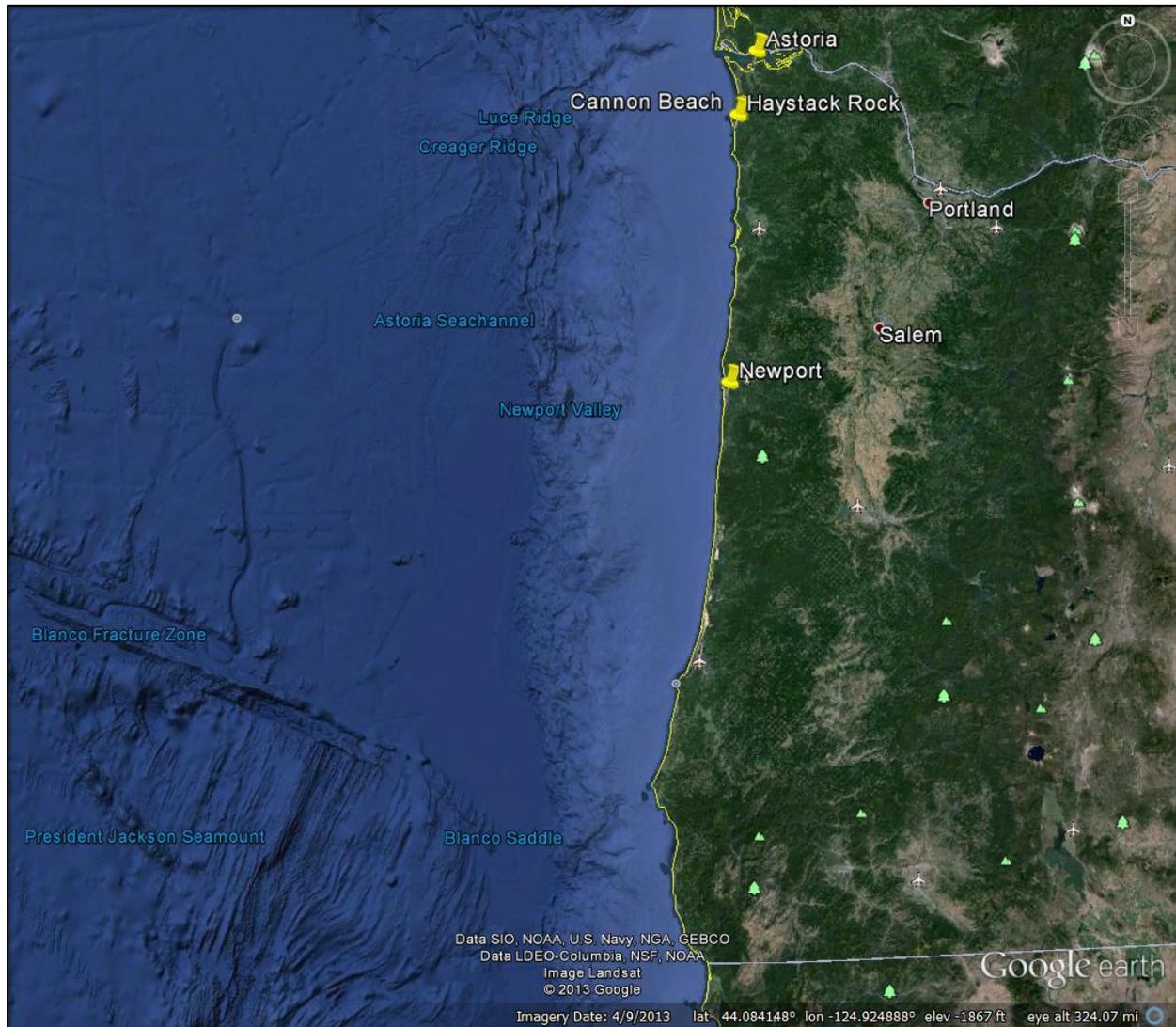


Figure 1. Map of the Oregon Coast with Haystack Rock at Cannon Beach identified.



Shawn W. Stephensen

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, and 2013 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. Canon 10x42 Image Stabilizer binoculars and 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 at the office. 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 Cannon EOS 5D Mark II digital camera with a Cannon Ultrasonic 20-35 mm lens from the instantaneous counts observation location in May 2010-13.

The series of digital photographs were photomerged (stitched together) 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 Canon 10x42 Image Stabilizer binoculars and 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. Miscellaneous notes including weather, general observation conditions, start and end time, tide, and other bird activity were recorded but not included in this report. All burrow occupancy data were recorded onto a datasheet (Appendix 2) during the survey and entered into an Excel spreadsheet. The datasheets and Excel files are archived at the Oregon Coast National Wildlife Refuge Complex office in Newport, Oregon for future reference.

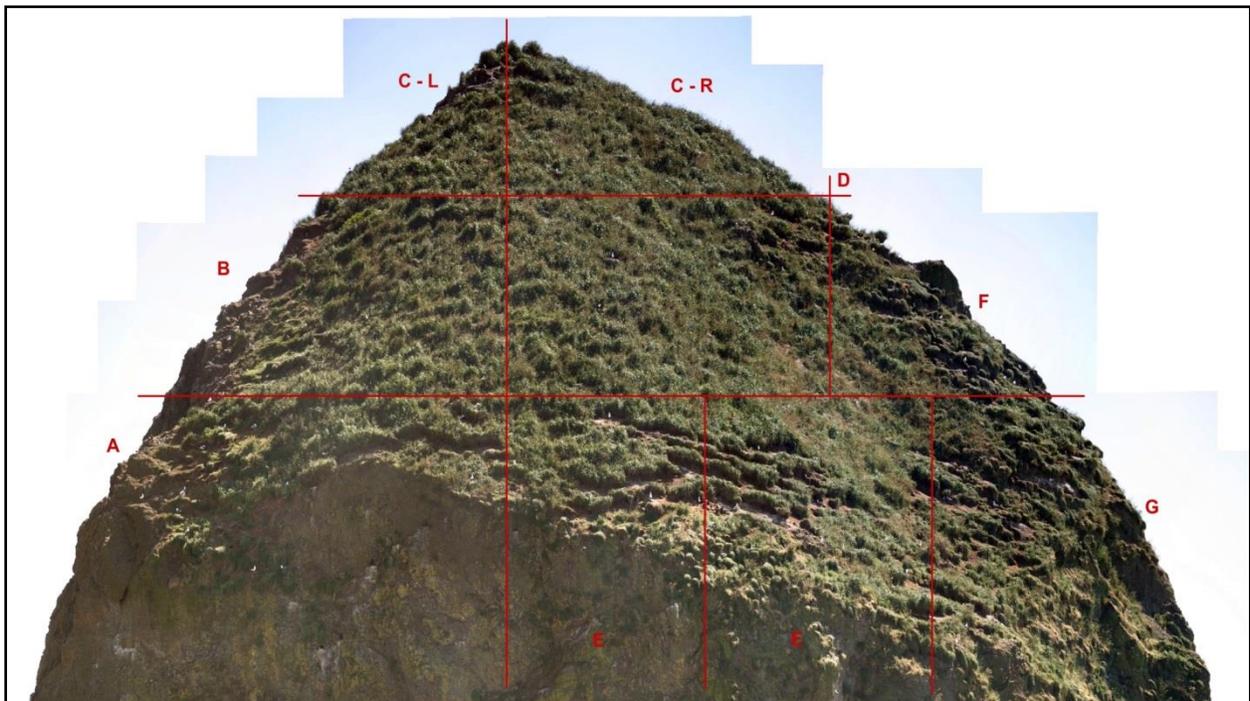


Figure 3. Digital photograph of Haystack Rock with section grid overlay.

Breeding Population Estimate

The annual individual 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 and 2013. 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.

RESULTS

Instantaneous Counts

The daily peak instantaneous counts (largest number of individual birds observed on a day during a weekly period) and mean count of Tufted Puffins were tallied (Table 1). The 2010 daily peak count ranged from 7 birds during week 5 of August to 99 birds during week 3 of July. In 2011, a minimum count of 3 birds occurred during week 1 of September and a maximum count of 75 birds during week 4 of July. The daily peak count during 2012 ranged from 1 during end of August and early September to 32 birds in July. The 2013 daily peak count ranged from 7 birds during first week of September to 56 birds the last week of July (Figure 4). The daily mean counts were 42, 33, 13, and 35 birds during 2010, 2011, 2012, and 2013 respectively (Table 1).

Table 1. Daily peak instantaneous counts of Tufted Puffins at Haystack Rock during 2010-13 (USFWS unpublished data).

2010		2011		2012		2013	
16-22 May	37	15-21 May	7	13-19 May		12-18 May	
23-29 May	36	22-28 May	18	20-26 May	4	19-25 May	
30 May – 05 June	32	29 May – 04 June	28	27 May – 02 June	9	26 May – 01 June	
06-12 June	24	05-11 June	31	03-09 June	2	02-08 June	25
13-19 June	29	12-18 June	19	10-16 June	9	09-15 June	38
20-26 June	19	19-25 June	36	17-23 June		16-22 June	30
27 June – 03 July	38	26 June – 02 July	34	24-30 June	18	23-29 June	37
04-10 July	48	03-09 July		01-07 July	26	30 June – 06 July	47
11-17 July	78	10-16 July	18	08-14 July	32	07-13 July	27
18-24 July	99	17-23 July	67	15-21 July	22	14-20 July	34
25-31 July	70	24-30 July	75	22-28 July	14	21-27 July	56
01-7 August	58	31 July – 06 August	30	29 July – 04 August	21	28 July – 03 Aug	28
08-14 August	38	07-13 August	49	05-11 August	17	04-10 August	40
15-21 August	35	14-20 August	30	12-18 August	15	11-17 August	45
22-28 August	21	21-27 August	55	19-25 August	5	18-24 August	
29 Aug – 04 Sept	7	28 Aug – 03 Sept	26	26 August – 01 Sept	1	25-31 August	35
05-11 September		04-10 September	3	02-08 September	1	01-07 September	7
Daily Mean	42	Daily Mean	33	Daily Mean	13	Daily Mean	35

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

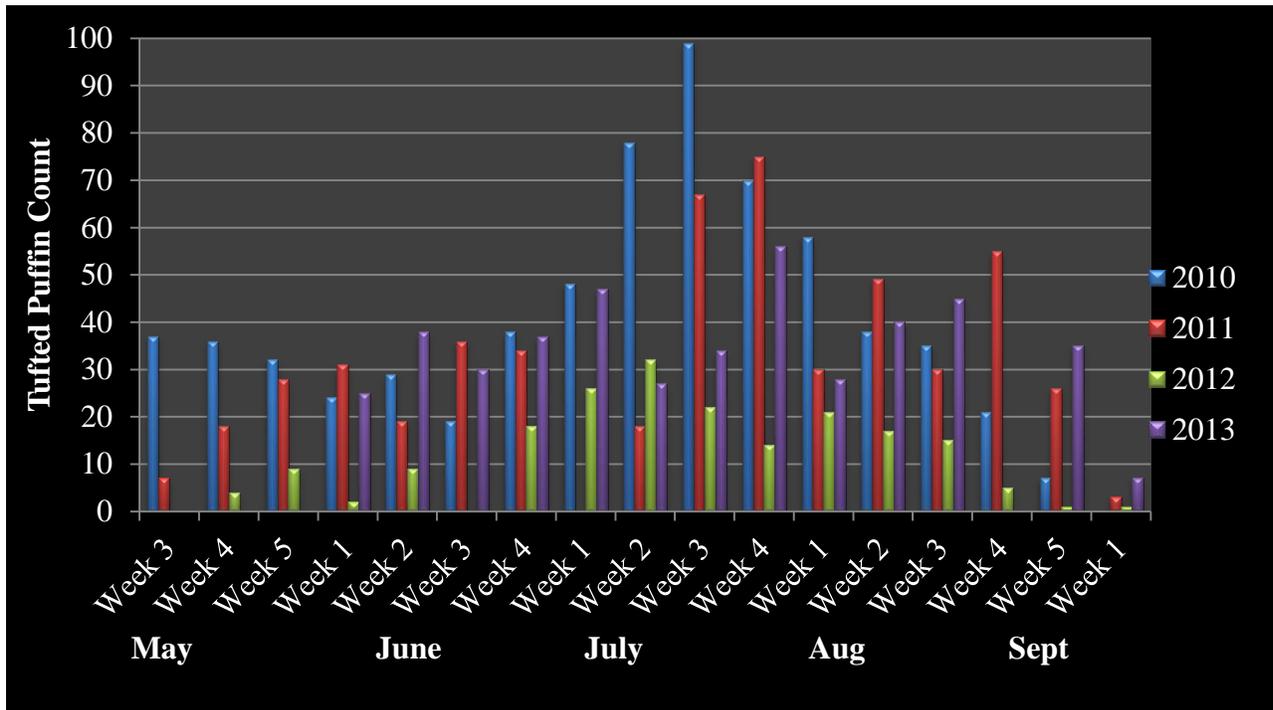


Figure 4. Daily peak instantaneous counts of Tufted Puffins at Haystack Rock during 2010-13 (USFWS unpublished data).

Burrow Occupancy

The total number of individual/different burrows labeled as occupied was 368, 171, 99, and 160 during 2010, 2011, 2012, and 2013 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, and 13 to 87 during 2013 (Table 2).

The number of detected occupied burrows exhibited a similar trend throughout each year with exception to the first part of 2010 (Figure 5). 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 and 2013 and first week of August in 2012.

Table 2. Occupied burrow tally by week and total number of individual occupied burrows at Haystack Rock during 2010-13 (USFWS unpublished data).

2010		2011		2012		2013	
16-22 May	12	15-21 May	2	20-26 May	4		
23-29 May	38	22-28 May	7	27 May-02 June	16		
30 May-05 June	50	29 May-04 June	8	03-09 June	9	02-08 June	38
06-12 June	165	05-11 June	17	10-16 June	28	09-15 June	46
13-19 June	157	12-18 June	16	17-23 June		16-22 June	41
20-26 June	139	19-25 June	11	24-30 June	25	23-29 June	45
27 June-03 July	85	26 June-02 July	32	01-07 July	42	30 June-06 July	56
04-10 July	116	03-09 July	32	08-14 July	52	07-13 July	79
11-17 July	125	10-16 July	43	15-21 July	42	14-20 July	76
18-24 July	70	17-23 July	85	22-28 July	45	21-27 July	87
25-31 July	83	24-30 July	91	29 July-04 Aug	58	28 July-03 Aug	61
01-7 August	69	31 July-06 August	59	05-11 August	44	04-10 August	85
08-14 August	65	07-13 August	66	12-18 August	36	11-17 August	78
15-21 August	55	14-20 August	66	19-25 August	31	18-24 August	
22-28 August	33	21-27 August	38	26 Aug-01 Sept	11	25-31 August	53
29 Aug-04 Sept	4	28 Aug-03 Sept	50	02-08 Sept	6	01-07 Sept	13
		04-10 September	5				
Total Occupied Burrows	368	Total Occupied Burrows	171	Total Occupied Burrows	99	Total Occupied Burrows	160

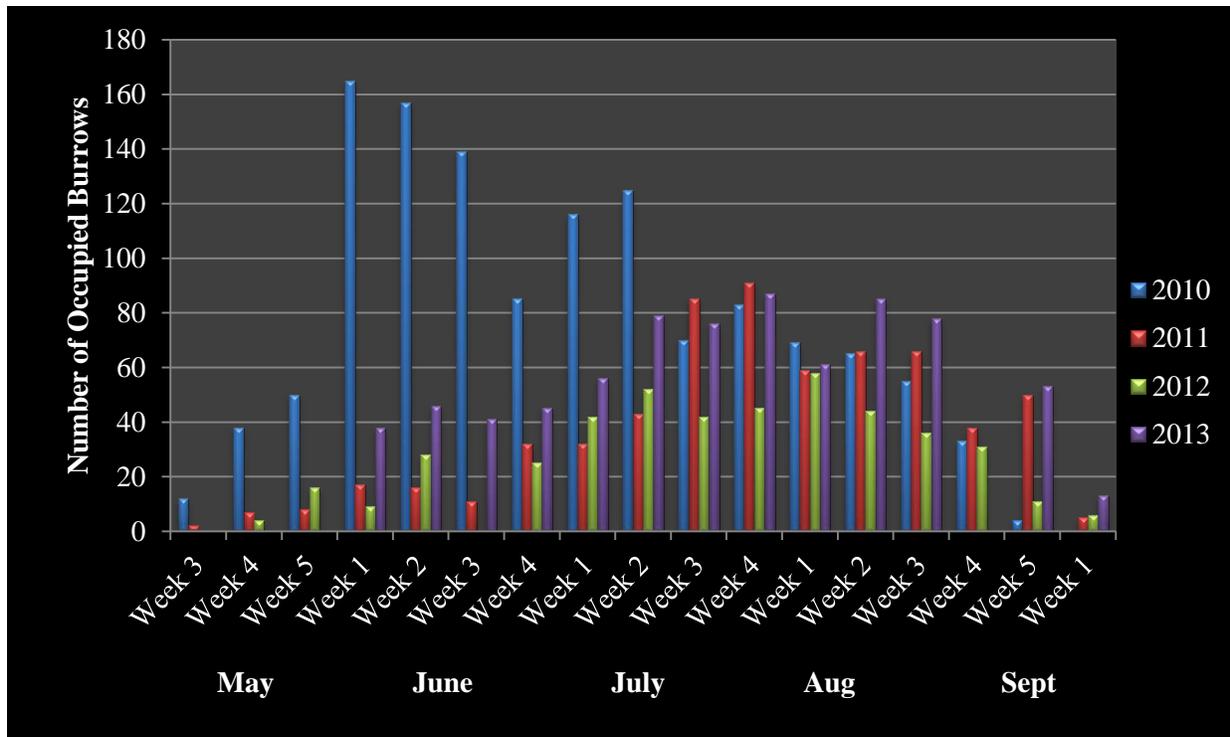


Figure 5. Number of occupied burrows during May to September 2010-13 (USFWS unpublished data).

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 since there is insufficient soil available for burrow excavation. During the 2010 and 2013 boat survey, 9 and 8 occupied burrows respectively were observed in the vegetated area on the west side of the rock.

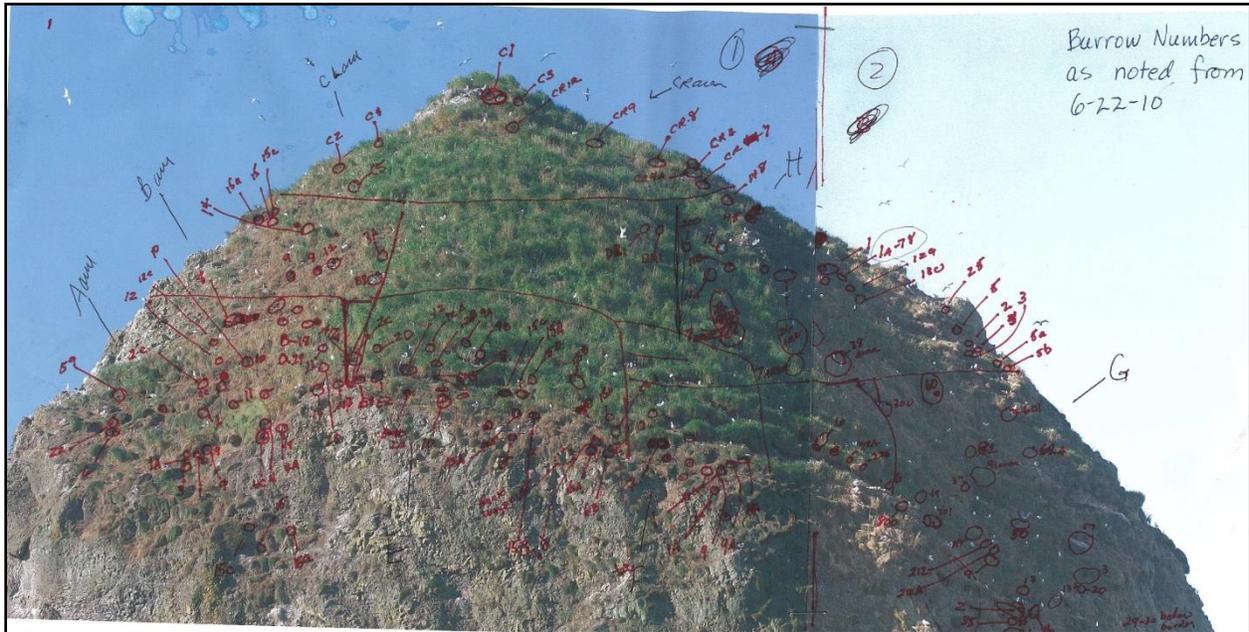


Figure 6. Occupied burrows numbered on digital photograph of Haystack Rock during 2010.

Breeding Population Estimates

The 2010 data indicated a total of 368 individual burrows were occupied, with 63 and 46 occupied for 5 and 6 weeks. The midpoint of the range of viable occupied burrows was 54.5, multiplied by 2 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. Time constraints and other commitments prevented boat surveys to be conducted in 2011 and 2012, therefore additional birds were not added to those population estimates. In 2011, 171 total occupied burrows were identified and 38 to 59 were viable burrows occupied 5 to 6 weeks. The midpoint of the range of viable occupied burrows (48.5) multiplied by 2 for a population estimate of 97. 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 pair or 74 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 pair 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 August 19, 2013 and 8 occupied burrows (or 16 individual birds) were documented (Table 3, Figure 7). The 1988 breeding population of 612 birds is the largest estimate ever recorded at Haystack Rock and when compared to the 2010-13 estimates, a decline is detected. However, when all

estimates are compared since 1960, no trends are exhibited since the population estimates are highly variable between years (Figure 7).

Table 3. Number of burrows occupied in relation to week (USFWS unpublished data).

Week	2010		2011		2012		2013	
	Number of burrows occupied for n week	Number of burrows occupied \geq n week	Number of burrows occupied for n week	Number of burrows occupied \geq n week	Number of burrows occupied for n week	Number of burrows occupied \geq n week	Number of burrows occupied for n week	Number of burrows occupied \geq n week
1	166	368	38	171	18	99	39	160
2	61	202	27	133	14	81	27	121
3	48	141	21	106	14	67	13	94
4	30	93	26	85	9	53	12	81
5	17	63	21	59	14	44	11	69
6	13	46	16	38	4	30	10	58
7	12	33	12	22	8	26	7	48
8	5	21	7	10	5	18	9	41
9	5	16	2	3	5	13	8	32
10	5	11	1	1	2	8	9	24
11	5	6			2	6	8	15
12	1	1			4	4	5	7
13							2	2

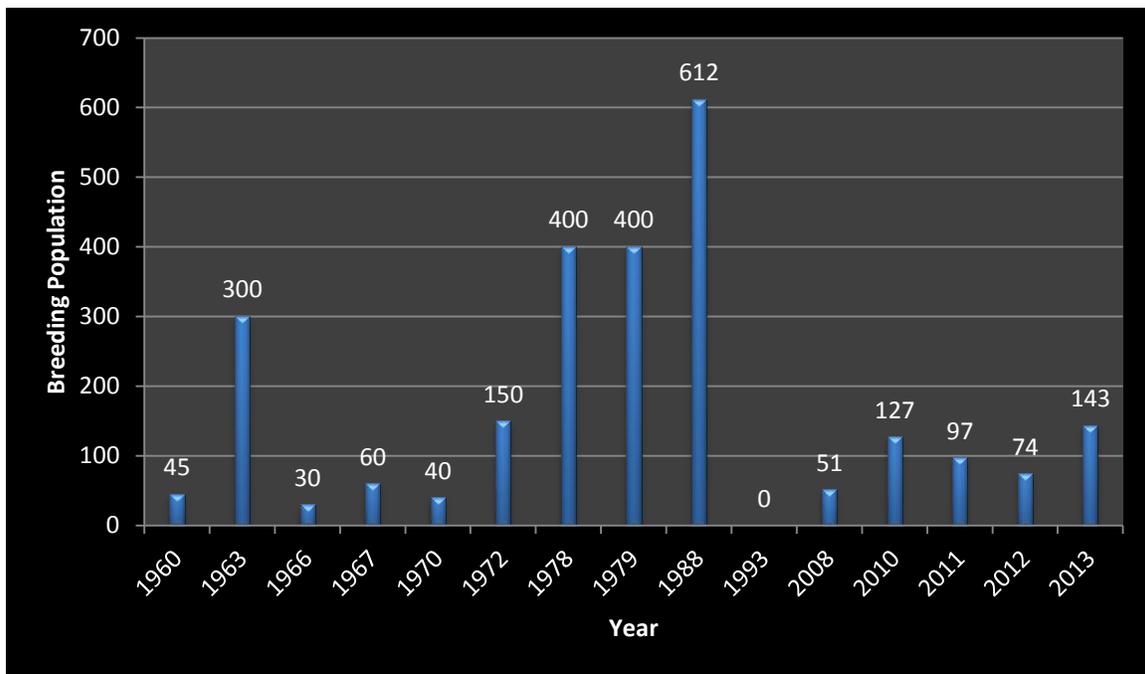


Figure 7. Tufted Puffin breeding population estimates 1960 – 2013 (Naughton et al. 2007, USFWS unpublished data).

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 4).

Table 4. 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 largest puffin colony in Oregon due to declines at other sites along the coast. A monitoring study of Tufted Puffins at Haystack Rock during 2010-13 included instantaneous counts and burrow occupancy protocol. This study concluded peak bird counts occurred in July during the hatching or chick rearing period. Many burrows were found to be occupied and are a good estimator of the breeding population. The 2013 population estimate indicates 143 individual Tufted Puffins breed at Haystack Rock. In addition, 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.

ACKNOWLEDGEMENTS

Richard Messenger and Mike Brownle were volunteer observers in 2010 and 2011 respectively and Tim Halloran in 2012 and 2013. 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. Nala Cardillo formerly of the Haystack Rock Awareness Program (HRAP) 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.

LITERATURE CITED

- 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.
- 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.
- 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. 2014. Draft Washington state status report for the Tufted Puffin. Washington Department of Fish and Wildlife, Olympia, Washington. 61 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.
- Naughton, M.B., D.S. Pitikin, 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.
- 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.
- 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.
- Udvardy, M.D.F. 1963. Zoogeographical study of the Pacific Alcidae. Proc. Pac. Sci. 10: 85-111.

Appendix 1. Tufted Puffin instantaneous counts datasheet.

TUFTED PUFFIN INSTANTANEOUS COUNTS – HAYSTACK ROCK 2013

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:					

Scan 5 Notes:					

Additional Notes:					

