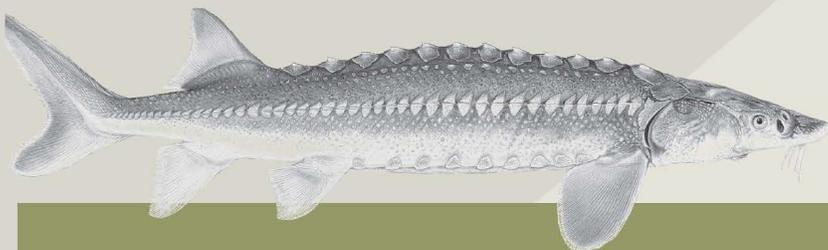
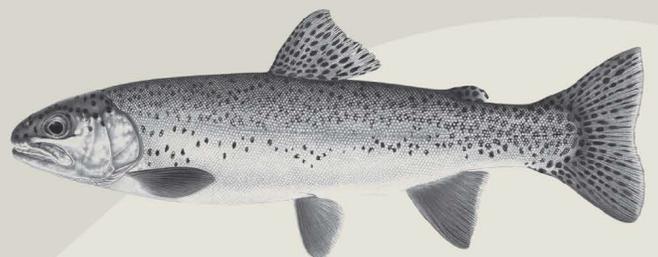




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Distribution and abundance of Steller sea lions (*Eumetopias jubatus*)
in Oregon, July 2025



Steller sea lion survey at Orford Reef, 3 July 2025.

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January 2026

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ABSTRACT

The Oregon Department of Fish and Wildlife’s Marine Mammal Program conducted a coastwide aerial photographic survey of Steller sea lions (*Eumetopias jubatus*) on 3 July 2025, timed to coincide with the peak of the breeding season after most pups had been born. A total of 9,287 sea lions were counted, including 2,565 pups and 6,722 non-pups. Applying survey correction factors developed for Steller sea lions in British Columbia, Canada, the total population during the 2025 breeding season was estimated to be between 11,000 and 12,500 animals. The largest aggregation was at the Pyramid Rock rookery at Rogue Reef, accounting for just over one-quarter of all animals counted ashore. Counts of both pups and non-pups in 2025 were the highest recorded in Oregon since surveys began in the late 1970s and reflect ongoing long-term population growth in the state and across the eastern Distinct Population Segment (DPS) of Steller sea lions, which ranges from California to southeast Alaska. Future work will include periodic statewide surveys, targeted site assessments, and long-term trend analyses to inform local-, state- and DPS-level management and conservation planning.

INTRODUCTION

The Steller sea lion (*Eumetopias jubatus*) is the largest member of the family Otariidae (eared seals) and is distributed throughout the North Pacific Rim, ranging from California northward and westward to Japan. Historical estimates suggest that population abundance during the 1950s was approximately 240,000–300,000 individuals (Loughlin 2002; NMFS 2008). During the 1970s and 1980s, however, populations in western Alaska declined by as much as 75%, leading to the species’ listing as threatened under the U.S. Endangered Species Act (ESA) in 1990 (U.S. Federal Register 1990). In 1997, the National Marine Fisheries Service (NMFS) designated two Distinct Population Segments (DPS; hereafter “stocks”) separated at 144°W longitude (Loughlin 1997), although subsequent genetic analyses have suggested evidence for a distinct Asian/Russian stock (Baker et al. 2005). Continued declines in the western stock resulted in its reclassification as endangered (U.S. Federal Register 1997). In contrast, the eastern stock continued to increase and, although initially listed as threatened, was delisted in 2013 (NMFS 2013; U.S. Federal Register 2013).

Steller sea lions in Oregon are part of the eastern stock, which is distributed from central California to southeast Alaska (see Appendix 1 for a bibliography of Steller sea lion studies conducted in, or using data from, Oregon). The Marine Mammal Program of the Oregon Department of Fish and Wildlife (ODFW) has conducted periodic aerial surveys of Steller sea lions and other pinnipeds in Oregon since the late 1970s (e.g., Brown 1988; Brown et al. 2005; Pitcher et al. 2007; Wright and Riemer 2024). The primary objectives of these surveys are to document the status and trends of pinniped populations in Oregon to inform conservation, management, and development activities and to support federal marine mammal stock assessments (e.g., Young et al. 2024). Federal stock assessments, in turn, are used to authorize the incidental take of marine mammals associated with human activities in Oregon, including commercial fisheries and marine infrastructure development.

In 2025, we conducted a coastwide aerial survey during the Steller sea lion breeding season to assess the status of Oregon's portion of the eastern stock. The survey was designed to provide a minimum count of animals hauled out at known rookeries and haulout sites under standardized conditions comparable to previous surveys. The objective of this paper is to report on the status of the population in 2025; detailed analyses of population trends at the state and stock levels will be presented in future reports by ODFW and NMFS, respectively.

METHODS

Survey design and flight operations

Population surveys for Steller sea lions in Oregon are standardized to occur during the peak of the breeding season, from late June through mid-July, after most pups have been born. Specific survey dates and times within this period are chosen to maximize counts by targeting lower tide levels, optimal weather conditions, and mid-morning to mid-afternoon windows, when the largest number of sea lions are expected to be hauled out on land. Ideally, a coastwide survey is completed in a single day, although multiple days are sometimes required due to patchy coastal fog or low clouds partially obscuring the coast.

In 2025, the survey was conducted from a Cessna 206H with a two-person crew: the pilot and a biologist (the first author) in the front right seat. The biologist was responsible for guiding the pilot, locating animals, and taking photographs. Surveys were flown from south to north at an altitude of approximately 300 m. All known haulout sites were either photographed or viewed with binoculars, while new sites were searched for during transit between known locations. Sites were typically orbited at least once, although some could be photographed on a single pass without orbiting.

Oblique photographs were taken through a partially open forward passenger window. Images were captured in JPEG format using a hand-held digital single-lens reflex (DSLR) camera (Nikon D800, 36.3 MP) with a 28-300 mm zoom lens (Nikkor f/3.5-5.6G ED VR), with most photographs taken at a 300 mm focal length. A tablet running ArcGIS Field Maps was used to guide the survey, while a handheld GPS unit (Garmin GPSMAP 78sc) and a timelapse video camera (GoPro Hero9 Silver) were used to document the flight and support post-survey data processing.

Photograph processing and sea lion counts

Aerial photographs were processed, and animals were counted, using ESRI software (ArcGIS Pro 3.5) following the methods described in Wright (2005). Briefly, a custom R script (R Core Team 2025) georeferenced each photograph to the location of the airplane at the time it was taken by matching the image timestamp with the nearest GPS track point. One or more subsets of images were then added to a map and manually mosaicked to create composite images for counting. Counted animals were stored in point layers by age class (pups and non-pups) and assigned attribute information (e.g., location, site, date).

Steller sea lion counts were assigned to discrete map locations using a multi-level naming convention consisting of location, site(s) within location, and occasionally subsite(s) within a site. Location and site names were generally based on prominent landscape features such as reefs, individual rocks, or capes and headlands, while finer-scale subsites were typically informal descriptors. Following Fritz et al. (2013), sites were classified as haulouts or rookeries, with the latter defined as sites where at least 50 pups were counted. An interactive atlas of all pinniped haulout locations in Oregon is available through ODFW (2025).

Data management and quality control

After initial counting, all data underwent a quality control review. A second observer (the second author) examined counts for omissions, double counting, and potential species misclassification. Georeferenced point layers were checked for consistency with known haulout and rookery locations, and metadata were created for each image, including date, time, and GPS coordinates.

Abundance estimation

Survey counts in this study reflect animals observed ashore during standardized aerial surveys. Therefore, non-pup counts exclude animals at sea, and pup counts exclude animals born after, or that died before, the survey. Although demographic multipliers (e.g., total pup production \times 4.5; Calkins and Pitcher 1982) and correction factors for non-pups at sea (e.g., non-pups ashore \times 1.48; Olesiuk 2018) have been developed for some regions, these approaches have not been validated across the species' range (Young et al. 2024). Consequently, we only report raw counts in the results and reserve speculation about total population abundance for the discussion.

RESULTS

Survey effort

The operational survey window for the 2025 breeding season spanned the last week of June and the first week of July (Table 1). Of the potential survey days, several were missed because the aircraft was unavailable or survey conditions were unfavorable. One flight attempt was canceled while en route because cloud cover was lower than forecasted. The only successful survey occurred on 3 July, resulting in a complete, high-quality coastwide survey of all known haulout and rookery sites. The survey resulted in over 1,200 images across 16 locations. Maps of the flight track and example survey images are provided in Appendices 2 and 3, respectively.

Sea lion counts

A total of 9,287 Steller sea lions, including 2,565 pups and 6,722 non-pups, were counted from aerial survey imagery (Figure 1, Table 2). The two locations with the largest counts, which contain Oregon's only official rookeries (i.e., sites with ≥ 50 pups), were Orford Reef and Rogue Reef. Orford Reef, containing five individual rookery sites, accounted for 28.1% of the statewide non-

Table 1. Survey windows and outcomes for the 2025 Steller sea lion survey in Oregon.

| Date | Outcome | Coverage | Quality |
|------|--|----------|---------|
| 6/23 | Aircraft unavailable | | |
| 6/24 | Cancelled en route due to lower than forecasted coastal clouds | | |
| 6/25 | Aircraft unavailable | | |
| 6/26 | Aircraft unavailable | | |
| 6/27 | Cancelled due to weather forecast | | |
| 6/30 | Aircraft unavailable | | |
| 7/1 | Cancelled due to high wave forecast | | |
| 7/2 | Cancelled due to high wave forecast | | |
| 7/3 | Survey conducted | Complete | High |
| 7/4 | Aircraft unavailable | | |

pup counts and 55.4% of pup counts. Rogue Reef, containing two rookery sites, accounted for 27.6% of the statewide non-pup counts and 43.7% of pup counts. Among all surveyed sites, the Pyramid Rock site at Rogue Reef had the highest single-site count, holding just over one-quarter of all sea lions counted ashore during the 2025 survey.

DISCUSSION

Sea lion counts

The 2025 counts of Steller sea lion non-pups and pups are the highest recorded in Oregon since intermittent surveys began in the late 1970s. These results reflect long-term growth in both the state population and the broader eastern stock (Young et al. 2024). This increase is important for understanding regional population dynamics, informing management strategies, and evaluating the effectiveness of conservation measures implemented in Oregon and across the species' range. Several caveats should be considered, however, when interpreting these counts.

First, although both historical and currently known haulout and rookery sites are well documented, and new sites are actively searched for during aerial surveys, animals located at atypical or previously unknown sites may still go undetected. Such undetected individuals could introduce uncertainty into population estimates and complicate comparisons with past surveys. However, the probability of missing a site generally decreases with group size, as larger aggregations are more easily observed from the air, suggesting that the potential impact on overall population totals is likely minimal.

Second, while Steller sea lions are generally the only species present at most sites, at Cape Arago they often co-occur with California sea lions, which can complicate species identification for some age classes. This challenge could be addressed in future surveys by supplementing crewed coastwide aerial surveys with targeted uncrewed aerial vehicle (UAV) flights, which can provide higher-resolution imagery through lower-altitude, longer-duration surveys. Such an approach would likely improve species differentiation and reduce uncertainty at mixed-species sites.

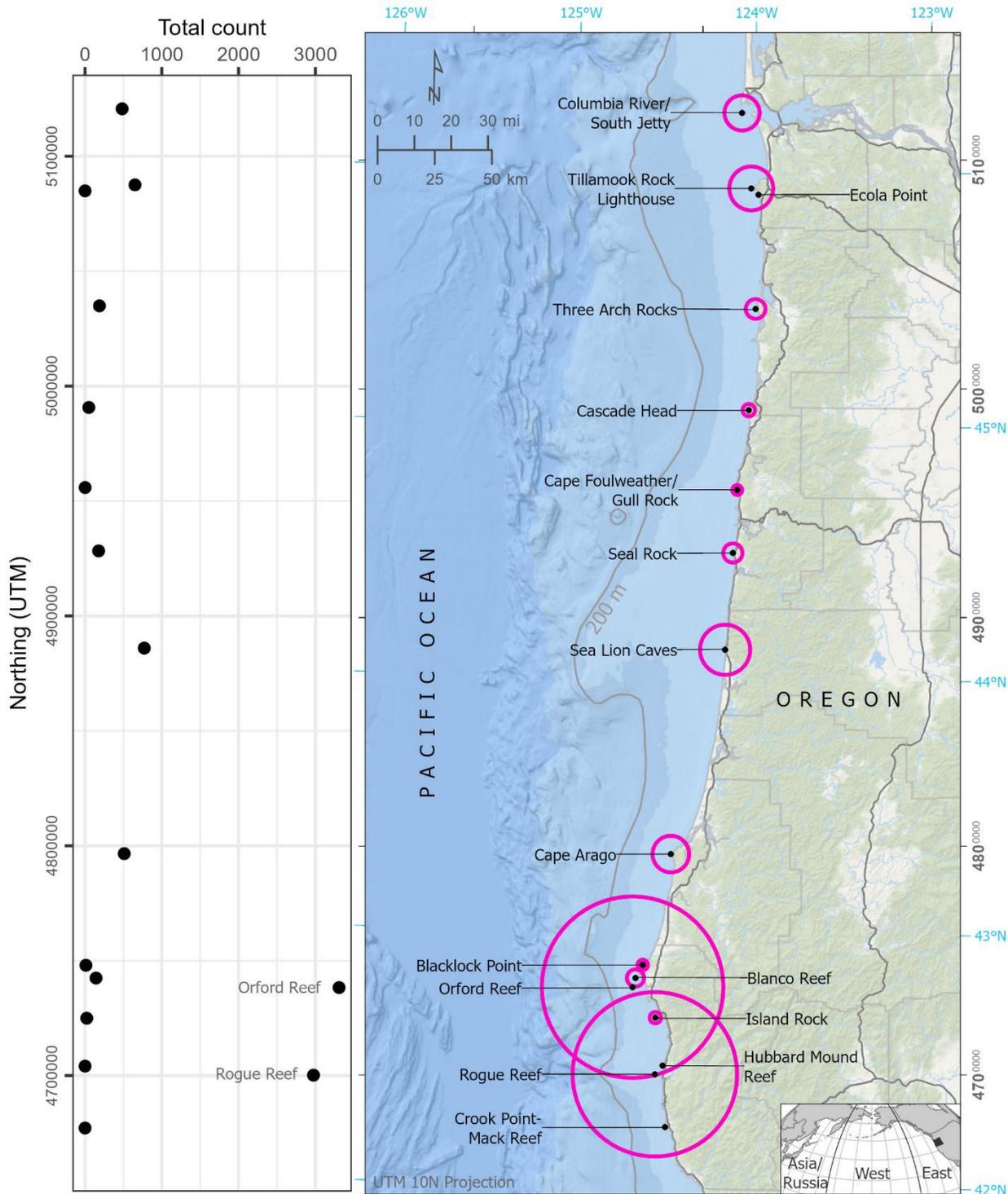


Figure 1. Counts of Steller sea lions ashore during the 3 July 2025 breeding season survey in Oregon. Circles on the map at right are proportional in size to the total counts shown in the graph at left. Inset map shows approximate species range along the North Pacific Rim and longitudinal boundaries for the Asian/Russian, western, and eastern stocks.

Table 2. Counts of Steller sea lions ashore during the 3 July 2025 breeding season survey in Oregon; locations are sorted from north to south.

| Location/Site | Location | | | | Site | | | |
|--------------------------------|--------------|--------------|--------------|------------|---------|-----|-------|---------|
| | Non-pup | Pup | Total | % Total | Non-pup | Pup | Total | % Total |
| Columbia River/South Jetty | 483 | 0 | 483 | 5.2 | | | | |
| Tillamook Rock Lighthouse | 643 | 7 | 650 | 7.0 | | | | |
| Ecola Point | 0 | 0 | 0 | 0 | | | | |
| Three Arch Rocks | 181 | 6 | 187 | 2.0 | | | | |
| Cascade Head | 49 | 0 | 49 | 0.5 | | | | |
| Cape Foulweather/Gull Rock | 1 | 0 | 1 | 0.0 | | | | |
| Seal Rock | 177 | 0 | 177 | 1.9 | | | | |
| Sea Lion Caves (exterior only) | 767 | 4 | 771 | 8.3 | | | | |
| Cape Arago | 504 | 6 | 510 | 5.5 | | | | |
| /Simpsons Reef | | | | | 328 | 0 | 328 | 64.3 |
| /Shell Island area | | | | | 176 | 6 | 182 | 35.7 |
| Blacklock Point | 11 | 0 | 11 | 0.1 | | | | |
| Blanco Reef | 143 | 0 | 143 | 1.5 | | | | |
| Orford Reef | 1,887 | 1,421 | 3,308 | 35.6 | | | | |
| /Arch Rock* | | | | | 264 | 182 | 446 | 13.5 |
| /Best Rock* | | | | | 262 | 146 | 408 | 12.3 |
| /Flat Black Rock | | | | | 7 | 0 | 7 | 0.2 |
| /Large Brown Rock | | | | | 60 | 34 | 94 | 2.8 |
| /Long Brown Rock* | | | | | 591 | 524 | 1,115 | 33.7 |
| /Seal Rock* | | | | | 361 | 340 | 701 | 21.2 |
| /Square White Rock | | | | | 10 | 0 | 10 | 0.3 |
| /Steamboat Rock area | | | | | 63 | 1 | 64 | 1.9 |
| /West Conical Rock* | | | | | 248 | 193 | 441 | 13.3 |
| /Miscellaneous rocks | | | | | 21 | 1 | 22 | 0.7 |
| Island Rock | 22 | 0 | 22 | 0.2 | | | | |
| Hubbard Mound Reef | 0 | 0 | 0 | 0 | | | | |
| Rogue Reef | 1,854 | 1,121 | 2,975 | 32.0 | | | | |
| /Double Rock | | | | | 74 | 0 | 74 | 2.5 |
| /Needle Rock* | | | | | 272 | 149 | 421 | 14.2 |
| /Pyramid Rock* | | | | | 1,401 | 972 | 2,373 | 79.8 |
| /South Seal Rock | | | | | 29 | 0 | 29 | 1.0 |
| /Miscellaneous rocks | | | | | 78 | 0 | 78 | 2.6 |
| Crook Point-Mack Reef | 0 | 0 | 0 | 0 | | | | |
| Total | 6,722 | 2,565 | 9,287 | 100 | | | | |

*Rookery (i.e., sites with ≥ 50 pups).

A final caveat is that Steller sea lions make wide-ranging seasonal movements, particularly juveniles and adult males (Jemison et al. 2013; Wright et al. 2017; Rehberg et al. 2018), so summer breeding-season counts will not reflect their distribution and abundance at other times of the year. For example, individuals marked as pups in Oregon have been documented as far north as the Gulf of Alaska (Wright et al. 2017), and although largely absent from the Columbia River during summer, over a hundred individuals regularly travel upriver each winter and spring to forage on eulachon (*Thaleichthys pacificus*), white sturgeon (*Acipenser transmontanus*), and salmonids (*Oncorhynchus* spp.) (Clark et al. 2025; ODFW 2025; Wright et al. 2025).

Abundance estimation

As noted previously, survey counts underestimate true population size, primarily because a portion of the non-pup population is foraging at sea during surveys and therefore unavailable for counting. Although no universally accepted method exists for estimating total population size of Steller sea lions, several approaches have been proposed to account for animals not observed ashore. Here, we explore two such estimators developed by Olesiuk (2018) for Steller sea lions in British Columbia, Canada, which also belong to the eastern stock.

The first estimator is based on modifications to the life-table analysis of Calkins and Pitcher (1982), which estimated that for a stable population of Steller sea lions in Alaska the total population size at the end of the pupping season averaged 4.5 times the total pup production. For an increasing population such as the eastern stock, however, Olesiuk (2018) found that this correction factor could range from 4.28 to 4.65. Applying this range to the 2,565 pups counted ashore (Table 2), and rounding to the nearest hundred, suggests that approximately 11,000–11,900 Steller sea lions (pups and non-pups) were present in Oregon during the 2025 breeding season.

The second estimator uses satellite tag data to adjust survey counts for the proportion of non-pups that were at sea during standardized survey conditions and thus unavailable for counting. Based on a small sample ($n = 11$) of Steller sea lions of various ages and sexes tracked during 2004-2006, Olesiuk (2018) found that 67.4% of non-pups were hauled out during the breeding-season survey window, corresponding to a correction factor of 1.48. Applying this factor to the 6,722 non-pups counted ashore (Table 2), and rounding to the nearest hundred, yields a point estimate of approximately 9,900 non-pups in Oregon in 2025, and thus a total breeding-season population of approximately 12,500 animals.

While these estimators were developed using data collected outside of Oregon, they nonetheless provide a useful framework for approximating breeding-season population size and resulted in relatively similar estimates. However, because pup survival for Steller sea lions in Oregon can be relatively low in some years (Wright et al. 2017), and because many individuals disperse outside the state during the non-breeding season, these estimates should be interpreted as annual maxima in statewide abundance. As such, they are not expected to reflect the population size in Oregon at other times of the year.

Site classification

Terrestrial areas used by Steller sea lions are traditionally classified as either haulouts or rookeries, with the latter defined as sites where adult males actively defend territories and where parturition and impregnation occurs (Calkins and Pitcher 1982). Some authors further classify haulouts as either year-round or winter-only sites (Olesiuk 2018), or as incidental stopover sites (Calkins and Pitcher 1982). Others recommend avoiding the haulout–rookery labels entirely, instead using the terms landing area and breeding area (Gentry 2021). Based on our observations, we found it useful to differentiate between three types of terrestrial sites used during the breeding season: primary rookeries, secondary rookeries, and bachelor haulouts.

Primary rookeries are sites that meet the operational definition of a rookery used by Fritz et al. (2013), defined as sites with ≥ 50 pups. In Oregon, these occur at Orford Reef and Rogue Reef (Figure 1, Table 2), with the nearest additional primary rookery located to the south at St. George Reef, California (Appendix 2). Adult males begin arriving at these large rookeries in April and typically depart by late August, after which they move north into Washington, British Columbia, and Alaska. Adult females begin pupping in late May, with peak pup counts in late June and early July. Food habits data from Pyramid Rock, Rogue Reef, indicate that during this period females feed almost exclusively on North Pacific hake (*Merluccius productus*) (Riemer et al. 2011), making this fish stock a critical source of maternal energy transfer and therefore crucial to pup survival. By September, females and pups disperse from the rookeries and move north to other established haulout sites, where they may remain for weeks to months while nursing. Cape Arago is one such site, where more than 1,000 female–pup pairs have been documented during recent fall surveys (ODFW unpublished data).

Secondary rookeries are sites where only small numbers of pups are born (typically < 10) and include Cape Arago, Sea Lion Caves, Three Arch Rocks, and Tillamook Rock Lighthouse (Figure 1, Table 2). These sites have only a small number of large adult males but substantial numbers of adult females and juveniles. Pupping is typically limited to specific areas and adult females nursing juveniles are commonly observed. Unlike primary rookeries, males at secondary rookeries do not appear to defend fixed territories but instead move throughout the area where they have been observed copulating with females. As an example, we documented a marked adult male (929R) at Simpson Reef, Cape Arago, during five consecutive breeding seasons (2021–2025). This animal was marked as a pup at Rogue Reef in 2011 (see Wright et al. 2017) and was resighted 34 times between 2012 and 2019 in British Columbia and northwestern Washington before first being observed in Oregon in 2021 at age 10. Notably, it has not been observed at Rogue Reef during the breeding season and appears to preferentially use Simpson Reef instead. The role of such males and their contribution to overall reproduction is not well understood, but they likely represent an important component of the breeding population.

The reasons sexually mature females use secondary rookeries remain unclear. It is unlikely that the few adult males at these sites are able to breed with all available females. Because few pups appear to be born at these sites, we assume that many of these females were either not impregnated the previous year or experienced fetal loss. Space on primary rookeries may also be

limited as the population increases, or some females may be too young or too old to participate in primary rookeries. In addition, many females are still nursing one- or two-year-old offspring, and because bringing juveniles into primary rookeries is rare, secondary sites may provide an alternative option for these females.

The third type of site is a “bachelor” haulout. There are approximately a half dozen of these sites spread along the coast in a typical year. Many occur near primary rookeries (e.g., Double Rock and South Seal Rock at Rogue Reef), while others, such as Cascade Head, are located farther away. Males using these sites appear to be either younger or older than territorial males at rookeries and are presumably individuals that are either not yet capable of, or no longer competitive in, territorial defense.

Two additional sites do not fit any of these patterns: Seal Rock and the South Jetty of the Columbia River (Figure 1, Table 2). Both sites support large adult males with no apparent territories, as well as large numbers of adult females, some of which are nursing yearlings and even two-year-olds but not pups. It is possible that these sites are not suitable for pupping or pup survival, as they can be washed over by higher tides and swell. For example, we received a report of a newborn Steller sea lion pup on the beach near Seal Rock on 24 June 2024. It is possible that this animal was born at this site and subsequently washed ashore.

Implications and future work

The data presented here document the status of Steller sea lions in Oregon during the 2025 breeding season. These data can inform conservation, management, and coastal development decisions and contribute to federal stock-level assessments, which are used to authorize the incidental take of marine mammals associated with human activities in Oregon, including commercial fisheries and marine infrastructure development. In addition, the data can be used to help evaluate the potential effects of Steller sea lion management in the lower Columbia River (e.g., Clark et al. 2025; Wright et al. 2025) and to provide context for ongoing research into Steller sea lion survival rates in the Pacific Northwest (e.g., Wright et al. 2017).

Looking ahead, future work will include periodic statewide breeding-season surveys to document changes in distribution and abundance, supplemented by more frequent monitoring at select sites using UAVs and other observation platforms. These efforts will support analyses of long-term population trends in Oregon and collaboration with NMFS to inform stock assessments.

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APPENDICES

Appendix 1. Bibliography of research conducted in, or containing data from, Oregon, where Steller sea lions were the focus of the study or a significant part of the findings.

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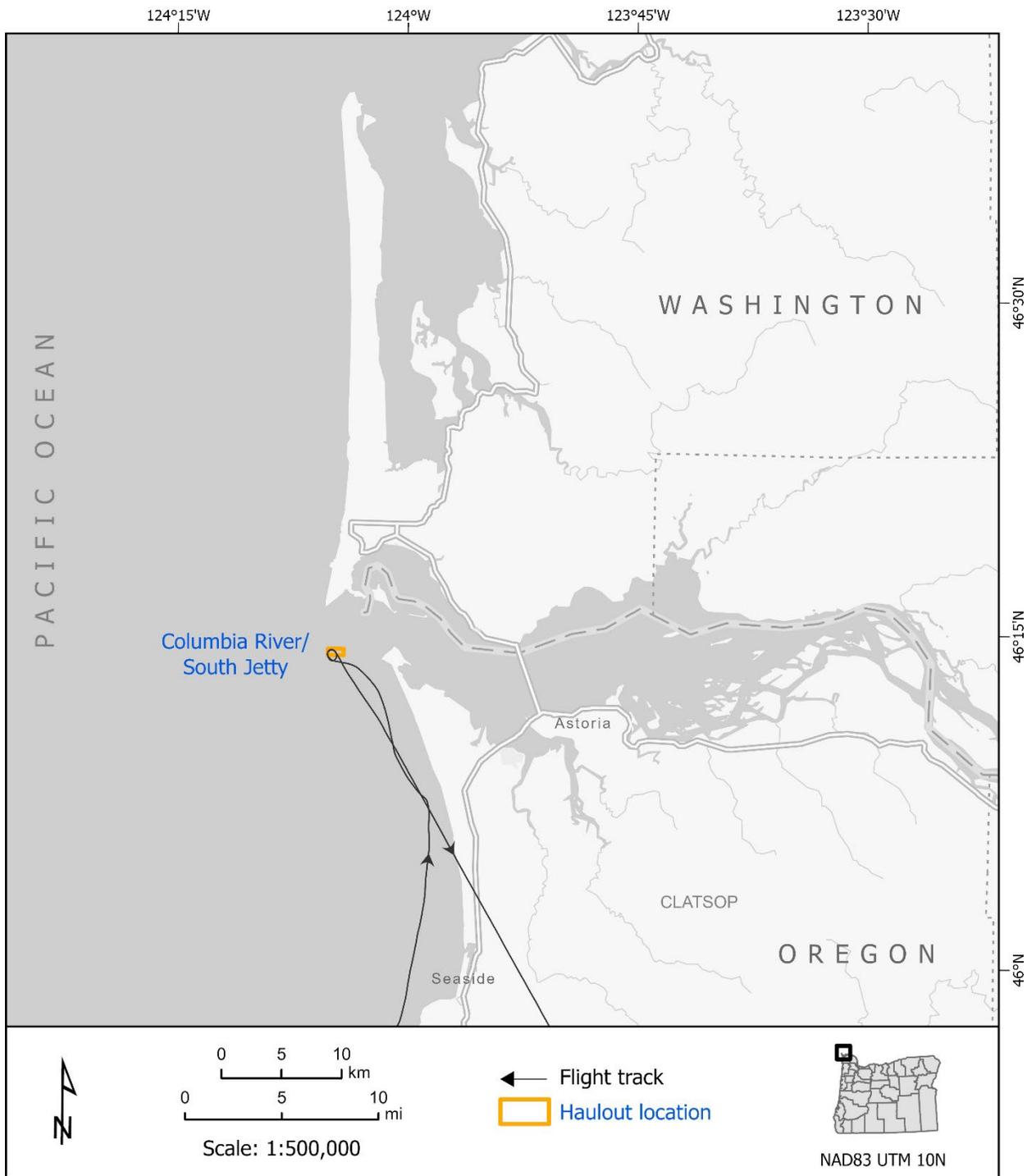
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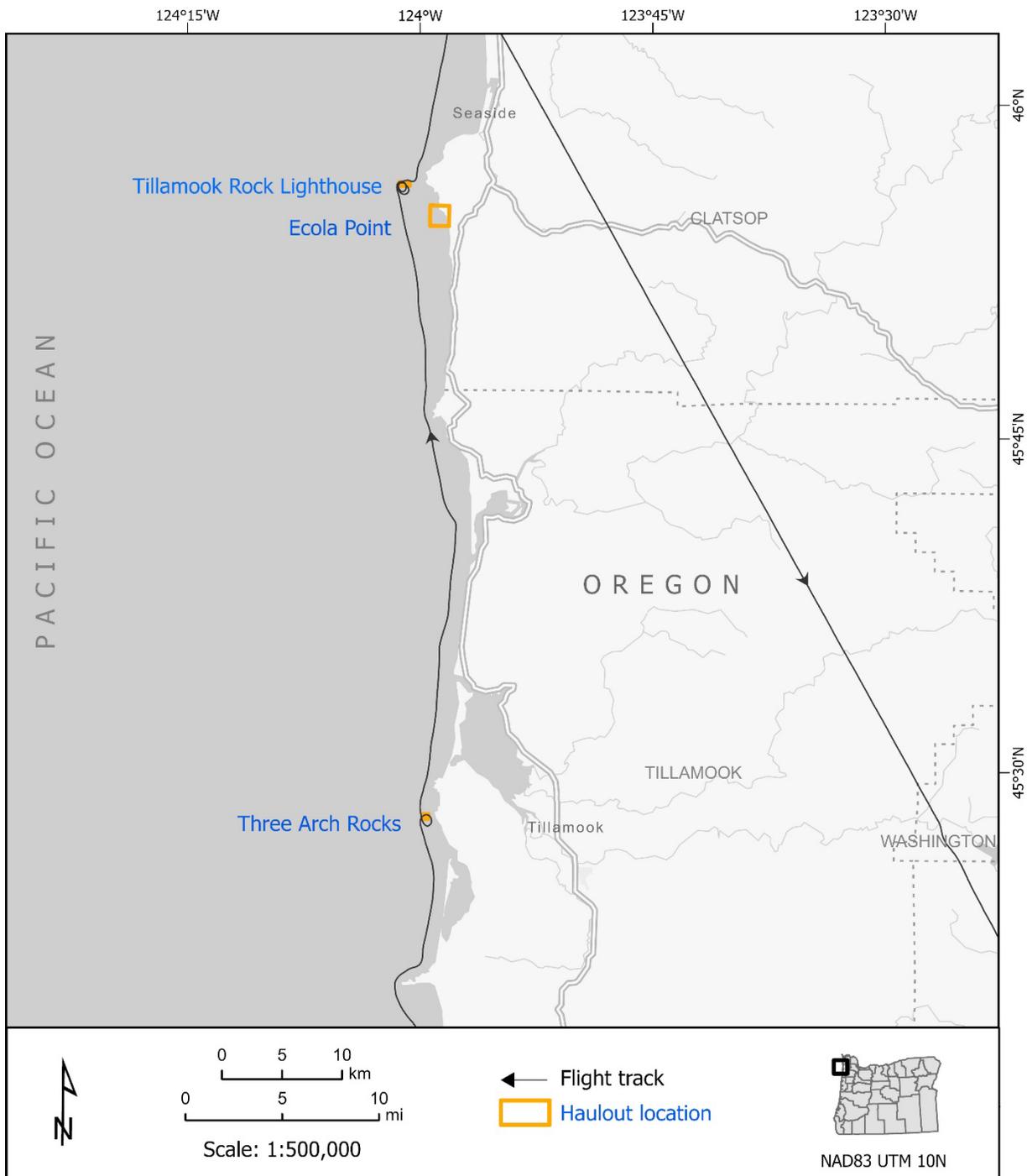
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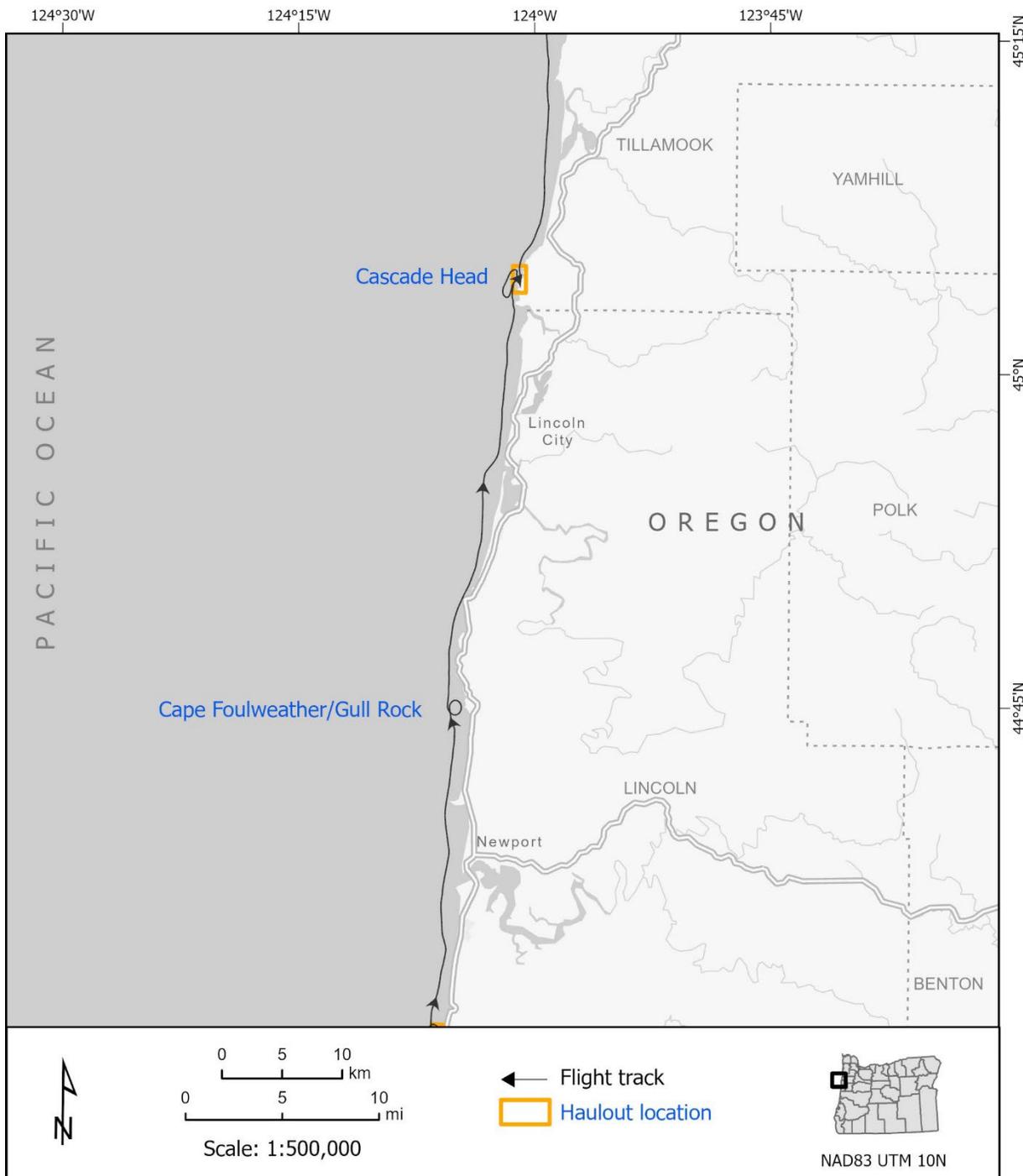
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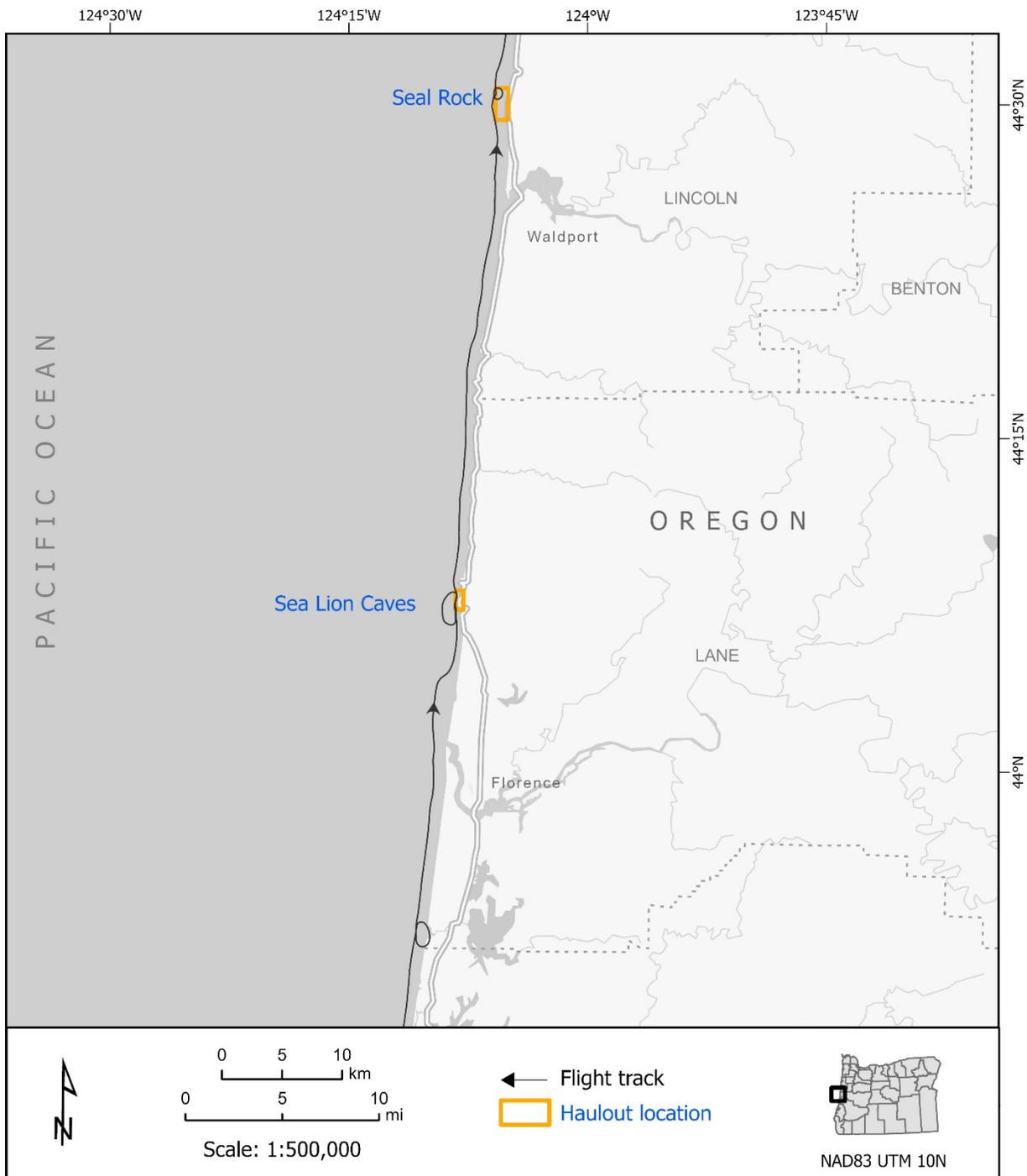
Appendix 2. Flight track and haulout locations from the 3 July 2025 Steller sea lion breeding season survey in Oregon.



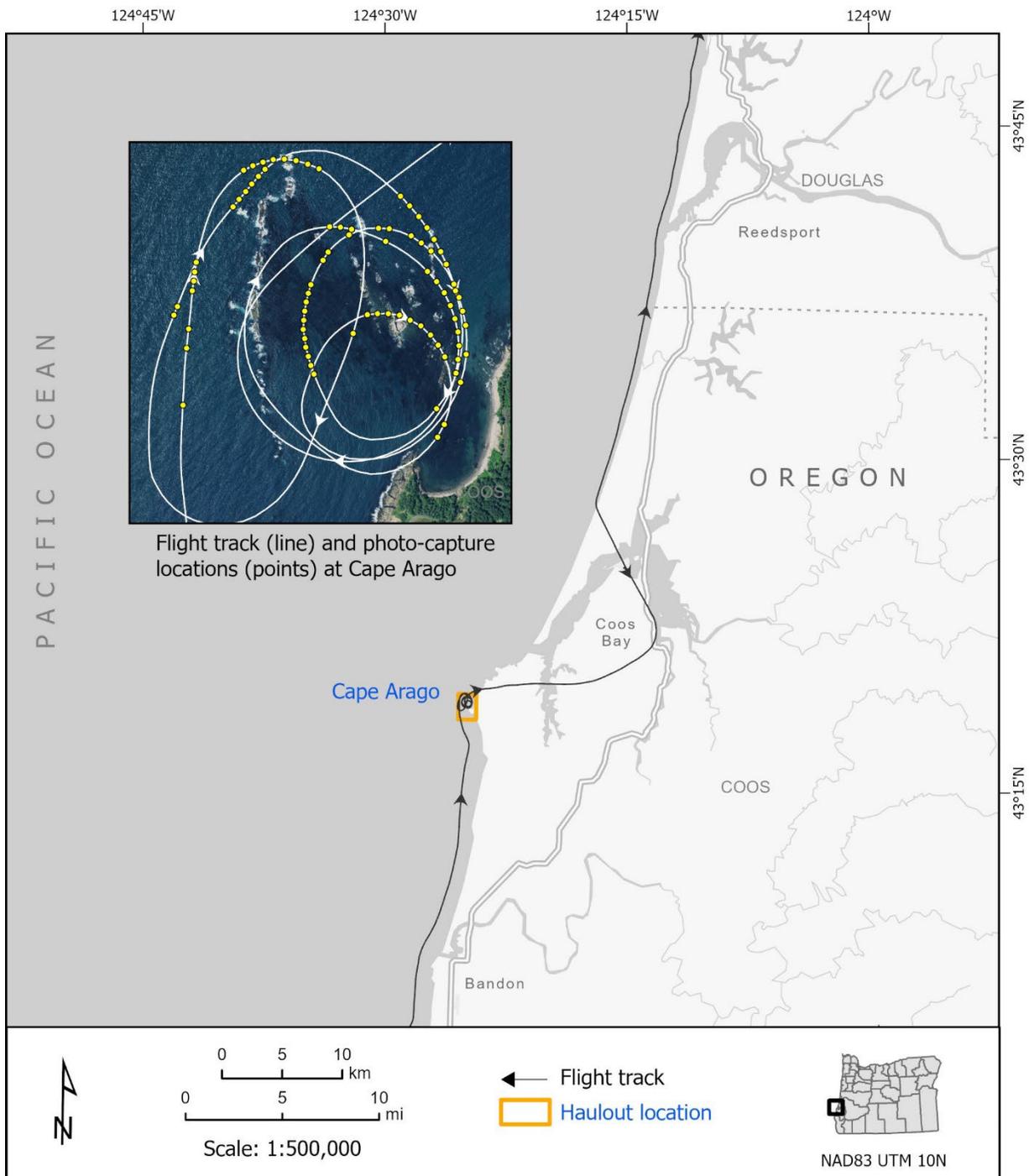
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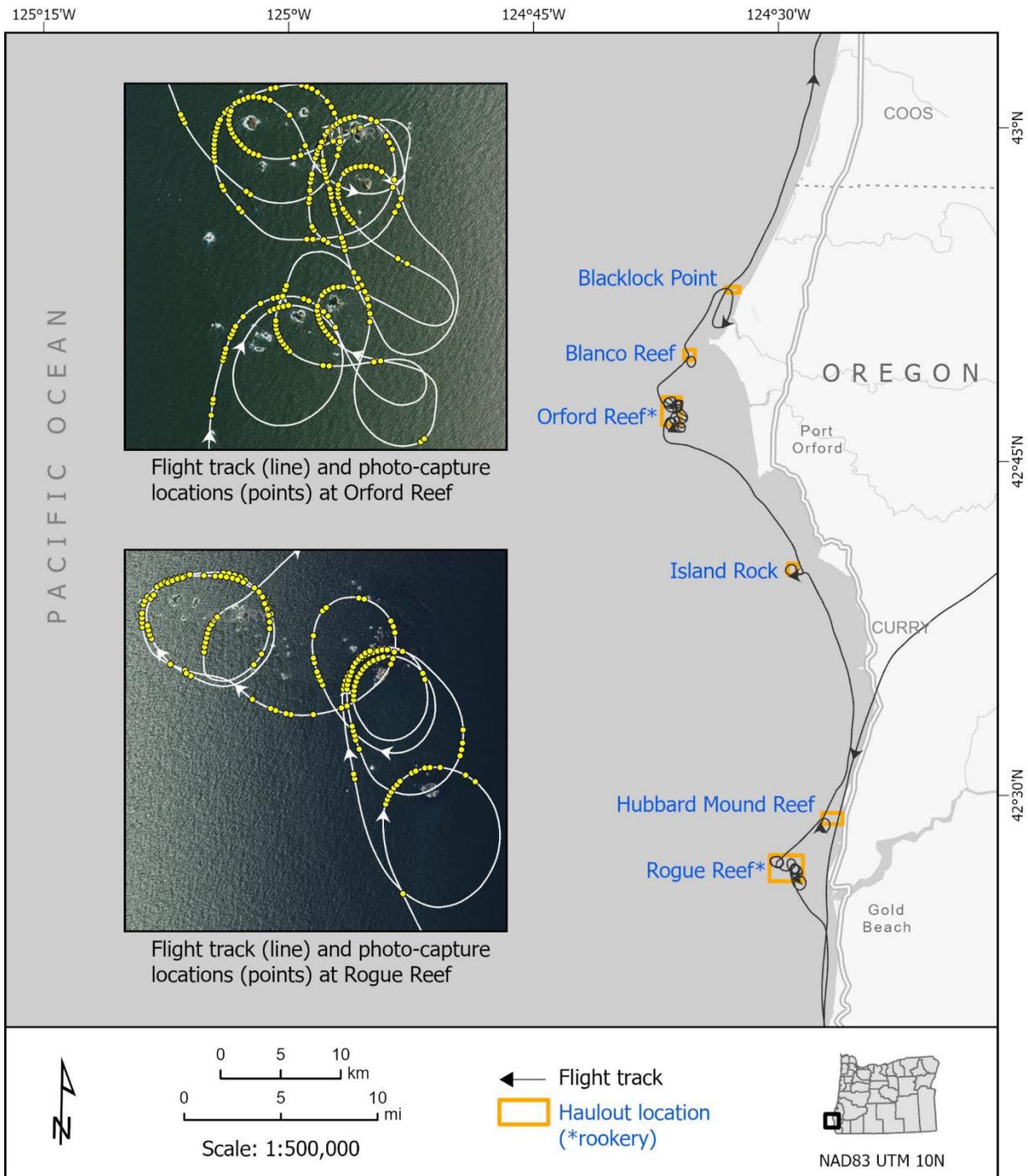
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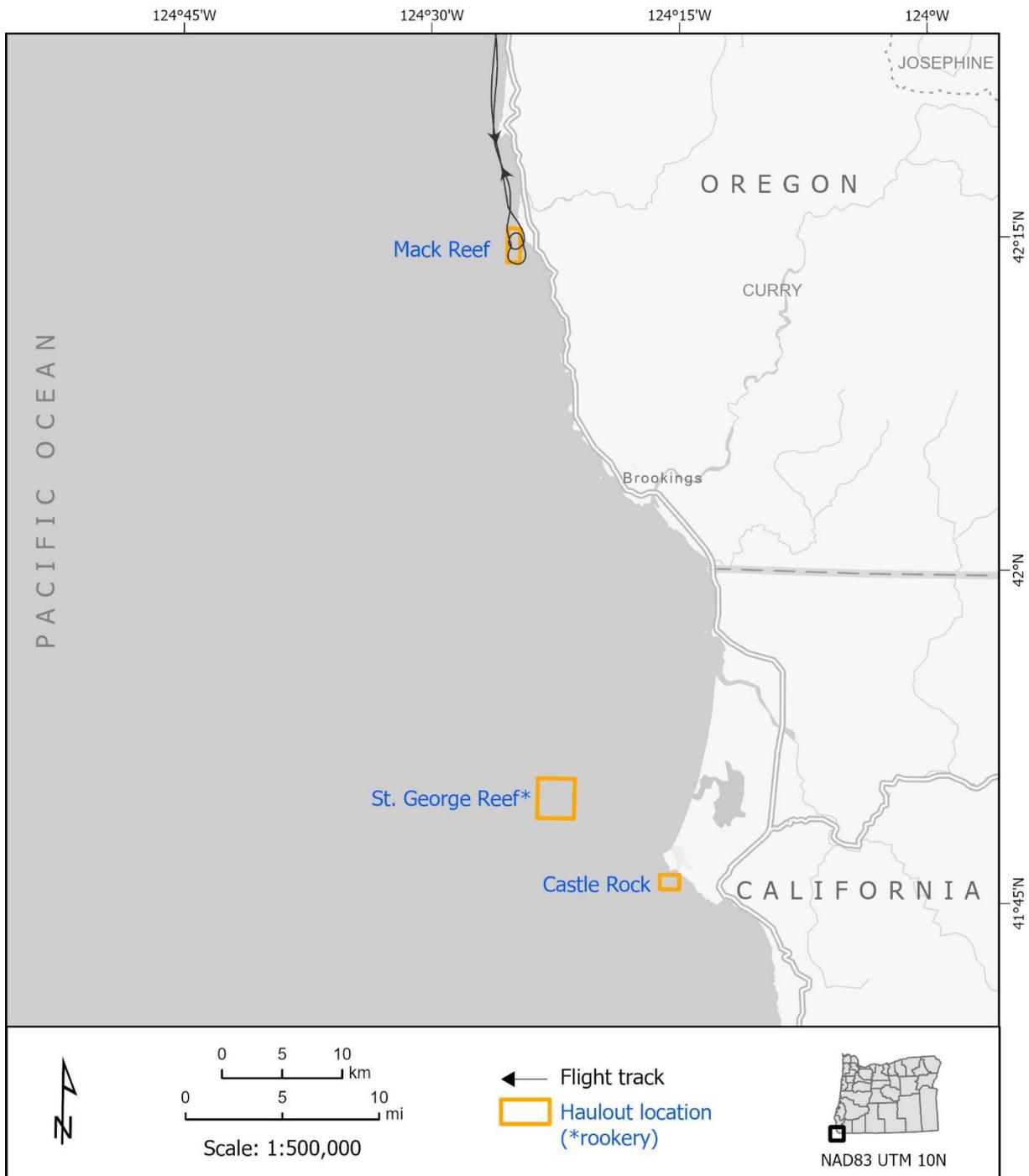
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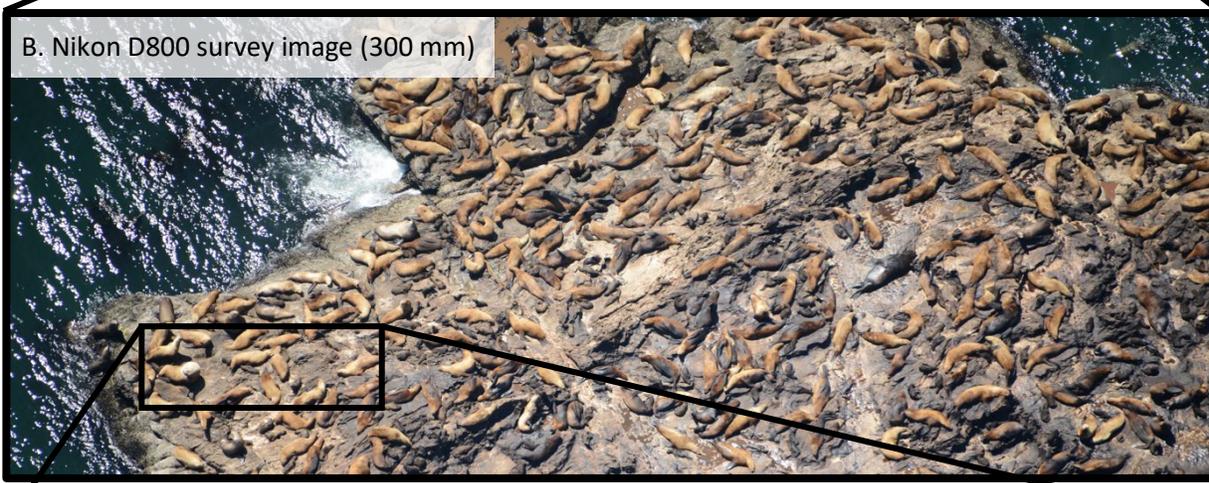
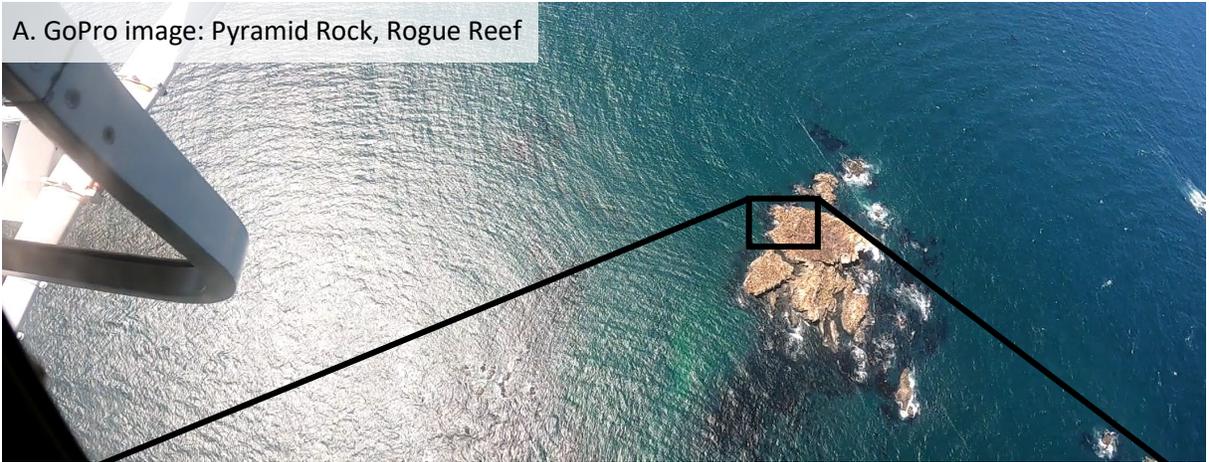
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Appendix 2. (continued)



Appendix 2. (continued)



Appendix 3. Steller sea lion survey imagery from Pyramid Rock, Rogue Reef, Oregon (11:49 a.m. PDT, July 3, 2025). MMPA Permit No. 27597.



4034 Fairview Industrial Drive SE
Salem, OR 97302