OCS Study
BOEM 2014-013

Nocturnal Surveys for Ashy Storm-Petrels (*Oceanodroma homochroa*) and Scripps's Murrelets (*Synthliboramphus scrippsi*) at Offshore Oil Production Platforms, Southern California

Final Report

Platform Grace with radar equipment mounted on the corner of the platform and Santa Cruz Island in the background.

U.S. Department of the Interior
Bureau of Ocean Energy Management
Pacific OCS Region

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Final Report

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DISCLAIMER

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Abbreviations and Acronyms

asl	above sea level
BOEM	Bureau of Ocean Energy Management
NPS	National Park Service
POCS	Pacific Outer Continental Shelf
USFWS	U.S. Fish and Wildlife Service

1. Introduction

The attraction of seabirds to bright lights and associated light-induced mortality of seabirds has been well-documented (Imber 1975, Reed et al. 1985, Telfer et al. 1987, Le Corre et al. 2002). The extent of this light-induced threat is unknown, but has been recognized for two special-status California seabird species, the Scripps's Murrelet (*Synthliboramphus scrippsi;* previously Xantus's Murrelet [*S. hypoleucus*]) and Ashy Storm-Petrel (*Oceanodroma homochroa*) (Carter et al. 2000, McCrary et al. 2003, U.S. Fish and Wildlife Service [USFWS] 2012, 2013). Dead Ashy Storm-Petrels have been recovered at Platform Hondo in the Santa Barbara Channel and at coastal locations in southern California with bright lights (Carter et al. 2000). The threat of artificial lighting is considered large for Ashy Storm-Petrels, potentially affecting over 35% of the total breeding population (Harvey 2012, USFWS 2013). Light attraction has been reported for the Scripps's Murrelet at a coastal location in central California (Carter et al. 2000, USFWS 2012). In addition, both species have been observed landing on or colliding with brightly lit boats at night off southern California (D. Pereksta, personal observation). Incidental observations like these are the only existing information regarding the effects of artificial lighting on these two species and no directed studies have been conducted to date. The Scripps's and Guadalupe Murrelet Technical Committee of the Pacific Seabird Group has identified lighting studies as a need to fill information gaps for these species. Lighting studies were also recommended for the Ashy Storm-Petrel in recent summaries of its status and threats (Carter et al. in Shuford and Gardali 2008, USFWS 2013).

Offshore oil operations are conducted from 27 platforms along the southern coast of California and all within the ranges of Scripps's Murrelets and Ashy Storm-Petrels (Briggs et al. 1987, McCrary et al. 2003). Twenty three of these platforms are overseen by BOEM and the remaining four are managed by the State of California. Offshore platform lights are used to illuminate work areas and to make the platforms visible to ocean vessels. In the near future, offshore renewable energy production is likely to be proposed along the Pacific Outer Continental Shelf (POCS) including coastal regions of southern California (USFWS 2009, 2013). Marine radar has been used to detect nocturnal seabirds, including Scripps's Murrelets and Ashy Storm-Petrels, near breeding colonies, and in low-light conditions where detections of the seabirds by other methods is difficult and often impossible (Hamer et al. 1995, 2005). Through previous radar studies off southern California, identification of multiple seabird species was determined based on differentiation by radar flight speeds and echo sizes while monitoring Scripps's Murrelet nesting colonies at night (Hamer et al. 2005). Marine radar was determined as a practicable method to employ to detect seabirds that may be attracted to bright lights on offshore oil platforms in the POCS region of southern California.

The observance and monitoring of two special-status, nocturnal seabird species, Scripps's Murrelet and Ashy Storm-Petrel near operating offshore oil platforms in the Santa Barbara Channel of southern California was the primary purpose of this study. Other specific objectives of this study included: (1) evaluating the extent to which Scripps's Murrelets and Ashy Storm-Petrels interact with bright lights of offshore oil platforms off the coast of southern California and; (2) determine if important rafting and foraging areas exist for these birds near offshore platforms.

2. Background

2.1 Scripps's Murrelet (formerly Xantus's Murrelet)

In 2012 the Xantus's Murrelet (*Synthliboramphus hypoleucus*) was split into two species now known as the Scripps's Murrelet (*Synthliboramphus scrippsi*) and Guadalupe Murrelet (*Synthliboramphus hypoleucus*) siting differences between breeding range, lack of interbreeding where ranges overlap, genetics, morphology and calls (Birt et al. 2012, Chesser et al. 2012). For this report, Scripps's Murrelet is of primary focus, which nest in loose colonies on the California Channel Islands of San Miguel, Santa Cruz, Anacapa, Santa Barbara Santa Catalina and San Clemente Islands, and San Benito, Coronado and San Jerónimo Islands off of Baja California, Mexico (Hunt et al. 1979, 1980, Murray et al. 1983, Carter et al. 1992, Drost and Lewis 1995, Chesser et al. 2012, USFWS 2013). The Guadalupe Murrelet breeds further south on islands off of Baja California, Mexico from Guadalupe Island south to the San Benito Islands (Chesser et al. 2012). However, unconfirmed breeding accounts of the Guadalupe Murrelet have been noted on the Channel Islands of San Clemente and Santa Barbara (Chesser et al. 2012).

Scripps's Murrelet are small with a length of 23 to 25 cm (9 to 10 in), but are relatively dense with an average mass of 148 to 187 gm (5 to 7 ounces) (Murray et al. 1983, Drost and Lewis 1995). They have a long non-synchronous breeding period extending over 4 months from March to June, with murrelets arriving to the general areas near nesting colonies in December and January (Hunt et al. 1979, Murray et al. 1983, Gaston and Jones 1998). Their nest sites occur mainly in rock crevices, caves, under shrubs and sometimes burrows dug by other animals (Drost and Lewis 1995). Chicks hatch between early April and early July and fledge within the first few days to feed at sea (Murray et al. 1983). Their use of largely inaccessible island habitats, nocturnal and non-daily nest visitations and foraging far from shore makes it difficult to find colonies, estimate population size and monitor population changes. Knowledge of Scripps's Murrelet population size and factors affecting these colonies is quite limited and varies from colony to colony (Carter et al. 1992, 1997, McChesney et al. 2000).

The Scripps's Murrelet is listed as threatened in the State of California and is a candidate for federal listing under the Endangered Species Act of 1973, as amended (USFWS 2004, 2010, 2013). Threats to this species are numerous and include predation and habitat degradation by introduced species (rats, cats), increased predation by native species, oil pollution, artificial light pollution and others (Pacific Seabird Group 2002, USFWS 2012). In 2002, the National Park Service (NPS) eradicated rats from Anacapa Island and the breeding population of Scripps's Murrelets has since increased (Whitworth et al. 2005, 2009). Additional efforts by the NPS are currently underway to eradicate rats and non-native plants from other Channel Islands in an effort to improve seabird breeding habitat and increase nesting success.

2.2 Ashy Storm-Petrel

The Ashy Storm-Petrel is one of four storm-petrel species that breed on islands along the Pacific Coast of North America. They are small seabirds with an average length of 20 cm (8 in) and weigh 38 grams (1.3 ounces) on average (Ainley 1995). The breeding season for Ashy Storm-Petrels is extremely long and can run from February through the following January (13 months), with egg-laying at its peak in June and July (Ainley et al. 1974, Ainley 1995, McIver 2002). Egg incubation by adults lasts from 42 to 59 days, and hatchlings are fed at the nest for approximately 3 months with peak fledging occurring from early to mid-October, but ranging from late August to January (Ainley et al. 1974, 1990).

The Ashy Storm-Petrel breeds primarily on islands off of California as far north as Bird Rock in Mendocino County, the Farallon Islands, five of the Channel Islands and as far south as Islas Todos Santos off of Baja California, Mexico (Ainley 1995, Carter et al. in Shuford and Gardali 2008). An estimated 36 percent of the species occurs within the Channel Islands (Harvey 2012). Ashy Storm-Petrels at-sea range extends from the Oregon – California border south to Baja California, Mexico.

In 2009, the USFWS determined that listing of the Ashy Storm-Petrel was not warranted, though the estimated breeding population of 10,000-11,000 is lower than many other avian species listed under the Endangered Species Act (USFWS 2009, 2013, Center for Biological Diversity 2010). This decision not to list the Ashy Storm-Petrel was legally challenged by the Center for Biological Diversity based on published studies of significant population declines on the Farallon Islands and declining at-sea populations in Mendocino County (Center for Biological Diversity 2010, 2013). In 2013 the USFWS completed a status review of the species and determined a listing was not warranted, citing that recent population trend data for the species shows fluctuations but not a long-term population decline and that the current and historic range remained the same (USFWS 2013). However, the status review noted that predation of Ashy Storm-Petrels by native predators Western Gulls (*Larus occidentalis*) and Burrowing Owls (*Athene cunicularia*) was an increasing threat (USFWS 2013).

3. Study Area

The study area is located within the Santa Barbara Channel of the Pacific Ocean and extends north to the offshore waters of Point Conception in southern California (Figure 1). This area is generally bounded by the towns of Ventura and Santa Barbara to the south and Santa Maria to the north. The Channel Islands consist of eight individual islands located in the Southern California Bight of southern California. Five of the Channel Islands, Santa Barbara, San Miguel, Santa Rosa, Santa Cruz and Anacapa are designated as a National Park. The offshore waters surrounding these five islands are protected as the Channel Islands National Marine Sanctuary and encompass 3,800 km^2 (1,470 mi^2) of nearshore and deepwater habitat. Due to the relative isolation of the Channel Islands for thousands of years, numerous endemic species are found here as well as the largest breeding colonies of seabirds in southern California. The Channel Islands contain an estimated 34 percent of Scripps's Murrelet and 36 percent of Ashy Storm-Petrel worldwide breeding populations (USFWS 2012, 2013).

This area of the outer continental shelf consists of natural oil seeps that were commercially developed for offshore oil production beginning in 1896 (Yerkes et al. 1969). Today, offshore oil development in southern California consists of 27 active oil platforms, 23 of which are regulated by BOEM and 4 regulated by the state of California. Radar and audio-visual surveys were conducted on two oil platforms, Hermosa to the north (near Point Conception) and platform Grace located west of Ventura. Of the 23 platforms regulated by BOEM, Platform Grace at 16.9 km (10.5 mi) offshore is the furthest platform from the mainland coast. Platform Hermosa is located 10.9 km (6.8 mi) offshore. These offshore oil platforms are located within the Santa Barbara Channel and immediately north of the Channel Islands (Figure 1). A third oil platform, Hondo, was visited, but found to be unsuitable for conducting radar surveys.

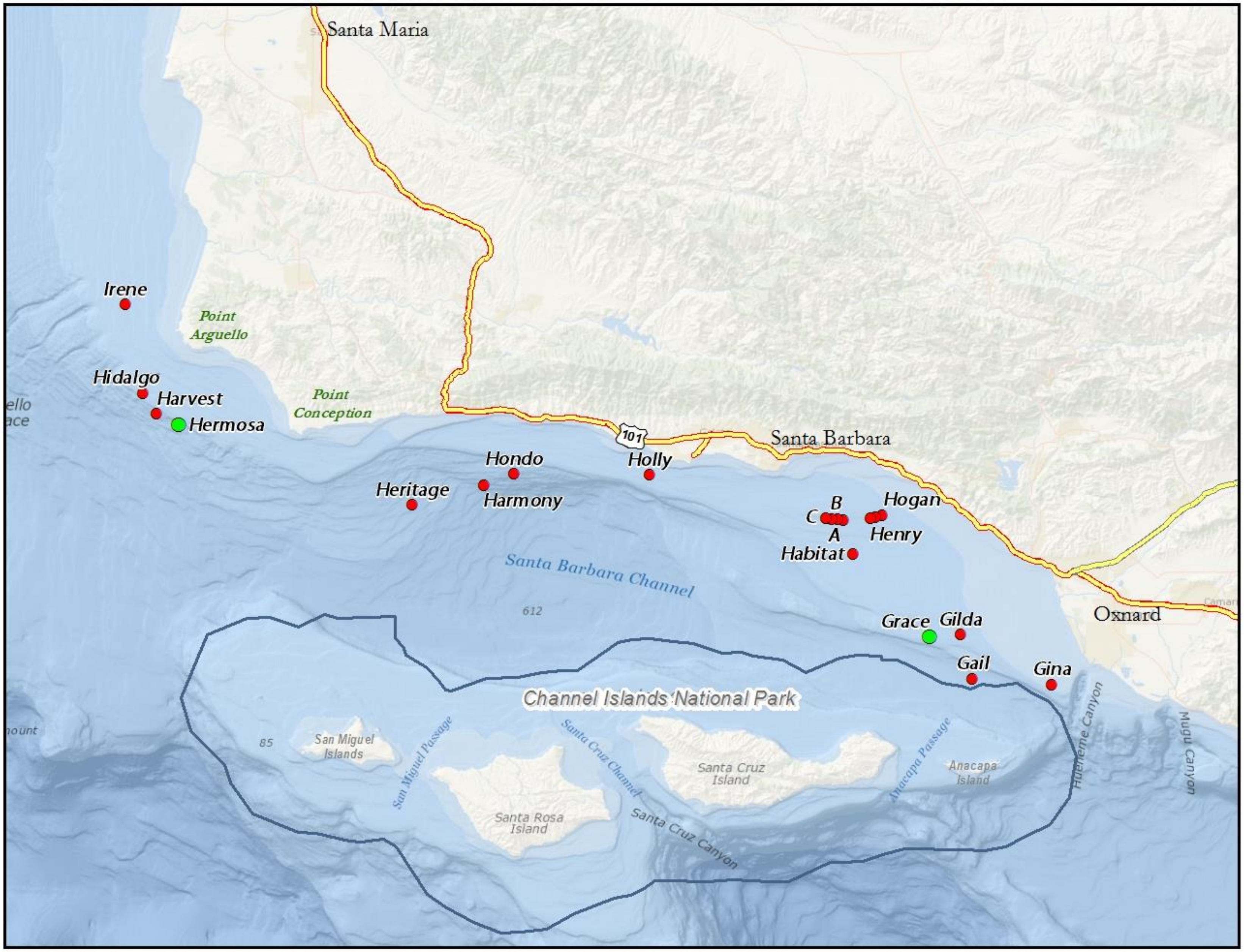

Figure 1. Radar and audio-visual study locations on offshore oil Platform Grace, in the Santa Barbara Channel and Platform Hermosa in the offshore waters near Point Conception, California.

4. Methods

4.1 Schedule and Survey Locations

Nocturnal radar and audio-visual monitoring surveys were conducted at POCS offshore platforms during the spring, summer and fall of 2013. The survey period coincided with peak breeding activities of adult Scripps's Murrelets and Ashy Storm-Petrels and the peak period of chick fledging. Surveys took place between March and November, with the spring surveys (March and April) focused on Scripps's Murrelets, while the summer and fall surveys (July – November) were focused on Ashy Storm-Petrels. Spring surveys consisted of two 10-night radar and audio-visual survey sessions (20 days total), and were conducted on platform Grace in March and April. Spring survey dates were selected to coincide with known peak breeding activities of adult Scripps's Murrelets from Anacapa Island and Santa Barbara Island nest data (Murray et al. 1983, Drost and Lewis 1995, Hamer and Meekins 2002). Four 10-night radar/visual surveys (40 days total) for Ashy Storm-Petrels were conducted on platforms Grace and Hermosa in the summer and fall. These survey periods were selected to capture the peak in breeding activities of Ashy Storm-Petrels on San Miguel, Santa Cruz and Anacapa Islands (Ainley and Boekelheide 1990). The July and August surveys took place on platform Grace, while the October and November surveys occurred on platform Hermosa. Spring, summer and fall survey periods were scheduled to coincide with the new moon. Timing surveys with moon phase was important to capture peak activity rates of these seabirds, which are lower during a full moon phase, primarily due to increases in predation (Manuwal 1974, Storey and Grimmer 1986, Nelson 1989, Ainley and Boekelheide 1990, Carter et al. 2000, Cruz et al. 2013). In addition, collisions resulting from attraction to artificial lights have been documented to occur most commonly during the new moon, or darker moon cycles (Verheijn 1981, Telfer et al. 1987).

The selection of specific oil platforms to survey for each season was made in cooperation with the BOEM Contracting Officer's Representative for the project. Platforms Grace and Hermosa were selected for this study based on the: (1) locations of the nesting colonies of Scripps's Murrelet and Ashy Storm-Petrel in relation to the platforms; (2) distance of the platforms to the nearest nesting colonies; (3) known or suspected ocean foraging locations of these two species and; (4) availability and access to individual platforms.

For all seasons sampled, the surveillance radar was operated throughout the night from 45 minutes after dusk (when darkness was complete and nocturnal birds became active) to 45 minutes before dawn, in order to capture all possible nocturnal activity. Each sweep of the radar and associated bird echoes were stored as a single digital archive file, and all the sweeps from a single night's survey were archived together in one folder. An observer worked for a period of 6 hours each night (three 2-hour periods) confirming the identifications of as many avian radar targets recorded on the radar as possible. These three consecutive 2-hour periods were planned to occur at different times each night over each 10 day period so that audio-visual data and radar target confirmations were sampled throughout the night. During the first 5 survey nights in each survey period, the observer monitored the radar the first 6 hours immediately following the start of each nightly survey session. For the last 5 nights in each survey period, the observer monitored the radar during the last 6 hours of each nightly survey session.

During each nightly 6-hour survey, three 30-minute outside observation periods were conducted on the oil platform deck. These observations occurred during the last 30 minutes of each 2-hour survey window and took place on the top open deck of each platform to record birds interacting with the platform lights. In addition, the observer conducted twice nightly platform searches (~1 hour per night) for any grounded seabirds that may have collided with the platform. The observer also performed twice daily seabird rafting surveys (~1 hour per day), which occurred in the daylight just before the start of each nightly survey session and again immediately after the conclusion of each nightly radar survey session when there was enough light to see. Therefore, the total nightly survey effort by the observer was ~ 8 hours. More detailed information on each of these survey methods can be found in the sections below.

4.2 Radar Equipment

To detect nocturnal seabirds near the offshore oil platforms, radar tracking in surveillance (horizontal) mode was performed using high-frequency marine radars (Furuno Model FR-1510 Mark 3, and Furuno Model 2117, Furuno Electric Company, Nishinomiya, Japan) transmitting at 9,410 MHz ±30MHz (i.e. X-band) with a 2-m (7-ft) long slotted wave guide array antenna with a peak power output of 12 kW. The radar antenna had a beam width of 1.23° (horizontal) and 20° (vertical) with side lobes of energy ± ~10° that helped detect birds beyond the fixed beam width. Detection of small targets at distance (i.e., birds) was enhanced by sophisticated signal processing techniques Furuno employs such as multi-level quantization (MLQ), echo stretch, echo average and a radar interference rejecter. The radar interference rejecter on these systems was developed by Furuno to reduce the amount of noise being received by the radar while not affecting the resolution of the targets being detected, thus improving target detection.

To enhance the detection of small targets and discrimination between close targets, pulse length was set to 0.07µs and 0.15µs. This is standard when operating radar units within the 0.25 km to 3 km ranges. The shorter pulse allows better detection of small targets and increased range resolution. Range resolution is a measure of the capability of the radar to detect the separation between those targets on the same bearing but having small differences in range. Maximum detection range capability can be reduced when using the shorter pulse length but better target definition and range accuracy allow for more accurate assessments of passage rate and flight behavior.

The operational scale of the radars could be adjusted from 0.5 to 96 km (0.3 to 59.7 mi). However, for purposes of this study, the radar was operated at the 1.5-km (0.9-mi) scale (3 km diameter, 7.1 km^2 [1.9 mi diameter, 2.7 mi^2]). Nocturnal seabird projects are typically operated at a range of 1.5 km (0.9 mi) in surveillance mode since murrelet-sized targets can be detected out to 1,200 to 1,500 meters (0.75 to 0.93 mi) (Hamer et al. 2005). Range accuracy was 1% of the maximum range of the scale in use, or 30 m (98 ft), whichever was greater. Bearing discrimination was greater than 2.5° and bearing accuracy was ± 1º. The radar unit was mounted on a mobile radar stand designed by Hamer Environmental that can be affixed to any platform with no modification to the platform itself. Since the antenna was 2 meters (6.6 ft) long, having a portable radar stand that can be easily transported and mounted was critical and also reduced time and effort to set-up and take-down the system before and after each 10-night survey period.

The radar was placed as close as possible to the corner of each oil platform to allow surveillance of the largest area surrounding the platform as possible (Figures 2 and 3). When feasible, the radar was also placed on the platform to scan in the direction of islands with known or suspected nesting colonies of each of the two species of interest.

The detectability of birds declines with distance. The ability to detect birds will vary with the size of the bird or flock, pulse and gain setting of the radar, weather conditions, orientation of the bird, and other factors. Because of multiple confounding factors, such as the variation in target size, the assumption of equal distribution of targets throughout the sampling area, and the variation in the shape and size of the effective radar-sampling beam, distance sampling methods were not used to correct for any possible decline in detectability with distance.

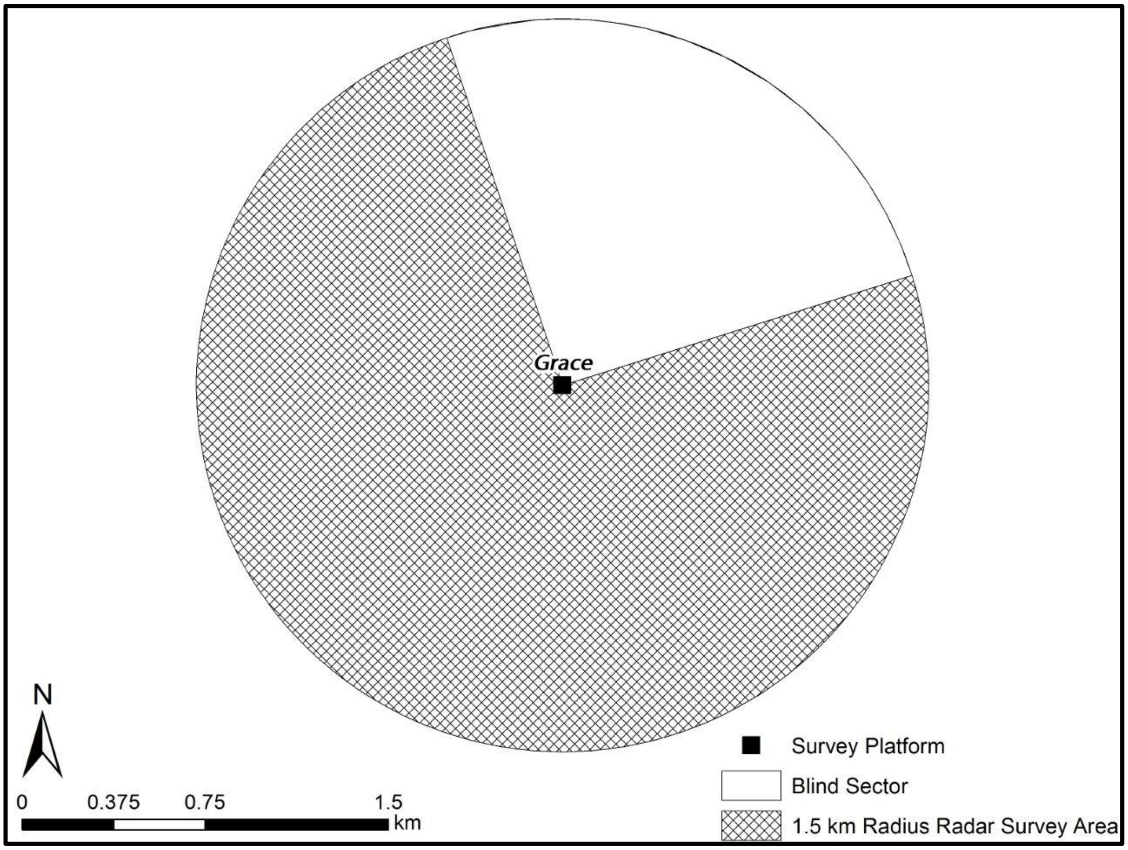

Figure 2. Spring and summer 2013 radar survey coverage on Platform Grace, showing the air space where birds could be detected (cross-hatched) and the portion of the radar blocked by the platform structure (blind sector, 345° - 75°) where no birds were visible.

The ability to detect nocturnal seabirds with ornithological radar can also decline with increasing sea clutter or other forms of clutter. Clutter forms on the radar monitor when radar energy bounces off solid objects such as the offshore platform itself and associated structures. In addition, higher waves in rougher sea conditions can form solid echoes (sea clutter) on the radar monitor creating conditions where the echoes of individual birds are difficult to detect. The radar system used was modified by Hamer Environmental to significantly reduce sea clutter by being able to tilt the radar antenna up to focus energy in the sky where birds were flying, while lessening the amount of energy hitting or scanning the sea surface. The radar was modified to be able to tilt in 5° increments from 0° to 60°. Typically, only a minor degree of tilt was needed to greatly reduce surrounding sea clutter. The second method used to reduce clutter was to carefully select appropriate radar station locations. For this study, radar locations on the offshore platform were selected that had a clear view of the surrounding sky and sea to maximize the detections of seabirds and minimize clutter. It was not possible to collect radar data during periods of heavy rain because the electronic filtering required to remove the echoes of the precipitation from the display screen also removes bird targets.

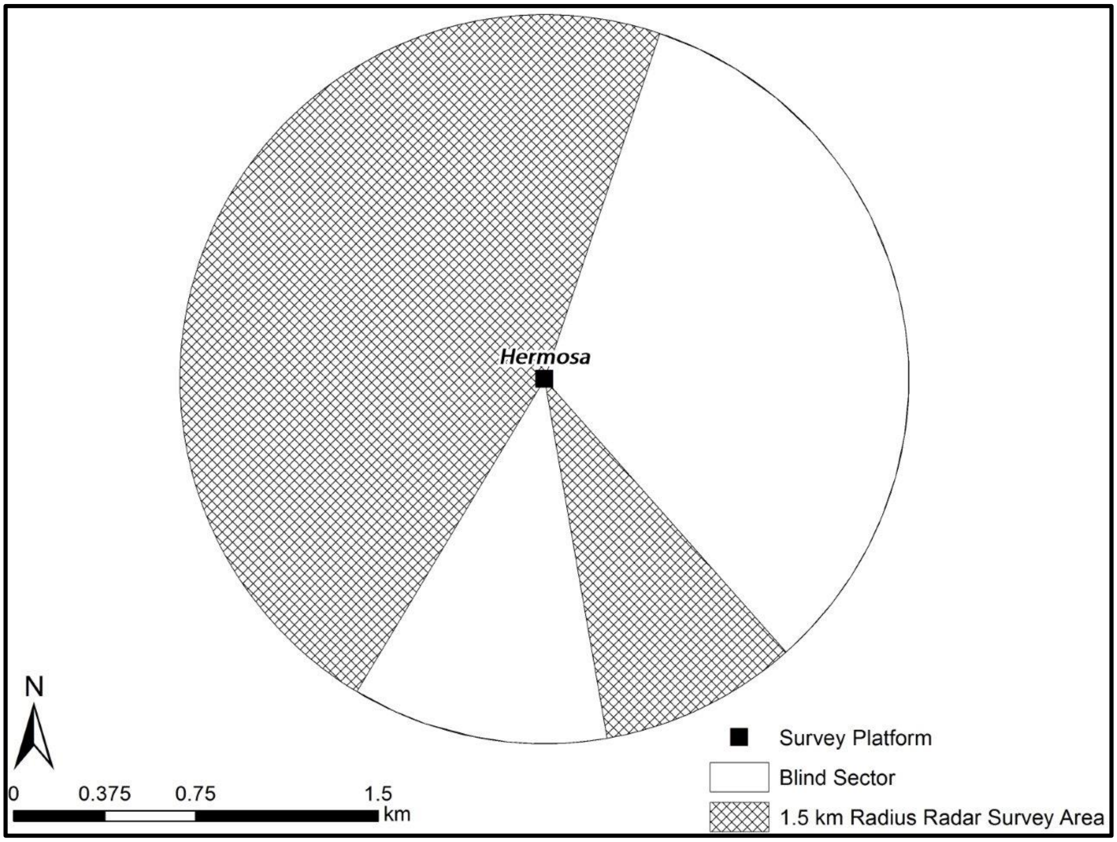

Figure 3. Fall 2013 radar survey coverage on Platform Hermosa, showing the air space where birds could be detected (cross-hatched) and portion of the radar blocked by the platform structures (blind sectors 18°-138° and 170°-210°) where no birds were visible.

The radar antenna rotated and scanned the horizon once every 2.5 seconds (sec). With each rotation the radar monitor displayed an echo of the targets being tracked. Echoes on the radar displays were retained for 30 sec, resulting in a trail of echoes as the targets moved, which enabled the flight paths of all birds to be plotted. Because the radar rotated at fixed time intervals, the distance between adjacent echoes was directly proportional to the ground speed of the targets. Therefore, the speed of the target could be calculated by measuring the distance between echoes. Echoes farther apart indicated faster moving targets. In surveillance position (horizontal), the radar obtained information on flight direction, flight behavior, overall flight path, movement rates (targets/hour [hr]/km) and the ground speed of birds (km/hr).

Raw output (video, trigger pulse, ships heading marker, and bearing pulse) from the radar were collected from the slave output of the radar using a dedicated computer. Each sweep of the radar and associated echoes were stored as a single digital archive file, and all the sweeps from a given survey period were archived together in a single folder on an external hard drive, which was cloned to a separate hard drive at the end of each night for data back-up.

4.3 Automated Radar Sampling Methods

During each of the six 10-night survey sessions, the marine radar unit was mounted on the offshore platform in a strategic position that maximized the area that could be scanned to detect seabird activity around the platform itself and surrounding sea. On both oil platforms, the radar was placed at the edge of the top two decks (one to two decks below the Helipad) and on or near the corner of the platform. Customized portable radar mounts were used to temporarily mount the radar unit on offshore platform decks. The mount itself raised the radar unit 2.1 meters (7 ft) off the oil platform base to reduce interference from surrounding structures and to eliminate any radiation exposure to people working on the platform. Raising the radar unit in this manner also allowed visibility over platform railings and other structures thus reducing clutter on the radar screen and maximizing the detection of birds in the surrounding airspace. The radar unit was programmed so that for regions where the 360 degree scan would hit the surrounding metal structures of the platform, the radar would turn off, and then immediately turn on again after passing these structures (blind sector). This feature reduced back-scatter and interference clutter from these objects and helped maximize the detection of birds.

Automated radar surveys were conducted nightly beginning 45 minutes after sunset continuously until 45 minutes before sunrise. The length of the nocturnal radar survey was dependent on the date, ranging from an average 8 hrs 10 min in July (shortest nights) to 11 hrs 47 min in November (longest nights). Echoes on the radar screen were recorded for the duration of each nocturnal survey using digital radar technologies and automatic tracking software to perform this task. Automated data collection and software analysis systems allowed permanent digital storage of all radar data along with replay or re-analysis of the data from any night or season at any time. This radar data was played back at higher speeds to quickly see the activity from any nocturnal sampling session. This system was much more accurate and efficient than an observer trying to record this data manually, since precise and consistent measurements of each echo are made by a computer. Automated software recorded: date, detection time, flight speed, echo size, number of echoes, echo locations, flight direction and reflectivity (strength of the each echo). Recording and analyzing the radar data in this way freed the radar technician to identify birds detected by the radar and record their flight behavior around the offshore platform.

4.4 Radar Data Analyses

Raw radar data were processed using a proprietary automated software system. After the removal of any clutter (non-moving objects) from the screen, detections of moving targets were processed. As in other studies, the term ''target'' was used to describe birds detected by radar because the species composition and size of a group of birds is usually unknown. For each radar detection of an avian target, the software recorded: date, detection time, distance between echoes (flight speed), reflectivity (a measure of the strength of the signal), echo size (targets can be filtered by several measures of size including radial span, angular span, perimeter, area), echo shape and number of echos. The individual targets were tracked over time using a complex multi-frame correspondence model. A minimum of four echos was needed before a target's flight path was tracked, to eliminate non-avian targets and to achieve higher accuracy of speed and flight direction measurements. The resulting tracks were then filtered based on flight speed, echo size, direction and directional coherence to exclude non-target bird species and insects.

To remove insects from our analysis, we omitted small targets ("speckle size") with lower energy reflectivity, and also targets having ground speeds (uncorrected for wind) of < 21.6 km/hr (< 13.4 mph). This speed threshold was based on previous radar studies from the literature, and radar data from Hamer Environmental, which have documented that most insects have an airspeed of < 6 m/second (21.6 km/hr), whereas the airspeed of most birds and bats is usually > 6 m/sec ([19.7 ft/sec], 21.6 km/hr) (Tuttle 1988, Larkin 1991, Bruderer and Boldt 2001, Kunz and Fenton 2003).

Different filters were applied to the radar data to record potential light attraction events (birds attracted to the lights of the platform) and to document nocturnally migrating birds during the spring and fall radar survey sessions. Radar filters, which differed between the two bird groups analyzed, included: echo size, flight direction and the distance of target flight path from the offshore platform. These filters are further described in subsequent light attraction and nocturnal migration sections of this report (4.4.1 and 4.4.2).

Radar Counts

Sampling periods included a single survey night, a season (20 days) and by hour. Counts of bird tracks during each sampling period were summed. These counts were then used to calculate movement rates (targets/hr/km), based on the number of hours sampled in each period (per night, season or hour) and are detailed in subsequent sections.

Flight Speeds

For each avian radar track, the time and distance of each echo comprising a track were automatically recorded by the radar tracking software. To calculate flight speeds (not adjusted for wind speed or direction) the distance (m) between the first and last echo was divided by the time between the first and last echo (seconds). This number (in m/sec) was then converted to km/hr to determine flight speed.

Flight Directions

Flight directions were calculated for each radar target track by averaging the bearing of each echo within the track and then converting the final bearing to a cardinal direction based on the track echo x and y coordinates. Flight directions for each track (degrees) were then summarized by night (for nocturnal migrants) and by survey season (for light attraction events) and graphed using ORIANA 3.0 software (ORIANA 2010). Mean flight directions, 95% confidence intervals and standard error were also calculated.

4.4.1 Light Attraction Target Filtering and Event Rate Analyses

To distinguish bird light attraction events from migratory birds, non-avian species (insects) and other resident birds, several filters were applied to the raw radar target data. Radar target filters included removing target with: speeds ≤ 21.6 km/hr (≤ 13.4 mph), average echo size ≤ 1340 area in spring and ≤ 950 area in summer and fall, echo intensity ≤ 0.3 (to eliminate small faint targets/insects) and flight direction. Echo size filters were higher in the spring, because the survey timing and location of spring radar surveys were designed to record Scripps's Murrelet-type targets and not the smaller Ashy Storm-Petrels, which have a similar body mass as a large passerine. The minimum echo size filter was lowered to ≤ 950 area for the summer and fall months to ensure recording of light attraction events for birds the size of an Ashy Storm-Petrel or larger. Only radar target flights with a bearing that would intersect the offshore oil platform were included as light attraction targets. Radar flights documented as flying away from the platform were excluded. These outbound only flights were believed to be non-target seabird species leaving their night roosts on the platform to forage out at sea, which would explain why an inbound flight to the platform was not documented in most cases. Regular observations were made of Western Gulls, cormorants and Brown Pelicans (*Pelecanus occidentalis*) roosting and taking off at night from the lowest deck level (near sea level) of both platforms. Radar targets with flights that changed course to divert around the platform were also excluded from the light attraction analysis. It was very likely that these flights were avoiding the platform due to the structure and associated artificial lighting.

A final filter of flight distances > 650 m (> 0.40 mi) from the platform was applied to exclude targets too far away to be considered light attraction events. All radar targets approaching the platform had to have a portion of their flight path cross within 650 m (0.40 mi) of the platform or closer to be recorded as a potential light attraction event (Figure 4).

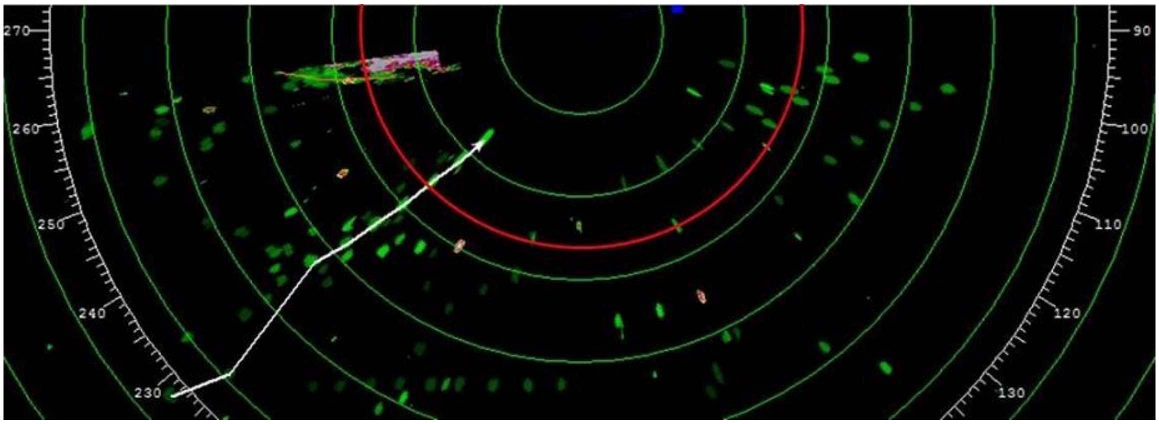

Figure 4. Radar screen capture of avian target (white track) flying toward platform (at top center of screen) and crossing the line (red) that was 650 meters from the radar and platform. This target was defined as a potential light attraction event. Each concentric circle represents a distance of 250 m from the radar.

To calculate potential light attraction event rates (targets/hr/km) was more complicated compared to the calculation of standard passage rates of migratory birds due to the non-linear, circular metric used to define a light attraction event. First a circle with a 650-m (0.40-mi) radius was mapped around each radar location (platform) and the circumference of the circle was calculated, with a resulting circumference of 3,367 m (2.1 mi) for each platform. Second, the portions of the circular circumference that were blocked by seasonal blind sectors were subtracted from the total circumference. These blind sectors were 345°-75° in spring and summer sessions (Platform Grace), and 18°-138° and 170°-210° in fall session (Platform Hermosa) (Figures 2 and 3). Although Platform Hermosa had a larger blind sector (18° - 217°) for the last five nights of fall surveys (2 to 6 November), only one radar light attraction event was recorded during this period, and so this larger blind sector was not needed for the fall event rate calculations. After subtracting the blind sector, the resulting circumference metric for spring and summer was 2,529 m (1.57 mi; Platform Grace), and 1,869 m (1.16 mi; Platform Hermosa) for fall. Third, counts of potential light attraction events were summarized per survey season, per night and per hour. Fourth, to calculate light attraction event rates per season, the total number of light attraction events was divided by the product of the total number of survey hours (164.6 hrs in spring, 169.3 hrs in summer, 225.4 hrs in fall) and the circumference length surveyed (650 m line) resulting in an average seasonal light attraction event rate of targets/hr/km.

Nightly light attraction events were also calculated for each survey night by dividing the total nightly count of light attraction events by the product of the total number of hours surveyed each night and the respective length of the circumference surveyed. This resulted in a nightly light attraction rate of targets/hr/km. Hourly light attraction event rates were calculated by dividing the night's counts of birds into hourly increments. For example, hour 20 contained all bird flights recorded between 2000 and 2059. The hourly light attraction event rates were then calculated for each hour by dividing the hourly count by 2,529 m (1.57 mi; spring and summer) or by 1,869 m (1.16 mi; fall) to get a resulting rate of targets/hr/km for each hour of the survey night. The standard error of each seasonal, nightly and hourly light attraction event rate was also calculated.

Similar to a blind sector, radar exclusion zones were created when needed on a nightly basis, when high winds caused ocean waves to clutter a portion of the radar screen, effectively blocking avian targets from view. Since these exclusion zones varied nightly, they were not considered in the calculations of light attraction event rates. However, the exclusion zones may have had an effect on final light attraction event rates in spring when wave clutter was generally higher and more exclusion zones were used.

4.4.2 Nocturnal Migration Radar Target Filtering and Passage Rate Analyses

Although the focus of this study was on two resident seabird species, nocturnal migrants were documented on radar during spring (March and April) and to a lesser extent in fall (September-October/November). To assess the magnitude of the nocturnal migration in spring and fall, one night of radar data from each season were selected for analysis. These two nights included 10 April and 2 October 2013. These two nights were selected for analysis because they contained the highest raw number of radar flight paths in their respective seasons. Filters were applied to the raw data in order to eliminate insects and non-migratory birds. These radar target filters included removing targets with: speeds ≤ 21.6 km/hr (≤ 13.4 mph), average echo size ≤ 700 area and echo intensity ≤ 0.3 (to eliminate faint targets and insects) and flight direction. In spring (10 April) migratory flights should be northerly, so only flights between 67.5° and 292.5° were included in the analyses. In fall (2 October) migratory flights should be southerly, so only flight directions between 112.5° and 247.5° were included in the analyses. After filters were applied, the resulting targets were counted and the total number of survey hours of each night was recorded.

Because this assessment was focused on nocturnal migrants, data collected in the first hour after dusk and last hour before dawn (crepuscular hours) were assessed for removal from passage rate calculations. In those first dusk and dawn hours, resident seabirds were active and may have influenced the calculation of nocturnal migrant passage rates if they were not excluded. Hours 2000 through 0500 (10 hours) were analyzed for the night of 10 April and hour 0600 was excluded. On 2 October, hours 2000 through 0600 (11 hours) were analyzed and hour 1900 was excluded.

Passage rates were defined as the average number of targets detected per linear kilometer of radar sampled per hour ($\frac{\sum detections}{km*hour}$). All targets detected out to a 3 km radius from the radar were included in the analysis. This standardized movement rate is a widely-used reporting metric for studies of bird migration using radar, allowing for comparison with other radar studies of similar design. For each of the two nights analyzed, passage rates were calculated both by night and separately for each hour of the survey night.

Nightly counts were divided by the product of the number of hours surveyed and the linear sampling distance, which was 6 km for 10 April and 3 km for 2 October, to get a passage rate of targets/hr/km. The linear sampling distance was different between the spring and fall survey nights, because the fall had a blind sector blocking the eastern half of the radar screen (due to the radar location on the oil platform), resulting in half of the linear visibility when compared to the spring. Hourly migratory bird passage rates were calculated by dividing the night's counts of birds into hourly increments. For example, hour 20 contained all bird flights recorded between 2000 and 2059. The hourly passage rates were then calculated for each hour by dividing the hourly count by 6 km for 10 April and by 3 km for 2 October to get a resulting rate of targets/hr/km for each hour of the survey night. The standard error of each nightly and hourly passage rate was also calculated.

4.5 Audiovisual Sampling Methods

4.5.1 Radar Surveys Conducted with an Observer

For the radar observer, each nightly survey was comprised of three 2-hour survey periods. The first 90 minutes of each 2-hour survey period was radar sampling. The surveyor monitored the radar screen for bird activity during this period. When a murrelet or storm-petrel-like target was seen on the radar screen in the vicinity of the platform (or any other avian target seen on radar approaching the platform), the observer would do two things. First the observer would note the time, the bearing and flight direction of the target on the radar screen. Second, the observer would step outside and visually scan the night sky in the direction of the approaching target to try to determine the species. The observer was outfitted with AN

PVS-7 & 14 third generation night-vision equipment and 10 power binoculars for these periods of viewing. However, due to the high amount of ambient light emitted by the platform lights, the night vision equipment was ineffective and thus only rarely used when conditions allowed. At the same time, there was not enough light emitted by the platform for binoculars to see more than a few meters at night. Therefore, the observer relied on eyesight to try and identify targets recorded by the radar that appeared to be approaching close to the platform. The observer visually scanned the air and sea adjacent to and above the platform and recorded all avian species observed, including: time, number of individuals, observed distance from the radar (m), bearing of observed target from radar (degrees), bird species (or genera), flight direction (degrees), flight height above the platform (meters), flight behavior (straight, erratic, circling) and any other relevant observed information. Any indications of light attraction, repeated circling or erratic flight behavior, evidence of fatigue or injury/collisions, or mortality was recorded. When a radar target was not observed visually by the surveyor, it was recorded as an unknown species. Radar species identification confirmation rates were calculated for each 10-day survey session.

4.5.2 Oil Platform Deck Visual Observation Periods

During each nightly 6-hour radar survey by the observer, three 30-minute outside observation periods were conducted on the oil platform deck. These observations occurred during the last 30 minutes of each consecutive 2-hour radar monitoring session and took place on the top Main deck of each platform. The observer stood in a location that provided a view of the maximum number of deck lights and airspace around the lights. The observer then recorded any birds interacting with the platform lights or flying in the near vicinity of the platform. The observer recorded: species of birds seen or heard, number of individuals, time of observation, distance from radar lab (m), flight direction, flight height above platform (m), and flight behavior. Due to the high number of Western Gulls seen in and around the platform at night, detection of this species was noted during each outside observation period, but their total numbers were not. Observers were equipped with night-vision equipment, but as noted they were ineffective due to the ambient light emitted by the lights on the platforms. The observer also recorded any behaviors such as roosting or resting on the platform and/or foraging in the vicinity when observed. Birds detected exhibiting light attraction during the visual observation periods were used in calculating a light attraction rate for each surveyed season, where applicable. These detection rates were then extrapolated over the length of each survey night for that season to get visual observation light attraction rates per night.

4.5.3 Grounded Seabird Searches

Twice nightly searches for grounded seabirds were conducted throughout all accessible areas of the platform. On Platform Grace, the observer had unobstructed access to all open levels of the platform, which included the Main deck (~27 m [88 ft] above sea level [asl]), the 66 deck (~20 m [66 ft] asl), the Mezzanine deck (~17 m [56 ft] asl), the 44 deck (~13 m [44 ft] asl) and the Spider deck (~7 m [22 ft] asl, the lowest deck on the platform). On Platform Hermosa, the observer was given unobstructed access to the uppermost decks of the platform, while accessing the lower decks required platform employee escort for safety reasons. Lower decks were visited only one time (5 October 2013) to document roosting birds, and approximately 20% of the platform was not searched. The Main deck on platform Hermosa was split into 2 levels, the top Main deck (~24 m (80 ft) asl) and the lower Main deck (~18 m (60 ft) asl). Below the lower Main deck was the Mezzanine deck (~15 m (50 ft) asl), which housed the control room. Searches took place immediately before or after the 6-hour outside observer survey period (~midnight), and again at the end of each nightly radar survey (just before sunrise). The surveyor spent 30 to 45 minutes per search thoroughly inspecting all accessible levels of the platforms looking for any birds that may have collided or landed on the platform. Special emphasis was taken to check behind or under structures on the platforms with a flashlight in case any birds were hiding in shadows or under objects. The locations of any dead or downed birds found were recorded, along with the species, condition of the individuals and notes on weather in case conditions were a factor in the bird's grounding. Digital photographs were also taken, though the pictures were of low quality because of a no flash photography policy on the platforms (flash photography interferes with fire alarm systems and can trigger a false alarm). Grounded seabird nightly detection rates were calculated for each season by dividing the number of grounded birds detected in a season by the number of nights surveyed in that season. No further extrapolations were conducted as all grounded birds on these survey nights were assumed to have been detected.

Peregrine Falcons (*Falco peregrinus*) were regularly observed hunting and storing bird carcasses on the oil platforms. For each downed bird or carcass detected, the outside observer looked for distinguishing features between grounded birds and falcon kill or falcon grounded birds. Peregrine Falcon kills typically exhibited broken necks, plucked breast feathers, head separated from body, or remnant body parts like wings and feet that a falcon would not typically consume. Falcon killed birds were also typically located on an area of the platform near Peregrine Falcon roosts, and bird carcasses were often stored in areas where a grounded bird would not be found, such as along I-beam rafters or on top of the radar antenna when not operational. Grounded birds could also exhibit a broken neck as a result of a collision with the platform or associated structures. These birds were usually distinguishable because they lacked blood spots found around the neck typical of a falcon kill and their location on the platform was not near a known Peregrine Falcon use area.

4.5.4 Rafting and Foraging Seabird Surveys

The observer conducted twice daily rafting and foraging seabird surveys from the top deck of the oil platforms. Surveys took 15 to 20 minutes each. Surveys occurred before and after each night’s radar survey (around sunset and again at sunrise) and were initiated when there was enough light to document any seabirds utilizing the areas around the platforms. Surveys were conducted from a minimum of four different vantage points on the platform to document avian use in the surrounding waters. The observer used binoculars and a spotting scope to identify the species and number of individuals in each raft, as well as recording any birds actively foraging or in flight. In some cases where the rafts or individuals were seen at great distances from the platform, the observer was only able to identify birds to genus. If time permitted, an additional rafting and foraging seabird survey was conducted during the middle of the day. Data collection included: time of survey, raft number, bird species, number of individuals, distance from platform (m), and direction from platform (degrees). Actively foraging or birds observed in flight were also recorded, noting: bird species, number of individuals, distance from platform (m), flight height (m above water level), direction from platform (degrees) and behavior (flying, foraging, etc.).

4.5.5 Weather Data Collection

Weather data were collected by the observer at the beginning of every survey hour (six hours nightly) or whenever there was a significant change in weather conditions. This data was collected on the Main deck of both platforms. Hourly data collection included: average wind speed (mph); wind direction (degrees or noted as variable or calm when conditions applied); cloud cover (to the nearest 5%); approximate ceiling height (m above sea level [asl] in several height categories); light condition (daylight without precipitation, daylight with precipitation, twilight without precipitation, twilight with precipitation, darkness without precipitation, darkness with precipitation), approximate minimal horizontal visibility (m); precipitation (no precipitation, fog, drizzle, light rain, heavy rain, hail) and; air temperature (ºC).

4.6 Oil Platform Light Emittance Assessment

An assessment was conducted to quantitatively compare artificial light emittance levels between oil platforms Grace and Hermosa. Methods developed by the Giant Segmented Mirror Telescope Program Office at the National Optical Astronomy Observatory were used to measure light intensity using night sky satellite imagery (National Optical Observatory 2009). This method does not provide illuminance values, but rather calculates the integrated density or sum of all pixel values in a given area (e.g. an oil platform) that can then be compared to another platform or other man-made structures. Digital imagery was obtained from NASA's Earth Observatory 2012 night-light composite imagery (April 18 and October 23, 2012) (NASA 2012). A screen capture of the imagery along the Santa Barbara coastline was created and the image was brought into ImageJ image analysis software (Figure 5).

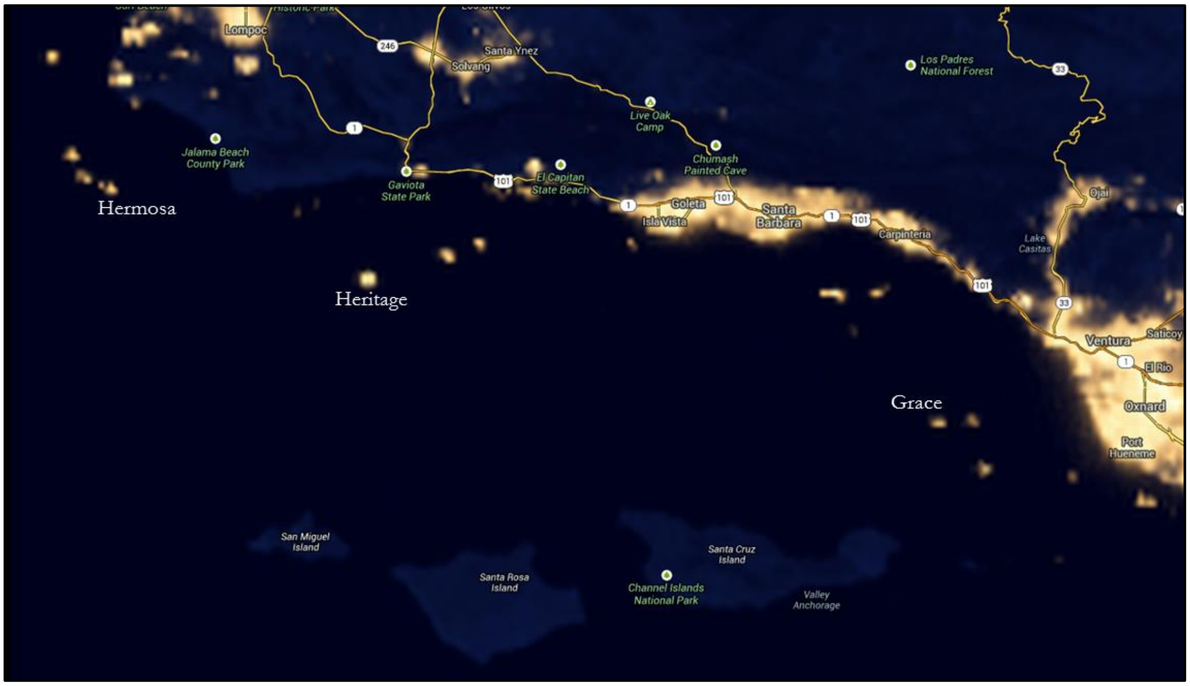

Figure 5.NASA's Earth Observatory 2012 night-light composite imagery (April 18 and October 23, 2012) showing the southern California coastline from Lompoc southeast to Oxnard, California. The two oil platforms used for the study area shown (Hermosa and Grace) along with a control platform (Heritage).

A polygon of the same size was drawn around the visual light emittance of each of the two survey platforms, Grace and Hermosa and also for a control platform. The size of each polygon was 3.48 km by 3.48 km (12.1 km^2). The control platform used was Heritage, which appeared to be the brightest in the region (Figures 5, 6). The area and the integrated density values were calculated within each polygon. Integrated density is the sum of all pixel values within the polygon, where dark areas have a value of zero; therefore the sum is a measurement of all of the light in the polygon. Resulting artificial light emittance values can then be compared between offshore oil platforms (or other man-made structures), as these differences may result in higher or lower levels of light attraction (or avoidance) by avian species.

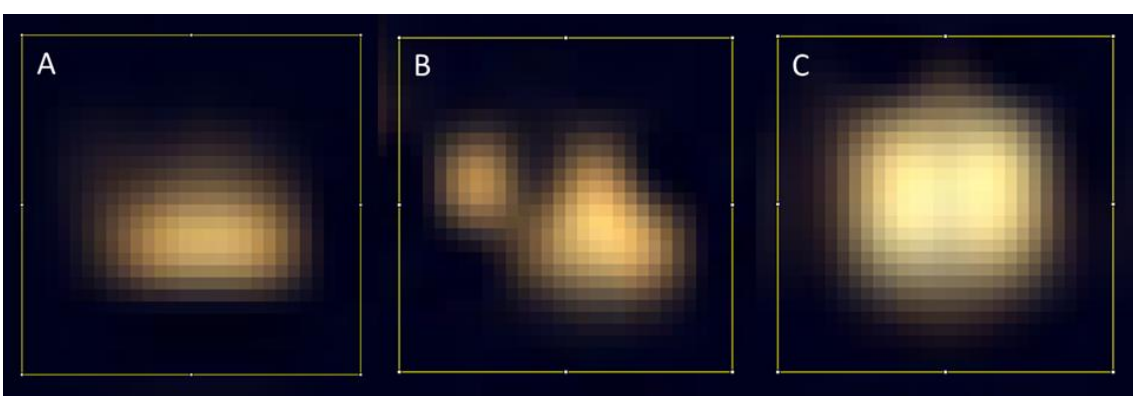

Figure 6. Polygons showing the boundaries of the areas analyzed for each integrated density test. Platform Grace (A), Hermosa (B) and Heritage (C).

5. Results

Survey efforts consisted of a total of 56 of 60 total nights of radar and 60 nights of audio-visual surveys conducted over the spring, summer and fall seasons, 2013 (Table 1). Twenty survey nights were successfully conducted in each of the summer and fall seasons. During the spring survey sessions, two nights were unusable due to weather events throughout the survey night (rain on 7 March and high winds on 4 April), and two nights were unusable due to equipment problems and radar data corruption (11 and 12 April). All radar surveys began 45 minutes after sunset and were completed 45 minutes prior to sunrise. The average number of hours the radar operated per night was 9.7, but ranged from 8.1 during July to 11.9 during November (Table 1). Average radar start times ranged from 1744 in November to 2059 in July. Average radar end times ranged from 0506 in July to 0639 in November. All radar surveys were conducted using a 12 kW x-band marine radar in surveillance (horizontal) mode and at a scale of 1.5 km (0.93 nautical miles) radius. The degrees of radar tilt varied from 20 to 35 degrees depending on sea conditions.

Observer surveys to document seabird attraction to lights on the platform deck were conducted during either the first or last six hours of each nightly radar survey (Appendix A). Those six nightly hours were divided between radar attraction observations (4.5 hours) and three 30-minute oil platform deck observation surveys (1.5 hours total). Nightly, 4.5 hours of radar observer time was spent performing radar based light attraction surveys, for a total of 90 hours over the course of each survey season. Oil platform deck observation surveys were conducted for 1.5 hours nightly, for a total of 30 hours each season. Observer surveys to identify radar light attraction targets were canceled on two nights, 6 and 7 April, due to high winds resulting in safety risk to the observer. So the observer remained inside for these periods and only identified targets on the radar monitor. However, the outside observation periods were completed on those nights as they could safely be conducted away from the edge of the platform. Over the 60 nights of surveys, a total of 261 hours of radar observer light attraction surveys were completed and 87 hours of oil platform deck observation surveys were conducted. Approximately 75 hours of grounded seabird searches (conducted twice nightly) were completed and 38 hours of rafting and transiting bird surveys (conducted twice daily) were completed over the course of the survey project. A detailed nightly summary of radar and audiovisual survey efforts are located in Appendix A.

5.1 Weather Conditions

Spring

Wind speeds were highly variable in the spring months (March and April), ranging from 0 to gusts as high as 96.6 km/hr (60.0 mph) with prevailing winds from the west-southwest. The windiest nights occurred on 6 March and 4 - 9 April 2013. Winds were so high on 6 and 7 April that observations for radar targets on the deck of the platform were not conducted for safety reasons. However outside observation periods were still conducted on these nights. All nights were free of precipitation except for 6 and 7 March. On 6 March light drizzle was present at the start of the survey. The night of 7 March had sustained light rain, which precluded analysis of collected radar data, due to rain clutter masking bird flight paths on the radar. Finally, 4 April had high winds throughout the survey night, which resulted in wave clutter covering the radar viewing area. All other spring nights were free of precipitation and had generally clear skies. Fog was present from 13 - 16 March and varied nightly from a minimum of half of the survey period to persisting throughout the entire night. Radar can detect avian targets even in heavy fog, so these nights were successful survey nights. The nights of the April survey session were clear, except for the last night of 14 April which was overcast (Appendix A). Spring surveys were scheduled to coincide with the new moon. The moon cycled from a waning crescent to a waxing crescent throughout both survey periods, with a new moon on 11 March and 10 April.

Summer

Wind speeds varied between 5.0 and 30.3 km/hr (3.1 and 18.8 mph) and predominately blew from the west-southwest (Appendix A). Cloud cover varied between 0 and 100% with cloudy nights throughout the entire July survey session (2 – 12 July). The first portion of the August survey session had variable cloudiness, but the last six nights were clear (7 – 12 August). There was no precipitation throughout the summer survey nights, but a few nights were foggy in early July (2 - 4 July). The moon cycled from a waning crescent to a waxing crescent throughout both survey periods, with a new moon on 8 July and 6 August.

Table 1. Radar survey effort summary for each of six 10-day survey sessions (60 nights total), including radar survey duration and radar settings.

10-Day Survey Session	2013 Survey Dates	Total Survey Nights	Platform Name	Avg. Start Time*	Avg. End Time*	Avg. Nightly Radar Duration	Radar Tilt	Radar Type	Blind Sector Setting (°)	Radar Range
Spring 1	Mar 6 – 15	10	Grace	2033	0627	9 hrs 54 min	20 - 30°	12 kW	345 - 75	1.5 km
Spring 2	Apr 4 – 13	10	Grace	2056	0549	8 hrs 53 min	20 - 30°	12 kW	345 - 75	1.5 km
Summer 1	Jul 2 – 11	10	Grace	2058	0508	8 hrs 10 min	25 - 35°	12 kW	345 - 75	1.5 km
Summer 2	Aug 2 – 11	10	Grace	2043	0529	8 hrs 46 min	30°	12 kW	345 - 75	1.5 km
Fall 1	Sep 28 - Oct 7	10	Hermosa	1925	0616	10 hrs 41 min	30 - 35°	12 kW	18 – 138 & 170 - 210	1.5 km
Fall 2	Oct 28 - Nov 2	6	Hermosa	1852	0639	11 hrs 47 min	30°	12 kW	18 – 138 & 170 - 210	1.5 km
Fall 2•	Nov 2 - Nov 6	4	Hermosa	1752	0539	11 hrs 47 min	30°	12 kW	18 - 217	1.5 km

* Avg. radar start time was 45 minutes after sunset and average radar end time was 45 minutes before sunrise.
• Fall 2 survey session had two different blind sector settings, due to active drilling 2 – 6 Nov, which required increasing the blind sector to 18 - 217°.

Fall

Wind speeds varied between 0 and 43.0 km/hr (0 and 26.7 mph) and predominately blew from the northwest, with occasional winds from the northeast. Cloud cover varied between 0 and 100% with many clear nights throughout both fall survey sessions. No precipitation was documented and fog was present on only one night; the night of 30 September. The moon cycled from a waning crescent to a waxing crescent throughout both survey periods, with a new moon on 4 October and 3 November.

5.2 Light Attraction Events Recorded by Radar

Western Gulls, cormorants (*Phalacrocorax spp.*), and on Platform Grace, Brown Pelicans were regularly observed in the near vicinity of the two platforms and were often observed roosting on the bottom deck of the platforms (open deck directly above sea level). For this reason, radar targets that were recorded only as flying away from the platform were not counted as light attraction radar targets, based on the regular observations of roosting species leaving the platform and heading out to sea. These outbound only flights were believed to be non-target seabird species leaving their night roosts on the platform to forage out at sea or were heading to the mainland or the Channel Islands. This flight behavior explains why an inbound flight to the platform was not documented in these cases.

The radar also detected varying levels of insects around the radar lab, particularly during the first hours of the survey after sunset. Insect observations were most accentuated on calm evenings. At no point during the radar surveys did the presence of insects affect the ability of the radar to detect birds, as in general, insects are only capable of attaining speeds of 32 km/h (< 20 mph) and were only detected at distances close to the radar. A majority of insects that were visible on the radar were small to medium-sized moths.

5.2.1 Light Attraction Event Counts

Spring

Over the twenty nights of the spring survey sessions, two nights were unusable due to poor weather conditions, which occurred on 6 March and 4 April. The radar data for these two nights was unusable due to rain or wind and wave clutter which masked the majority of avian flight paths on the radar. An additional two nights of radar data were unusable on 11 and 12 April, due to radar equipment and software problems resulting in the corruption of the radar data. As a result, 16 of the 20 survey nights (164.6 hrs) in spring were analyzed for evidence of avian light attraction (Figure 7). A total of 48 avian radar targets were documented as light attraction events with 13 targets recorded in March and 35 in April. One night (7 April) accounted for 20 of the 48 total light attraction events (42% of the total). All 48 avian targets were recorded flying within 650 meters (0.40 mi) of Platform Grace and all with a flight bearing that would intersect with the platform. Nocturnal migrants were regularly observed on the radar, but they were generally excluded as light attraction flights based on their echo size and flight direction (north to northwest). In addition, the majority of nocturnal migrants appeared to avoid the platform and thus their flight paths often took them to the east or west of the platform itself. Avian light attraction event target speeds averaged 50.4 km/hr (31.3 mph) and ranged from 27.6 to 78.5 km/hr (17.1 to 48.8 mph).

Summer

Over the 20 survey nights during summer (July and August), a total of 9 avian radar targets were recorded as light attraction events on the surveillance radar (Figure 7). Avian light attraction event target speeds averaged 38.4 km/hr (23.8 mph) and ranged from 28.5 to 52.4 km/hr (17.8 to 32.6 mph).

Fall

Over the 20 survey nights during fall (September/October and October/November), a total of 12 avian radar targets were recorded as light attraction events on the surveillance radar (Figure 7). Their speeds averaged 45.1 km/hr (28.0 mph) and ranged from 18.2 to 78.5 km/hr (11.4 to 48.8 mph).

5.2.2 Light Attraction Event Rates

Spring

Mean light attraction event rates were calculated using 164.6 hours of survey effort, as four survey nights of radar data were lost due to weather or software data corruption (4 nights of 20). The average light attraction rate of avian targets recorded flying toward the platform was 0.13 ± 0.07 targets/hr/km. The average nightly light attraction rate of avian targets in spring was 3.00 targets/night. Avian targets recorded flying toward the platform were detected during 9 of 16 (56%) survey nights. The highest light attraction rate was recorded on 7 April with 0.82 ± 0.26 targets/hr/km.

Summer

Mean light attraction rates were calculated using 169.3 hours of survey effort (20 nights). The average light attraction rate of avian targets recorded flying toward the platform on surveillance radar was 0.02 ± 0.02 targets/hr/km. The average nightly light attraction rate of avian radar targets in summer was 0.45 targets/night. Avian radar targets flying toward the platform were recorded during 9 of 20 (45%) survey nights. For each of nine nights with light attraction events, the detection consisted of a single bird and a resulting event rate varied from 0.04 to 0.06 targets/hr/km.

Fall

Mean light attraction rates were calculated using 225.4 hours of survey effort (20 nights). The average fall light attraction rate of avian targets recorded flying toward the platform on surveillance radar was 0.03 ± 0.02 targets/hr/km. The average nightly light attraction rate of avian targets in fall was 0.60 targets/night. Avian targets flying toward the platform were recorded during 7 of 20 (35%) nights. The highest light attraction rate was recorded on 1 October with 0.20 ± 0.15 targets/hr/km detected.

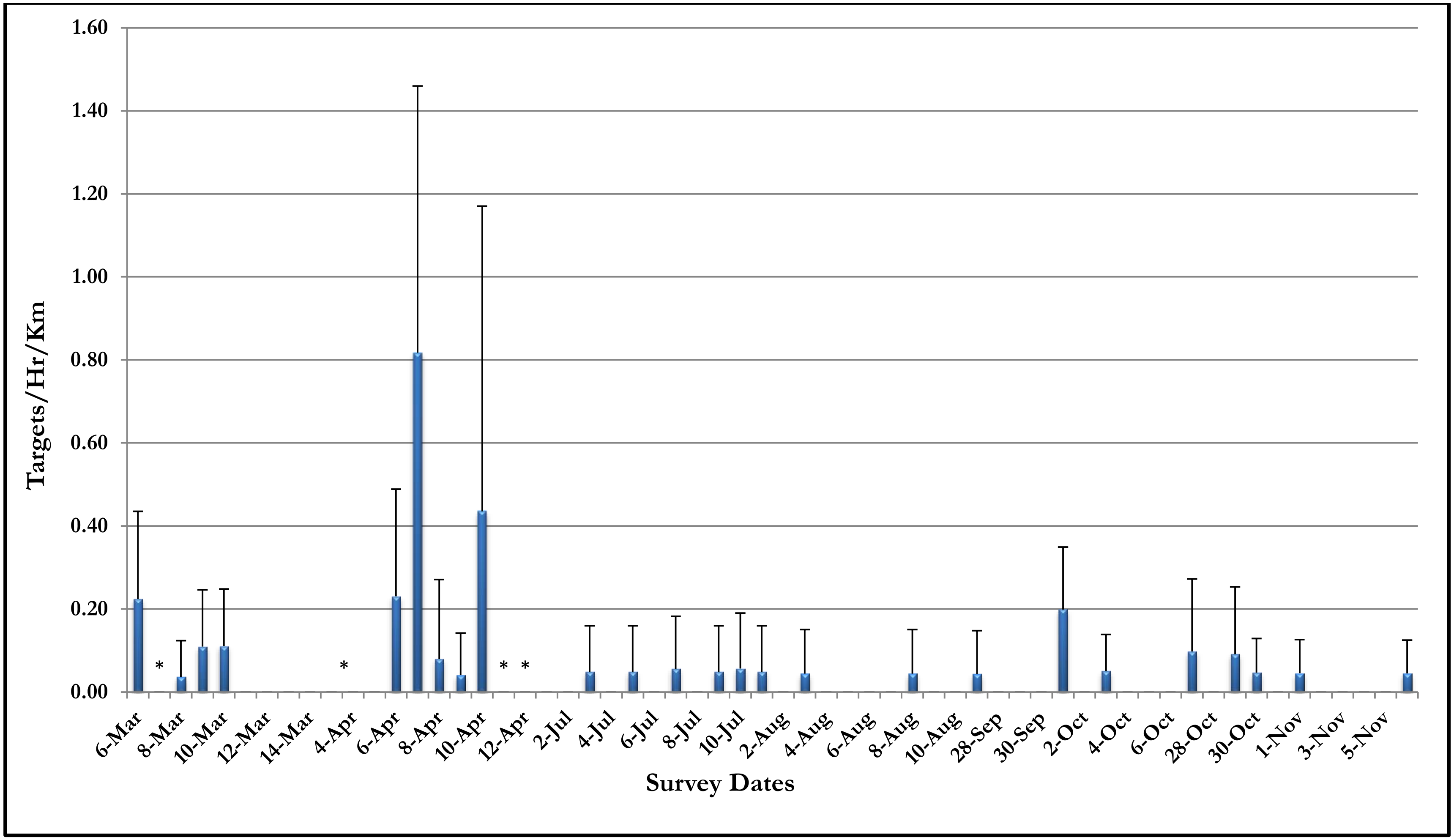

Figure 7. Light attraction events recorded by radar for all survey nights (60 nights in spring, summer fall 2013), listed as an average hourly rate per night (+SE). Four nights where no radar data was usable due to poor weather or equipment/software failure are denoted by *, and dates with no bars indicate an absence of light attraction events on that survey night.

5.2.3 Timing of Light Attraction Events

Spring

For the spring survey season (March and April), average sunset occurred at 1914 and sunrise at 0653. The number of avian light attraction events peaked at 2000 and again between 2300 and 0200 with 26 events recorded during this second peak period. The peak hourly rate of avian light attraction events was 0.24 targets/hr/km at 2000 and 0.17 targets/hr/km at midnight and 0200 (Figure 8). The average hourly rate for light attraction events in spring was 0.13 ± 0.07 targets/hr/km.

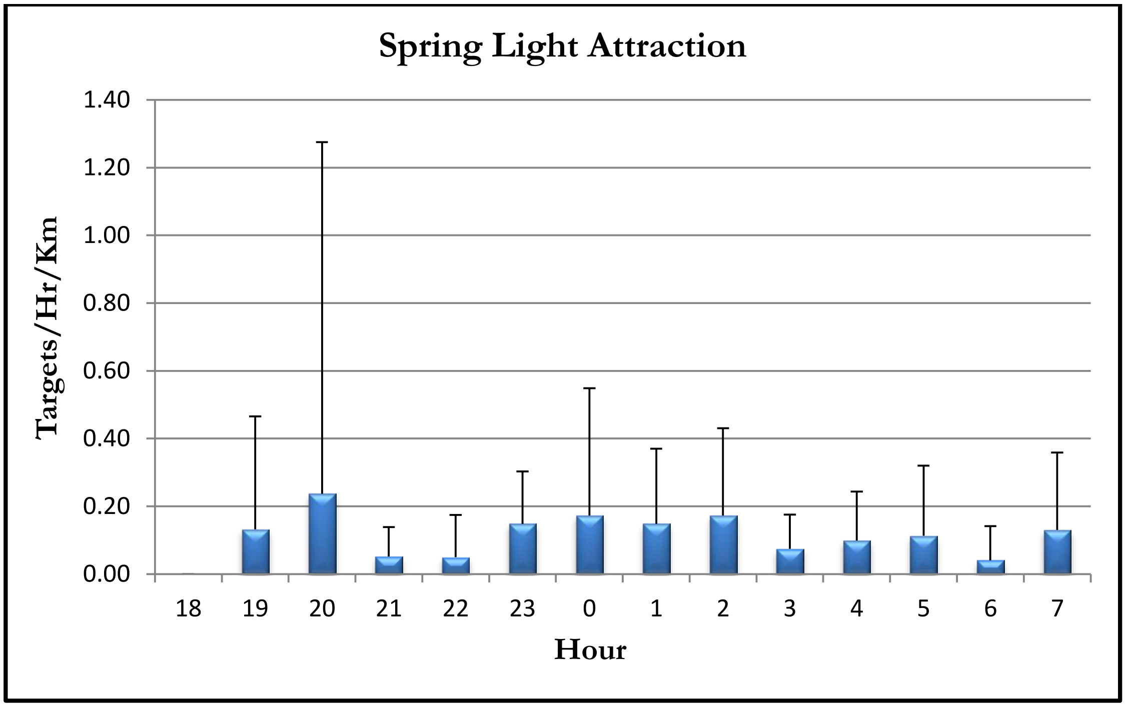

Figure 8.Timing of avian light attraction events detected within a 650 meter radius of Platform Grace, spring 2013.

Summer

For the summer survey season (July and August), average sunset occurred at 2048 and sunrise at 0522. The number of avian light attraction events peaked at 2200 with 4 avian targets recorded at a rate of 0.08 targets/hr/km (Figure 9). The average hourly rate for avian light attraction events in summer was 0.02 ± 0.02 targets/hr/km.

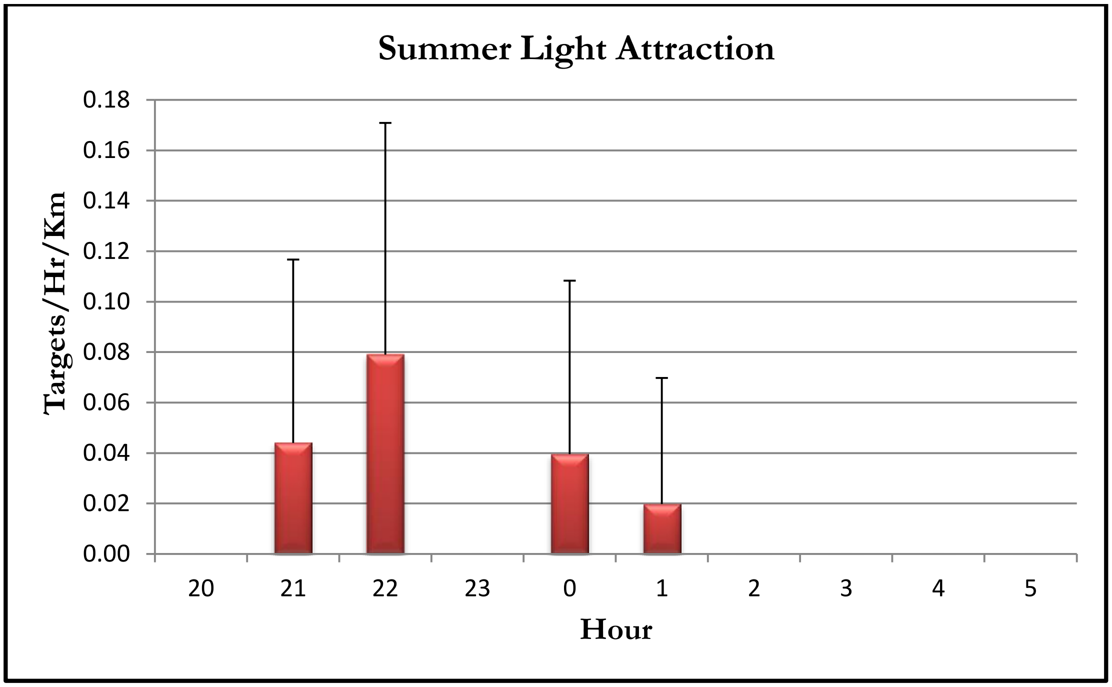

Figure 9. Timing of avian light attraction events detected within a 650 meter radius of Platform Grace, summer 2013.

Fall

For the fall survey season (September/October and October/November), average sunset occurred at 1848 and sunrise at 0557. The number of light attraction events peaked between 1900 and 2000 with 9 avian targets recorded. The peak hourly rate of avian light attraction events occurred at 1900 with 0.18 ± 0.14 targets/hr/km (Figure 10). The average hourly rate for light attraction events recorded in fall was 0.03 ± 0.02 targets/hr/km.

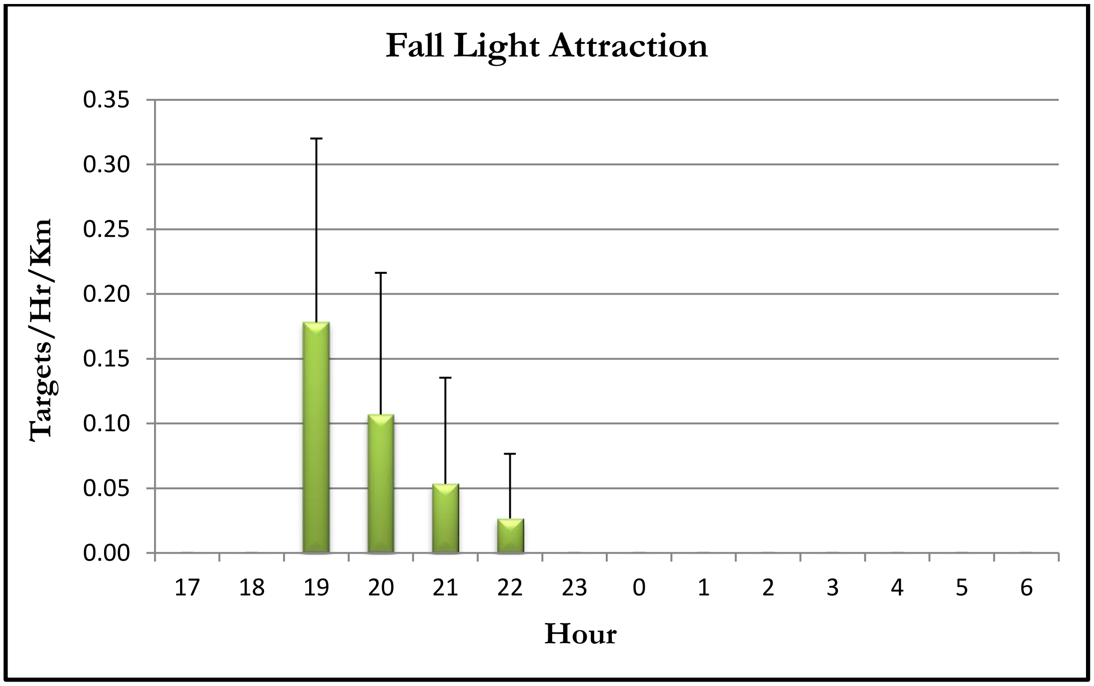

Figure 10. Timing of avian light attraction events detected within a 650 meter radius of Platform Grace, fall 2013.

5.2.4 Flight Direction

The average flight direction of light attraction events in spring was 40.4° ± 9.0° (Figure 11). The average flight direction of radar targets recorded flying toward the platform in summer was 63.5°. In fall, the average flight direction of light attraction events was 182.7° ± 8.2° (Figure 11).

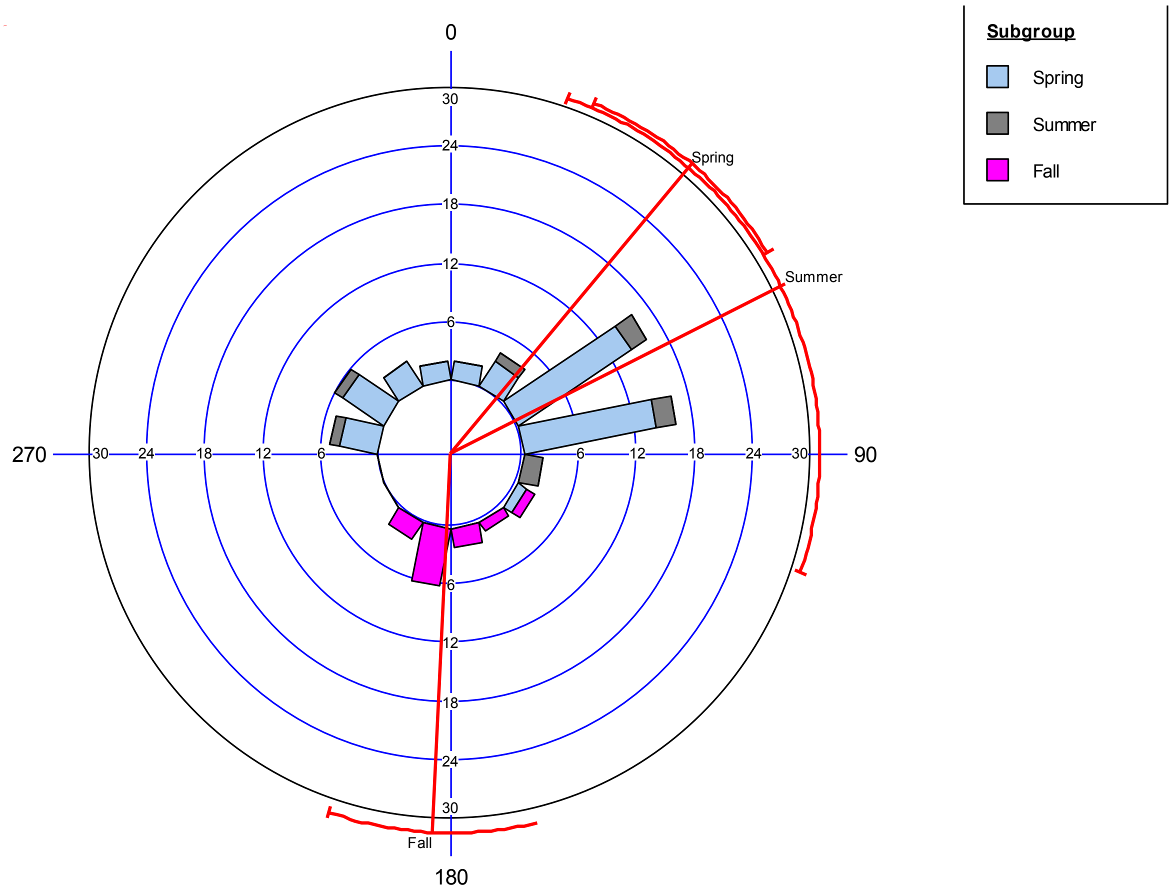

Figure 11. Flight directions of light attraction events recorded on surveillance radar, spring, summer and fall. Mean flight directions are shown as solid red lines (with 95% confidence limits).

5.2.5 Identification of Radar Targets

During each nightly radar survey, observers spent 4.5 hours attempting to identify radar targets that were approaching the platform to genera or species. Observers were equipped with AN PVS-7 & 14 third generation night-vision equipment and 10 power binoculars to aid in species identification, if weather conditions allowed. However, the high intensity of the ambient light emitted from the platform lights along with light pollution from external sources (shore-based lights, boats, stars, nearby platforms) made species identification with night vision equipment completely ineffective. At the same time, the light emitted by the platform did not extend very far from the platform deck for binoculars to see more than a few meters at night. Therefore, the observer relied on eyesight to try and identify targets recorded by radar that appeared to be approaching the platform although visible sight distance was only ~10 m (33 ft).

Overall, observers attempted to identify 75 radar targets that were recorded flying in the vicinity of the platform during the six 10-day survey sessions (Table 2). Eleven of these targets were seen by the observer, with 8 of them identified as Western Gulls (WEGU). Two targets were identified as unknown gulls (UNGU), while 1 target was identified as an unknown small bird (UNSB) (Table 2). The remaining 64 targets were not visually detected by the observer.

Table 2. Radar target species identification and confirmation rates.

Survey Month	Platform	No. of Targets	No. of Targets Identified	Identification Rate (%)	Identified Targets* (No. of each)
March	Grace	15	10	66.7	WEGU (7) UNGU (2) UNSB (1)
April	Grace	2	0	0	
July	Grace	7	1	14.3	WEGU
August	Grace	6	0	0	
Sept/Oct	Hermosa	30	0	0	
Oct/Nov	Hermosa	15	0	0	
Totals		**75**	**11**	**14.7**	**WEGU (8)** **UNGU (2)** **UNSB (1)**

*****Identified radar targets included: Western Gull (WEGU), unknown gull (UNGU) and unknown small bird (UNSB).

5.3 Nocturnal Migrant-Type Radar Targets

5.3.1 Passage Rates

<u>Spring</u>

Since the radar was operating and recording data all night long, it also recorded avian nocturnal migration activity over the oil platforms. A screen capture image of the radar monitor was taken at 0200 on 10 April 2013 to exemplify the avian nocturnal migratory activity recorded by the radar in spring 2013 (Figure 12). This night was analyzed since it had the maximum number of targets recorded during the spring. This image represents one 2.5 second sweep of the radar. Birds beyond a 3 km radius do not appear in the image since the radar data was truncated at this distance for this figure. Each line of echoes represents a track of a single bird in flight around the platform. There are no radar tracks visible in the northeast quarter since this is the region not visible to the radar due to the shadow caused by the oil platform itself (blind sector). Each concentric circle on the image represents a distance of 250 m.

A total of 12,177 nocturnal migrant-type radar targets were recorded during the night of 10 April 2013 between the hours of 2000 to 0500. An average of 203 ± 246 targets/hr/km were recorded throughout the night. Radar data from other spring nights were not analyzed specifically for nocturnal migration activity since it was not an objective of this study. Migratory–type target flight speeds for this night averaged 46.0 ± 0.13 km/hr (28.6 mph) and ranged from 11.7 to 105.8 km/hr (7.3 to 65.6 mph). Flight speeds were not adjusted for wind speed or wind direction.

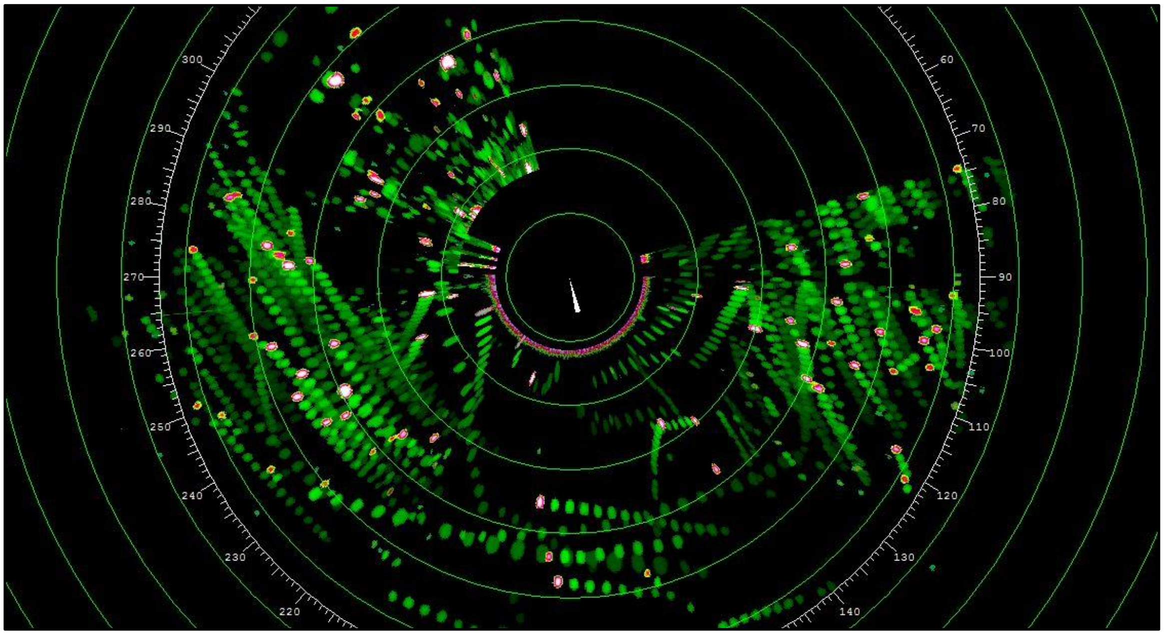

Figure 12. Radar screen capture image taken at 0200 on 10 April, 2013 showing northerly avian migratory activity surrounding Platform Grace. Each concentric circle represents a distance of 250 m. No birds can be seen beyond a 1.5 km radius since the radar data was clipped at this distance for this figure. Each line of echoes shows an individual bird in flight.

Fall

A total of 828 nocturnal migrant-type targets were recorded on the fall sample night of 2 October 2013. This night was analyzed since it had the maximum number of targets recorded during the fall. An average 25 ± 14 targets/hr/km were recorded throughout this night between the hours of 2000 to 0600. Radar data from other fall nights were not analyzed specifically for nocturnal migration activity since it was not an objective of this study. Migratory–type target flight speeds for the fall night averaged 77.1 ± 0.44 km/hr (47.9 mph) and ranged from 16.9 to 107.0 km/hr (10.5 to 66.4 mph). Flight speeds were not adjusted for wind speed or wind direction. Targets on this night were being greatly aided by the wind speed and direction.

5.3.2 Timing of Nocturnal Migration

Spring

For the radar session on 10 April 2013, sunset occurred at 1926 and sunrise at 0631. The timing of movement of nocturnal migrant-type radar targets peaked between 0100 and 0200 with 4,622 total targets recorded during these two hours of the night alone. Overall migratory activity was relatively low from dusk to midnight, but increased rapidly after midnight and remained high between 0100 and 0500 hours (Figure 13).

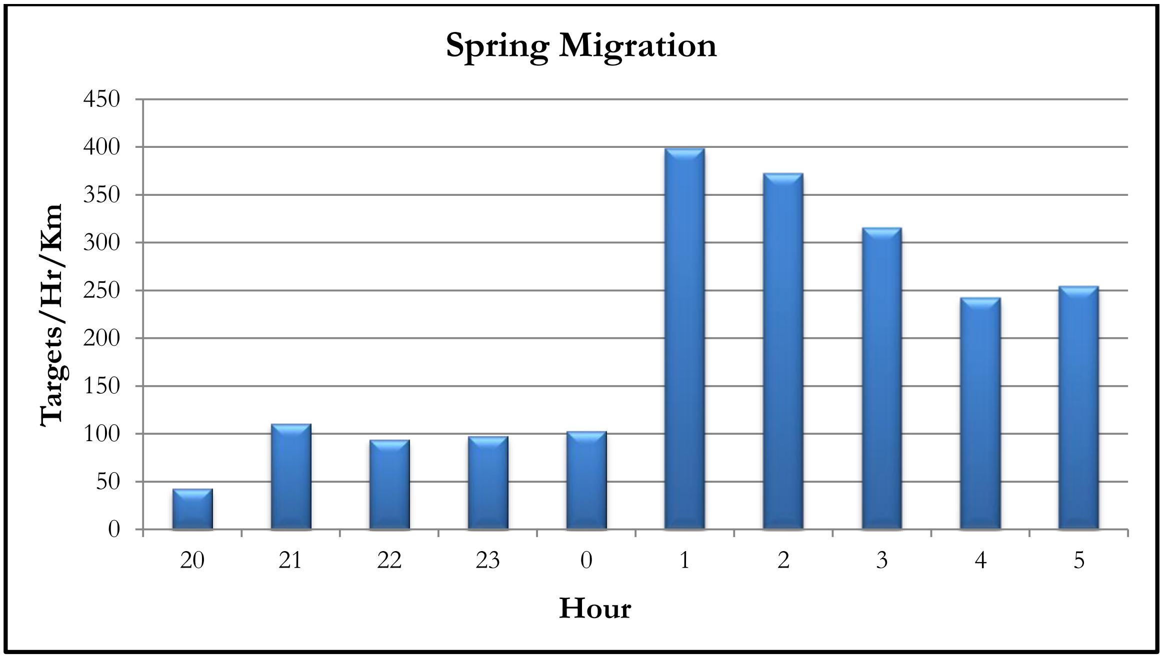

Figure 13. Timing of movements of nocturnal migrant-type radar targets detected within a 3 km radius of Platform Grace on 10 April 2013.

Fall

For the radar session on 2 October 2013, sunset occurred at 1844 and sunrise at 0658. The timing of movement of nocturnal migrant-type radar targets peaked between 2100 and 2200 with 296 total targets recorded during these 2 hours. In general, migration activity declined after 2200 hours and was lowest at sunrise (0600 hour). Overall migratory activity in the fall was comparatively lower than spring and followed a different nightly pattern with activity higher from 2000 to midnight and then declining towards dawn (Figure 14).

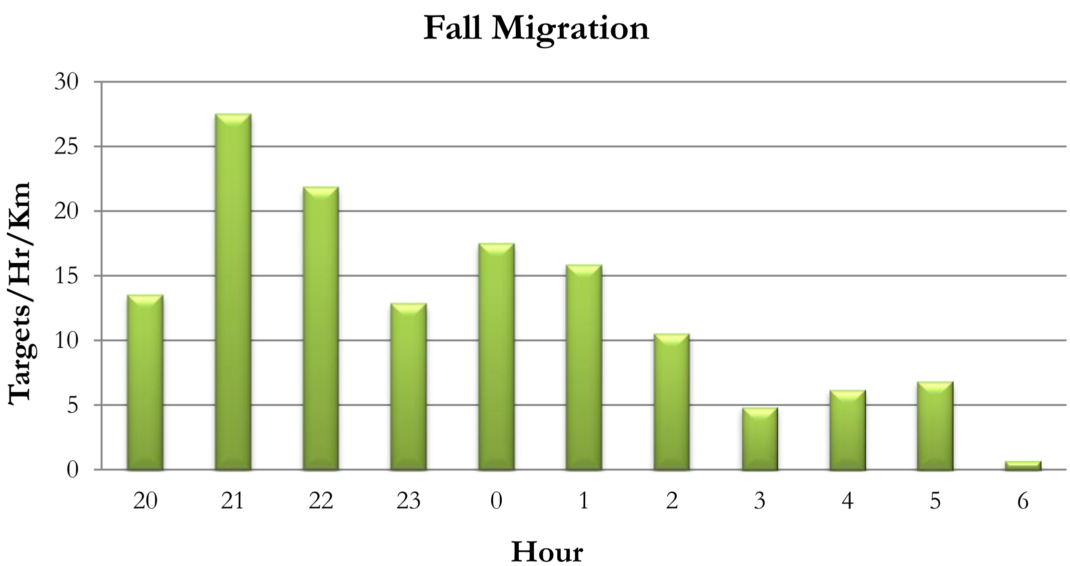

Figure 14. Timing of movements of nocturnal migrant-type radar targets detected within a 3.0 km radius of Platform Hermosa on 2 October 2013.

5.3.3 Flight Direction

Spring

On the night of 10 April 2013, 12,177 nocturnal migrant type-targets were recorded on horizontal radar within a 3.0 km radius of Platform Grace. The mean flight direction of these targets were northwest at 338° ± 0.35° (Figure 15). Flights were consistently northerly throughout the peak migratory hours, though avoidance of the platform by migrants was also detected (Figure 16).

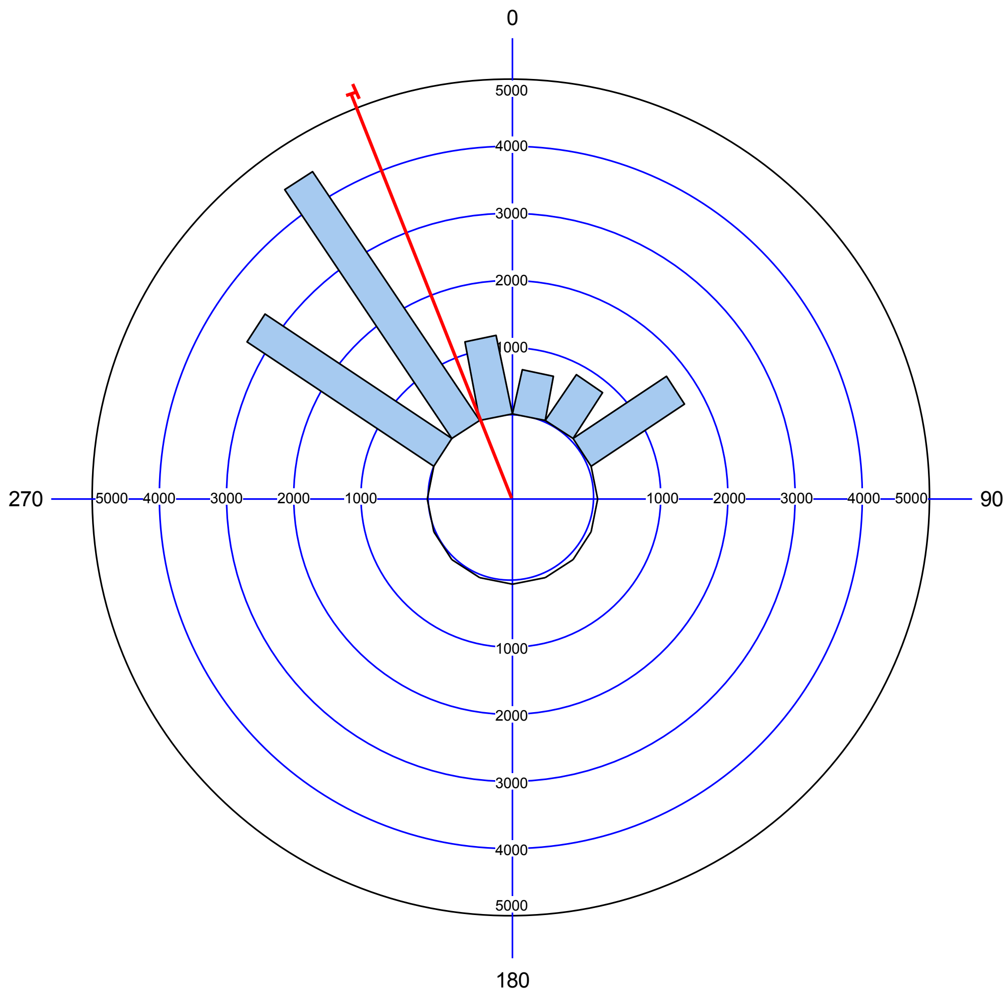

Figure 15. Mean flight direction of nocturnal migrant-type targets on surveillance radar detected within a 3 km radius of Platform Grace on 10 April 2013.

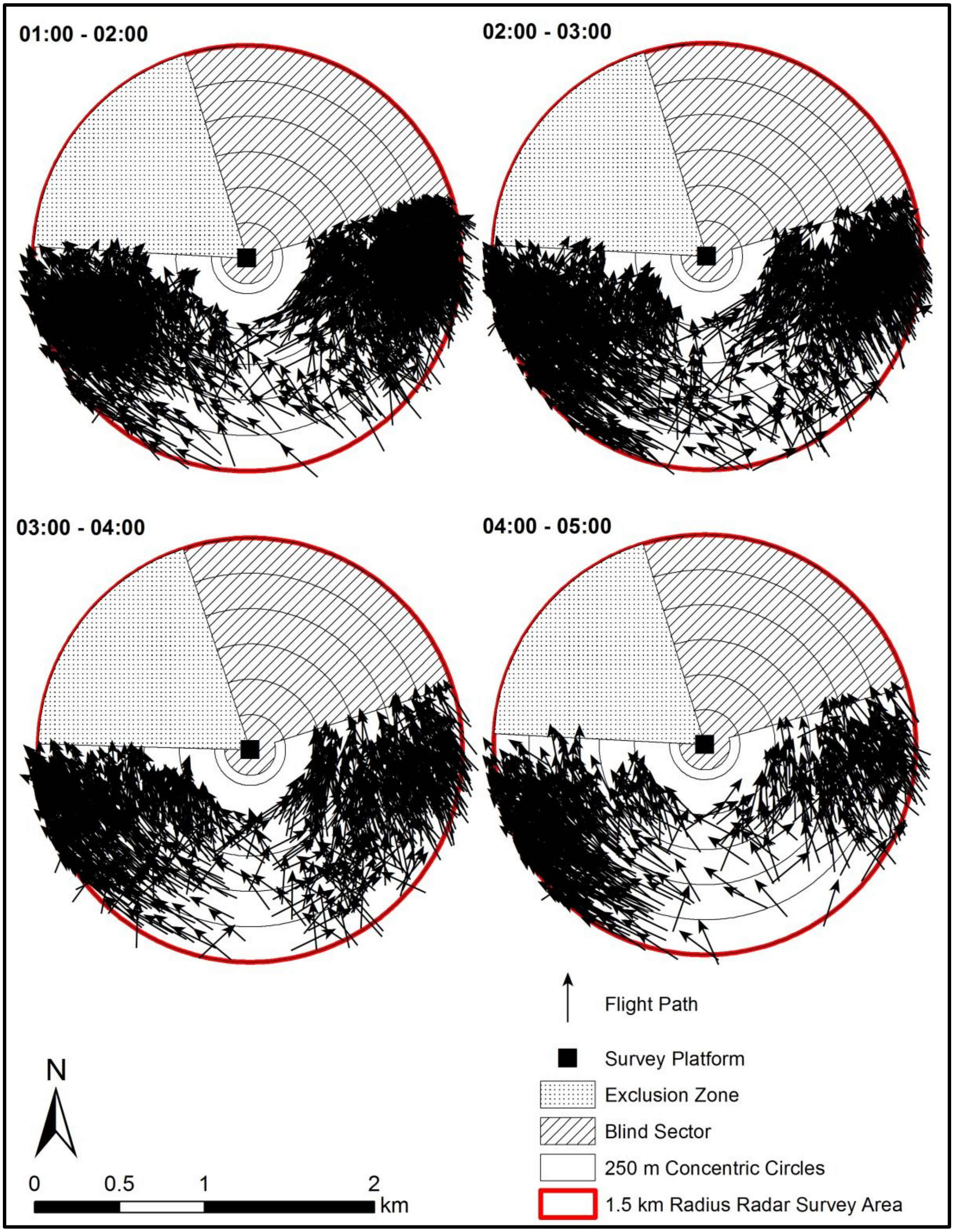

Figure 16. Avian flight paths mapped in hourly increments during peak migratory activity from 0100 to 0500 (4 hours total) on 10 April 2013. The mapped flight paths show northerly bird flights and consistent avoidance of Platform Grace. Areas of radar screen with no visibility included portions of radar blocked by the platform (blind sector) and by wave clutter (exclusion zone).

Fall

On the night of 2 October 2013, 828 nocturnal migrant type-targets were recorded on horizontal radar based on Platform Hermosa. The mean flight direction of these targets was southwest at 207° ± 0.45° (Figure 17).

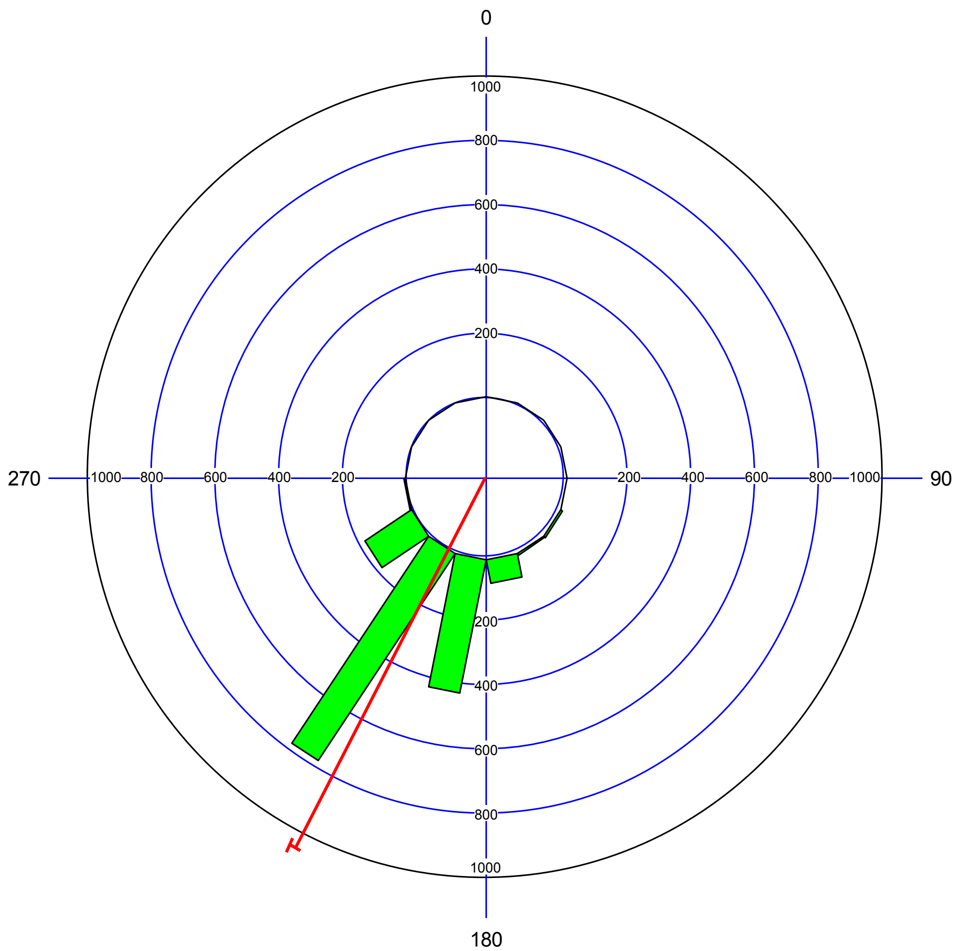

Figure 17. Mean flight direction of nocturnal migrant-type targets on surveillance radar detected within a 3.0 km radius of Platform Hermosa on 2 October 2013.

5.4 Outside Audio-Visual Observations

5.4.1 Oil Platform Deck Visual Observation Periods

Observers conducted three 30 minute visual observation periods per night on the top open deck of each platform. During each 30 minute observation period, the observer recorded any birds seen interacting with the platform lights or flying within the vicinity of the platform. Due to the large numbers of Western Gulls utilizing the platform, their detection during each nightly survey was noted but detailed information on each Western Gull interaction was not.

Platform Grace

A total of 120 30-minute visual observation sessions (60 hours total) were conducted over 40 nights in March, April, July, and August on Platform Grace. Other than Western Gulls, no other seabirds were detected interacting with the platform lights. On 13 March at 0356, songbirds were heard flying over the platform. On 15 March at 0553, songbirds were once again heard flying over the platform. On 16 March at 0152, songbirds and waterfowl were heard flying over the platform. Detections in March suggest migrating passerines and waterfowl were passing over the platform.

On 11 April at 0316, 2 Brown Pelicans were seen foraging in the water 100 m off the platform (Table 3). On 12 April at 0515, a group of 12 Kingbirds (*Tyrannus sp.*, unable to identify species) were seen feeding on insects on the top deck of the platform. On 5 August at 2211, 4 Brown Pelicans were seen feeding 50 m off the side of the platform. These detections suggest that oil platforms offer feeding opportunities for migrating passerines, as well as some seabirds that utilize the ambient light to aid in fishing.

Platform Hermosa

A total of 60 30-minute visual observation sessions (30 hours total) were conducted over 20 nights in September, October, and November on Platform Hermosa. On 30 September at 2100, a Cassin's Auklet (*Ptychoramphus aleuticus*) was detected flying 15m over the platform from the south, then circled over the platform and flew back to the south (Table 3). On 5 October at 0545, an unidentified bat was observed feeding on moths above the platform. On 6 October at 0545 and again on 7 October at 0145, a bat was observed foraging over and around the platform.

On 7 October at 0345, a Red-necked Phalarope (*Phalaropus lobatus*) was observed flying into the south platform wall on the top Main Deck (just outside of the galley). The phalarope was seen flying into the south wall once and then was slowly approached by the observer. The bird then flew into the wall a second time. It then flew southward in the direction from which it first came from, flying just above the platform deck. The observer was not sure if the phalarope flew off the platform, or landed on the lower portion of the main deck. It was not seen again. This detection is also described in the Grounded Seabird Section of this report. On 4 November at 0106, a Leach's Storm-Petrel (*Oceanodrama leucorhoa*) was observed flying erratically 15 m above the platform from the south. The bird flew over the Helipad and was not seen again (Table 3). A fall light attraction detection rate was calculated using the 3 birds detected on platform Hermosa in the fall during the visual observation periods. A total of 30 hours of visual observations were completed over 20 survey nights in the fall. Dividing the 3 light attraction birds detected into the 20 nights sampled during the fall survey session results in a detection rate of 0.15 light attracted birds observed per night. However, this number needs to be adjusted for the hours of the night where there was no visual survey effort. The total hourly survey effort during the visual observation periods in the fall was 30 hours, while the total hours of night that were available to sample was 226.8 hours. Adjusting the detection rate of light attracted birds by the hours not sampled resulted in an adjusted nightly detection rate of 1.13 light attracted birds detected per night during the fall surveys on platform Hermosa.

Table 3. Summary of seabirds detected during visual observation periods.

Date	Platform	Time	Species	Weather	Summary of Detection
4/11/2013	Grace	0316	Brown Pelican	Clear and Calm; Visibility > 5000 m	2 individuals seen foraging 100 m off side of platform
8/5/2013	Grace	2211	Brown Pelican	Cloudy and Windy, 11.7 mph @ 270 degrees; Visibility > 5000 m	4 individuals seen foraging 50 m off side of platform
9/30/2013	Hermosa	2100	Cassin's Auklet	Foggy and Windy, 19.7 mph @ 40 degrees; Visibility < 2500 m	Observed flying 15m over platform from the south, then circled back towards the south
10/7/2013	Hermosa	0353	Red-necked Phalarope	Clear and Windy, 17.2 mph @ 40 degrees; Visibility > 5000 m	Observed flying twice into south wall of upper Main Deck near galley, then flew off to the south.
11/4/2013	Hermosa	0106	Leach's Storm-Petrel	Cloudy and Windy, 13.9 mph @ 320; Visibility > 5000 m	Observed flying erratically 15m above the platform from the south

5.4.2 Grounded Bird Search Results

Platform Grace

Observers conducted twice-nightly grounded seabird searches on Platform Grace during the spring and summer survey seasons. A total of 80 surveys were conducted over 40 nights in March, April, July, and August (Table 4). Surveys lasted 30-45 minutes each, on average. On Platform Grace, the observer had unrestricted access to all levels and decks of the platform, as there was no active drilling taking place. No detections of grounded birds were recorded. Western Gulls were seen landing on the platform on a nightly basis, but they appeared to be mostly attracted to the garbage containers. Multiple fresh Peregrine Falcon kills were found during these searches and these data are summarized separately in section 5.4.4.

Table 4. Summary of grounded seabirds recorded on Platform Hermosa.

Date	Platform	Time	Avian Species	Weather	Summary of Detection
9/28/2013	Hermosa	2330	Rhinoceros Auklet	Clear and Windy, 15.1 mph @ 320 degrees	Found alive and uninjured at base of SW staircase on Mezzanine Deck.
10/3/2013	Hermosa	0154	Red-necked Phalarope	Clear and Windy, 21.7 mph @ 20 degrees	Found alive and uninjured at base of NW staircase on lower Main Deck.
10/29/2013	Hermosa	2052	Cassin's Auklet	Clear and Breezy, 9.2 mph @ 335 degrees	Found upside down on NW staircase near lower Main Deck. Appeared dead at first, then became active and hid behind life jacket container. Likely collided with platform.

<u>Platform Hermosa</u>

Observers conducted twice-nightly grounded seabird searches on Platform Hermosa during the fall survey season. A total of 40 surveys were conducted over 20 nights in September and October. Surveys were 30 to 45 minutes, on average. On Platform Hermosa, the observer's access was somewhat restricted in that observers were not permitted to go to certain parts of the platform without an escort. Over the 40 surveys, 4 detections of grounded birds were recorded (Table 4).

During the September/October 10 day survey session, a Rhinoceros Auklet (*Cerorhinca monocerata*) and a Red-necked Phalarope were found alive on the platform (Table 4). The Rhinoceros Auklet was found on 28 September at 2330, near the southwest staircase of the Mezzanine Deck, on a clear and windy night. The bird was seen sitting at the base of the staircase in a dimly lit area with no nearby bright lights. The auklet appeared calm and uninjured when approached by the observer. Because the auklet was found at the base of a heavily used staircase, it was gently released off the side of the platform.

On 3 October at 0154, a Red-necked Phalarope was found alive during the mid-survey grounded seabird search. The bird was found near the northwest Main Deck staircase on a clear and windy night, and was spooked by the observer when approached. The phalarope appeared to be uninjured (Figure 18). The observer took a digital photograph of the bird and left it alone. On 7 October at 0353, a Red-necked Phalarope was observed flying into the south platform wall during an outside observation session, and was summarized separately in section 5.4.1. One of the night-shift cooks mentioned that he had also seen birds fly into the wall of the platform in this same area before, though usually during periods of fog. The detection rate of grounded birds found on platform Hermosa during the fall survey period was 0.15 birds per night. Adding this number to the number of light attracted birds observed in the fall after adjusting for periods of the nights not sampled (1.13 birds/night), results in a total rate of 1.28 light attracted or grounded birds detected per night in the fall.

Figure 18. Red-necked Phalarope observed 8 October 2013 at 0353 on Platform Hermosa.

During the October/November 10 day survey session, a Cassin's Auklet was found on 29 October at 2052, on a clear and breezy night. The auklet was found on the northwest Main Deck staircase, at the base of a container of life jackets. The bird was found upside down (Figure 19), and appeared to be a Peregrine Falcon kill at first glance. As the observer approached and touched the auklet, it rolled back over and scurried a few feet away, behind the container of life jackets. The bird appeared to be uninjured but seemed stressed (Figure 20). It appeared to have flown in and collided with the platform. The observer left the bird, but periodically checked on it throughout the night. The auklet was still seen in the same area at sunrise, but then never observed again on subsequent surveys.

Figure 19. Cassin's Auklet first observed after collision with Platform Hermosa wall on 29 October 2013 at 2052.

Figure 20. Cassin's Auklet observed after collision with Platform Hermosa wall on 29 October 2013. This is the second observation where the bird is recovering from the collision.

5.4.3 Rafting and Transiting Seabird Surveys

Observers conducted twice-daily rafting and transiting seabird surveys in the daylight hours before and after each nightly survey throughout the survey season. Surveys took 15-20 minutes to complete and took place around sunset and sunrise while there was still enough light to detect birds. Observers used binoculars and a spotting scope to identify any birds seen rafting or flying in the vicinity of the platform.

Platform Grace

A total of 80 surveys were conducted over 40 days in March, April, July, and August. Scripps's Murrelets were seen rafting off Platform Grace on multiple surveys in March. On 8 March, two separate rafts of Scripps's Murrelets were recorded rafting and foraging off Platform Grace during the sunset survey. A loose raft of ~250 individual murrelets was seen to the southeast ~300 m from the platform (Table 5). During the same survey, a smaller raft of 18 individuals was seen 125 m from the platform to the northwest. These rafts of Scripps's Murrelets slowly broke up as dusk approached with the birds seen flying south towards Anacapa Island. On 12 March, a loose raft of ~30 Scripps's Murrelets was seen foraging 700 m north of the platform during the sunset survey (Table 5). Once again, the raft of birds broke apart as dusk approached and the individuals flew south in small groups of 2-3 birds.

Ashy Storm-Petrels were positively identified during one survey in August. On 9 August, two Ashy Storm-Petrels were seen foraging in a raft of other seabirds 400 m to the southeast of the platform during the sunset survey (Table 5). The raft was made up of ~20 birds and also contained Sooty Shearwaters (*Puffinus griseus*) and unidentified storm-petrels. Differentiating species of storm-petrels was difficult, especially when the birds were seen rafting on the water at large distances from the platform. In this case, the observer was able to identify the two Ashy Storm-Petrels only after they broke off from the rafts and flew away. Two other rafts of unidentified storm-petrels were also seen to the south and northwest of the platform during this survey, with ~15 and ~25 individuals in each raft respectively. On 7 July, five suspected storm-petrels were seen transiting 500 m to the north of the platform during the sunrise survey. These individuals were too far out to identify to species (Table 5). A number of other seabird species were also recorded during the rafting and transiting seabird surveys (Table 5).

Platform Hermosa

A total of 40 surveys were conducted over 20 days in September, October, and November on Platform Hermosa. On 6 November, a single Scripps's Murrelet was seen rafting 225 m northeast of the platform during the sunrise survey (Table 5). This was the only detection of Scripps's Murrelets on Platform Hermosa. Ashy Storm-Petrels were not detected during the rafting and transiting seabird surveys on Platform Hermosa. Other seabirds recorded from these survey sessions can be found in Table 6.

Table 5. Summary of Scripps's Murrelets and Ashy Storm-Petrels recorded during rafting and transiting seabird surveys.

Date	Platform	Survey	Species	Summary of Detection
3/6/2013	Grace	Sunset	Scripps's Murrelet	Loose raft of ~18 birds seen 125 m to the northwest of the platform
3/6/2013	Grace	Sunset	Scripps's Murrelet	Loose raft of ~250 birds seen 300 m southeast of the platform
3/8/2013	Grace	Sunset	Scripps's Murrelet	Loose raft of ~30 birds seen 700 m to the north of the platform
8/9/2013	Grace	Sunset	Ashy Storm-Petrel	Two confirmed Ashy Storm-Petrels seen in a raft of ~20 seabirds floating 400 m southeast of the platform.
11/6/2013	Hermosa	Sunrise	Scripps's Murrelet	Single bird seen rafting 225 m northeast of the platform

Table 6. Species list of birds recorded during rafting and transiting seabird surveys.

Rafting Birds Species List	Scientific Name	Code
Ashy Storm-Petrel	*Oceanodroma homochroa*	ASSP
Black-vented Shearwater	*Puffinus opisthomelas*	BVSH
Brown Pelican	*Pelecanuserythrorhynchos*	BRPE
Cassin's Auklet	*Ptychoramphus aleuticus*	CAAU
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO
Pelagic Cormorant	*Phalacrocorax pelagicus*	PECO
Peregrine Falcon	*Falco peregrinus*	PEFA
Pink-footed Shearwater	*Puffinus creatopus*	PFSH
Scripps's Murrelet	*Synthliboramphus scrippsi*	SCMU
Sooty Shearwater	*Puffinus griseus*	SOSH
Unidentified Cormorant		UNCO
Unidentified Shearwater		UNSH
Unidentified Storm-Petrel		UNSP
Western Grebe	*Aechmophorus occidentalis*	WEGR
Western Gull	*Larus occidentalis*	WEGU

5.4.4 Peregrine Falcons and Other Raptors

During the 60 days of radar and visual surveys throughout the spring, summer and fall seasons, observers recorded the use of the oil platforms by Peregrine Falcons for roosting and hunting. Peregrine Falcons were seen during the spring (Platform Grace) and fall (Platform Hermosa) survey sessions, along with bird carcasses exhibiting signs of falcon predation. These signs included headless carcasses, whole carcasses with spots of blood on the breasts, heads only, or the wings from deceased birds. Some of the crew on Platform Hermosa also mentioned the presence of an owl at various times throughout the year, though none were seen during the project.

<u>Platform Grace</u>

On Platform Grace, carcasses from Peregrine Falcon predation on seabirds were evident from the first day of surveys on 6 March. The platform crew made the observer aware of multiple known falcon roosting spots on the platform. Searching these areas, the observer found the heads of five Scripps's Murrelets near these falcon roost sites. Grounded seabird surveys often yielded more seabird carcasses of Peregrine Falcon kills. Individual headless carcasses of fresh Scripps's Murrelets were found on 7 March and 8 March at known falcon roosting locations. The falcon itself was spotted by the observer on 10 March on multiple levels of the platform, during both the outside observation periods and grounded seabird searches.

In April, the observer detected the falcon upon arrival onto the platform. On 4 April, a whole Scripps's Murrelet carcass was found on top of the radar antenna, while another was found at the base of the radar pedestal. Another 7 Scripps's Murrelet carcasses were found throughout the platform (Figure 21), along with the decapitated carcass of a Western Meadowlark (*Sturnella neglecta*) with its head nearby. Soon after, the falcon was observed eating the Scripps's Murrelet carcass that was on the radar antenna, along with the murrelet carcass resting at the base of the radar pedestal (Figure 22). On the night of 5 April, another whole Scripps' Murrelet carcass was found near a known falcon roosting location. After 5 April, the falcon was no longer detected on Platform Grace for the remainder of the April survey session. During the July and August survey sessions, no Peregrine Falcons were detected and no additional bird carcasses were found.

<u>Platform Hermosa</u>

On Platform Hermosa, observers detected one or more Peregrine Falcons almost daily throughout the fall survey sessions. At times, a pair of falcons were seen roosting near one another, or hunting together in the vicinity of the platform. After arriving on Platform Hermosa on 26 September, the observer was alerted to known roosting locations of the falcons by the platform crew. The head of a Sabine's Gull (*Xema sabini*) and a Cassin's Auklet carcass were discovered at one of these roosting locations on 26 September. Throughout the remainder of the September/October survey session, two additional Cassin's Auklet carcasses, and two Red-necked Phalarope carcasses were found at these roost locations.

Figure 21. Scripps's Murrelet carcass with wings and spine of second Scripps's Murrelet killed by Peregrine Falcon found on Platform Grace 4 April 2013.

Figure 22. Peregrine Falcon observed eating a Scripps's Murrelet carcass on top of the radar antenna located on Platform Grace, 4 April 2013.

Upon the observer's arrival onto Platform Hermosa for the October/November survey session on 28 October, the observer noted 3 Red-necked Phalarope and 5 Cassin's Auklet carcasses stashed beneath one of the falcon roost sites. By the next morning, all of the carcasses were gone, and a pair of Peregrine Falcons was seen roosting in the same location. Throughout the remainder of the 10 day October/November survey session, another 2 Red-necked Phalaropes, 6 Cassin's Auklets, 2 unknown gulls, 1 Green-winged Teal (*Anas carolinensis*), and 1 unidentified shorebird carcass were found at locations throughout the platform. On the final morning of the survey session, a pair of Peregrine Falcons was observed hunting together off the west side of the platform, at first chasing a songbird and then chasing Western Gulls.

The platform crew also alerted the observer to the presence of an unidentified owl that sometimes roosted on the platform. One of the crew members showed a cell phone photograph to the observer, who identified the owl in the picture as a Burrowing Owl. The owl was known to roost in the crane shack located on the top Main Deck of the platform. The owl was never detected by the observer, but had been seen multiple times by platform crew members.

5.5 Oil Platform Artificial Light Emittance Levels

Three offshore oil platforms, Grace, Hermosa and Heritage (control), were assessed to determine relative artificial light emittance levels from composite night satellite imagery (NASA 2012). Overall, the control oil platform, Heritage had the highest integrated density value at 806.1 km^2, indicating the highest light emittance of the three platforms (Table 7). This result concurs with the higher visual emittance in the night sky imagery (Figure 5) when compared to the two surveyed platforms, Grace and Hermosa. Between the two survey platforms, Hermosa, with a value of 485.5 km^2, had a higher integrated density value than Grace by 96.1 km^2 points (Table 7). Based on integrated density values, Hermosa was 125% brighter than Grace (or Grace was 20% dimmer than Hermosa). Heritage, the control, was 166% brighter than Hermosa and 207% brighter than Grace, based on the calculated integrated density values.

Table 7. Integrated density results for two survey platforms (Grace, Hermosa) and control platform (Heritage).

Platform	Area (km^2)	Integrated Density (km^2)
Grace	12.1	389.5
Hermosa	12.1	485.5
Heritage	12.1	806.1

6. Discussion

6.1 Survey Effort

The nocturnal radar sampling effort for this project consisted of 56 successful survey nights out of 60 nights (93%) attempted in 2013. The audio-visual sampling effort was conducted for all 60 of 60 nights attempted. Four nights of surveys were unusable due to two nights of poor weather (7 March and 4 April) and two nights lost due to radar equipment and software failure resulting in data corruption (11 and 12 April). Radar target identification surveys were successfully conducted for 4.5 hours per night for a total of 270 hours of effort over the study period. All oil platform deck visual observation periods were conducted in three 30-minute increments nightly for a total survey effort of 90 hours. Twice-nightly grounded seabird searches and twice-daily rafting and transiting bird surveys were all successfully completed for a total sampling effort of 75 and 38 hours respectively. In summary, the sampling effort originally planned for each study objective was achieved overall.

6.2 Weather

Weather likely plays an important role in the rates of seabird attraction to oil platform lights. Six detections of seabirds either grounding themselves or flying toward the light just above the platform were recorded during the 60-day study period. These detections only occurred during the fall survey session, with winds ranging from 14.8 to 34.9 km/hr (9.2 to 21.7 mph) at the time of detections. The mean wind speed for the 6 detections was 25.9 km/hr (16.1 mph). Four out of the six detections occurred on clear nights, including all four instances of seabirds found grounded on the platform. The Leach's Storm-Petrel that was detected flying erratically over the platform on 4 November occurred during cloudy conditions, while the Cassin's Auklet detected circling over the platform on 30 September occurred during foggy conditions with a visibility of < 2,500 m.

The results may suggest that higher winds could also play a role in light attraction events on oil platforms in the POCS, but due to the small sample size of events detected during this study, more data was needed to draw any conclusions on weather patterns and their association with light attraction in seabirds. No clear relationship between weather and radar recorded light attraction events were found in this study and many nights with fog had zero light attraction events observed on radar. Future studies may benefit from the installation of mobile weather stations on the study platforms in order to collect weather data throughout each survey night. Weather buoys located in the Santa Barbara Channel may also provide more detailed weather patterns that occurred during survey nights.

6.3 Light Attraction Events Recorded by Radar

Western Gulls, cormorants, and on Platform Grace, Brown Pelicans, were regularly observed flying in the near vicinity of the two platforms and were often observed roosting on the bottom deck of both platforms. These species were often seen foraging in the near vicinity of the platforms both day and night and thus were often observed resting or foraging on the surface of the water. The flight speeds of cormorants measured by Hamer et al. (2005) in a radar study of Scripps's Murrelets conducted in the Channel Islands averaged 54.8 km/h (34.1 mph; range: 24.1 – 86.8 km/h [15.0 – 53.9 mph]) and were reported to greatly overlap that of Scripps's Murrelet (average 58.4 km/h [36.2 mph], range: 45.0–98.2 km/h [28.0-61.0 mph]). Radar echo sizes of the two species were also found to be similar. The radar study (Hamer et al. 2005) also found that the flight speeds of Western Gulls and Brown Pelicans overlapped with the lower range of the flight speeds of the Scripps's Murrelet, although the echo sizes of gulls and pelicans were usually larger than Scripps's Murrelets. In addition, during the spring and fall nocturnal migration periods, there were nights with hundreds or thousands of migrating birds being detected by the radar flying toward and over the platforms (Figures 12 and 16). These detections of migrating birds likely included a large number of migrating shorebirds and waterfowl with echo sizes and flight speeds similar to Scripps's Murrelets. Therefore, due to the overlap in the radar signatures of these species with the Scripps's murrelets and the high level of nocturnal activity of other seabird species around the lighted platforms, radar targets approaching the platform could not be reliably confirmed as Scripps's Murrelets.

In previous radar studies of Scripps's Murrelets Hamer et al. (2005) conducted in the Channel Islands, it was possible for the researchers to identify murrelets on radar, because at the breeding colonies they surveyed, there were no other birds species active at night that could be commonly mis-identified as Scripp's Murrelets. The exceptions were Cassin's Auklets, which were rare at their survey sites, and Cormorants, which were only active during the day. To further reduce the error of identifying Scripps's Murrelets from other birds at breeding colonies, they only recorded murrelets type targets flying to or from the breeding colonies and only birds within 400 m of the breeding habitat (Hamer et al. 2005). Using these methods, they could filter out migrating birds, other species flying parallel to the breeding colonies (cliffs and bluffs), and other seabird species active farther out to sea. This study was also aided by the fact that it was truly dark at night at the island breeding colonies with no artificial lights attracting other species of birds.

For the summer and fall surveys where Ashy Storm-Petrels were the focus of the study, there were no data available on the flight speed or echo size of this species to be able to discriminate them on radar from other species of birds recorded approaching the platform. Therefore as a conservative measure, for all three seasons, all targets flying toward the platform within 650 m (0.4 mi) were simply defined as light attraction events and usually could not be identified to species. The exception was the few radar targets that were identified by the outside observer. These confirmed targets were almost all gulls, indicating that a proportion of the light attraction events being recorded were local birds using the platform for roosting and foraging. These birds would sometimes fly in from the mainland or Channel Islands to roost on the platform. No Scripps's Murrelets or Ashy Storm Petrels were observed to fly into the lights of the platform and neither of these two species was found grounded on either of the two platforms studied.

Light attraction events as measured by radar were extremely low on the majority of the 56 nights sampled. The average number of light attraction events recorded per night over the 56-day period was only 1.23 events per night with the majority of these targets (69.5%) recorded in the spring during an active nocturnal bird migration occurring over Santa Barbara Channel. Over the three seasons, light attraction events were recorded on only 44.5% of the nights sampled. The percentage of nights with light attraction events declined as the seasons progressed with 56, 45, and 35% of the nights having one or more events for spring, summer and fall respectively. Only 5 nights (8.9%) of the 56 nights sampled had light attraction rates ≥ 0.20 targets/hr/km and 4 of these nights were in the spring and likely due to migrating birds.

For spring, light attraction event target speeds averaged 50.4 km/hr (31.3 mph) and ranged from 27.6 to 78.5 km/hr (17.1 to 48.8 mph), which was in the range of the average flight speed of Scripps's Murrelets (58.4 km/h) reported by Hamer et al. (2005). It is likely that a large proportion of recorded light attraction events in spring were actually migrating birds. Migratory–type target flight speeds for the night of 10 April were similar to the average speed of light attraction targets with an average flight speed of 46.0 km/hr (28.6 mph). Nights with the highest number of light attraction events (≥ 0.20 targets/hr/km) occurred in March and April during the height of nocturnal bird migration. On 10 April, the radar recorded 12,177 targets heading in a northerly direction and passing within 3.0 km (1.8 mi) of the platform. Three nights in April (6, 7 and 10 April) had the highest light attraction rates recorded over the three seasons sampled (Figure 7). However, visibility on these three nights was good, with > 5,000 m (3.1 mi) horizontal visibility, 0% cloud cover and no fog or precipitation. In addition, the average flight direction of light attraction targets in the spring (Figure 11) was northerly (40.4°) indicating these events were mostly due to migration activity. The mean hourly pattern of light attraction events recorded through the night in spring (Figure 8) also show a pattern more typical of migrating birds, with low rates at dusk, increasing to a peak after midnight, and rapidly falling off towards dawn. Therefore, increases in light attraction rates in spring and the higher percentage of nights with light attraction events for this period were most likely due to an active and ongoing nocturnal spring migration. Flight directions of light attraction events in summer were variable (Figure 11) indicating a lack of avian nocturnal migration activity during this period.

Other nights with light attraction rates ranging from ≥ 0.09 to 0.11 targets/hr/km also had 0% cloud cover and horizontal visibility > 5,000 m (3.1 mi). These nights included 9 and 10 March along with 7 and 29 October. Many of the nights sampled with fog present had zero light attraction events recorded, including 13 and 15 March, 2 July and 30 September. Therefore, light attraction events recorded by radar did not appear to increase with poorer visibility conditions or be related to weather conditions associated with fog, rain, or heavy cloud cover. However, poor weather conditions do likely play a role in avian light attraction; therefore, our results are likely due to recording migrating birds and non-target seabird species approaching the platforms as light attraction events.

In fall, the average flight direction of light attraction targets was south at 182.7° while the flight direction of migrating birds recorded on the night of 2 October was very similar, southwest at 207°. Therefore, some proportion of light attraction events measured on radar in fall was most likely due to fall nocturnal migrating birds.

However, unlike spring, the mean hourly pattern of radar light attraction events recorded through the night in summer and fall were not typical of a bird migration pattern (Figures 9 and 10). Both of these seasons show light attraction events beginning 1-2 hours after dusk, occurring for only a 4-5 hour period, declining after initial peaks after dusk, and then typically ending near midnight. In addition, fall light attraction target flight speeds averaged 45.1 km/hr (28.0 mph) and ranged from 18.2 to 78.5 km/hr (11.4 to 48.8 mph), which was much slower than the average flight speed (77.1 km/hr [47.9 mph]) of migrating birds measured on 2 October. Therefore, it is possible that a larger proportion of the targets recorded during these two seasons were birds being attracted to the lights. The findings of grounded birds and additional visual observations of birds being attracted to the lights of Platform Hermosa in the fall support this idea. The higher artificial light emittance levels (as quantified by satellite imagery) measured from Hermosa (125% brighter than Grace) may have caused a higher level of avian light attraction to this platform compared to the Grace Platform. On Grace, no grounded birds where found and no visual observations of birds being attracted to lights were recorded. Although the difference in seasons sampled and locations of these two platforms might have also contributed to the difference in light attraction rates found between the two platforms, total light emittance levels from structures should be taken into consideration when designing future studies or analyzing avian light attraction data.

6.3.1 Identification of Radar Targets

Although radar can provide detailed information on the relative size of a bird in flight, its flight speed, flight direction, flight path and flight behavior, it cannot necessarily identify these targets to genera or species. The exception is when there are few other species present in an area or the species being studied has unique flight speeds, flight behavior, body size, other feature, or a combination of these characteristics. Therefore, one objective of the study was to try and identify radar targets approaching the platform. Visual identification to genera or species of avian radar targets approaching the platforms proved to be the most difficult task during the study. Use of night vision equipment to identify birds flying in the vicinity of the platforms was ineffective due to the intense ambient light pollution emitted from the platform lights and other light sources. Binoculars were also deemed ineffective, as the light emitted by the platforms did not project far enough out from the platform for them to be a useful identification tool. Therefore, observers had to rely on eyesight to identify birds at night, which made identification of targets beyond 10 m (33 ft) from the platform extremely difficult. Therefore, of the 75 radar targets where an attempt was made to identify the species of the target approaching the platform, only 14.7% (n = 11) of these individuals were identified. The majority of these targets turned out to be Western Gulls or unidentified gulls (91%). Due to the large amount of nocturnal flight activity of gulls around the platforms, the majority of targets observed approaching the platform were this species. Another reason so few radar targets were visually observerd approaching the platform is that many of these birds may have flew in and landed on the water near the platform, but never completely reached the platform itself. In addition, many of these birds may have flown in and perched on the lowest decks, which the observers would have a difficult time seeing since observers were on the top upper deck during these periods monitoring the radar. Another factor limiting the identification of radar targets is that the height of birds approaching the platform was unknown since there was no vertical radar on deck. Surveillance (horizontal) radar does not provide height information. So, some of these light attraction targets could have been high and thus not visible to the observers with only 10 m visibility. However, birds flying completely into the platform lights were identifiable by the observers since at that point, it was like seeing birds in broad daylight. Over the course of the study, no radar targets were identified as Scripps's Murrelets or Ashy Storm-Petrels.

Another approach to gather data on birds attracted to lights was tried in this study by placing an observer on the top Main Deck and visually recording any birds interacting with the lights of the platform. As stated, the platform lights were so bright that an observer standing on the Main Deck could usually identify birds to species as they flew in toward the lights. Multiple light attraction events were recorded using this method.

6.4 Nocturnal Migrant Type Radar Targets

Nocturnal migration was assessed for a single survey night for spring and fall surveys seasons which included 10 April and 2 October 2013. Although this radar data was available for all nights sampled, a fuller assessment of nocturnal bird migration was not conducted for all spring and fall survey nights because this was outside of the primary study objective. Information on avian offshore migration movement rates and spatial flight patterns are extremely limited, but one study in the POCS Santa Barbara Channel region suggested migratory activity to be very limited and resulting light attraction events by nocturnal migrants to be of less concern here than along the Gulf of Mexico and the North Sea region of the Atlantic coast (Johnson et al. 2011). The detection of 12,177 birds with an average hourly passage rate of 203 ± 246 targets/hr/km on 10 April suggests nocturnal migration in the Santa Barbara Channel may be more significant than previously thought. Therefore, the oil platforms and associated lights may pose a greater risk to nocturnal migrants in this region than previously believed.

The hourly timing of flights through the night on 10 April was also consistent with a spring nocturnal migration, which was low after dusk, peaked at 0100 and then declined towards dawn. For fall, passage rates were very low on 2 October and averaged only 25 ± 14 targets/hr/km. Nocturnal flights on 2 October did not follow a typical nocturnal migration pattern, with activity peaking very early in the evening hours of 2100 and 2200 and then slowly declining over the remainder of the night (2300 – 0600). There was no information on avian nocturnal migration for offshore areas of the POCS and southern California in general, so conclusions on the comparative significance of passage rates detected in this study are limited. Fall mean passage rates at a proposed onshore wind site in Shasta County, California were 290 ± 246 targets/hr/km over a sample of 71 nights (Mabee and Sanzenbacher 2008). Low passage rates, atypical nightly timing of nocturnal migrant targets on 2 October, and higher passage rates recorded from one onshore study in California, suggest the peak fall migration activity was missed in this study and thus was likely underestimated. Survey dates for this study in fall (October/November) were selected to coincide with activities of Ashy Storm-Petrels, and so fell outside the expected peak fall avian nocturnal migration period (~late August through September).

Directional patterns of nocturnal migrants on the two sample nights were consistent with those of other nocturnal migration studies in California. The mean flight direction on 10 April was northwest at 338° ± 0.35° (Figure 15) and was consistent with an average spring flight direction of 315° from a nocturnal migration study using radar near Palm Springs (McCrary et al. 1983). On 2 October the mean flight direction recorded in this study was southwest at 207° ± 0.45° (Figure 17). Fall mean flight direction of nocturnal migrants was similar for a radar study of nocturnal migrants conducted in Shasta County, California with a mean flight direction of 194° (Mabee and Sanzenbacher 2008).

6.4.1 Platform Avoidance by Nocturnal Migrants

By mapping the flight paths of all nocturnally migrating birds on 2 April, it was apparent that the large majority of birds were altering their flight paths to avoid the oil platform. Much lower flight densities of birds were recorded south and southeast of Platform Grace compared to east and west of the platform (Figures 12 and 16). Avoidance was consistent throughout the peak migration hours of 0100 – 0500. This avoidance behavior was likely due to the artificial lighting being emitted by the platform. Avoidance on 10 April may have been enhanced due to clear weather conditions that night, allowing visibility of the lighted platform from a greater distance. Other offshore studies of nocturnally migrating birds in Europe have shown a similar pattern of avoidance as birds approach lighted structures (Isselbächer and Isselbächer 2001, Schmeidel 2001, Desholm and Kahlert 2005, Hüppop et al. 2006, Peterson et al. 2006).

Avoidance at an offshore wind farm in Denmark was documented for diurnal migrants (Desholm and Kahlert 2005). Nocturnal migrants passed more frequently through the Nysted wind farm, presumably due to lower visibility, but still avoided individual wind turbines.

Although the evidence of general avoidance of offshore structures by nocturnal migrants may help reduce collision risk, weather conditions (precipitation and fog) which limit bird visibility have resulted in high collision and fallout events (Russell 2005, Hüppop et al. 2006). A study conducted at an offshore platform in the Baltic Sea, documented over 50% of all avian collisions with the platform occurred on only two nights in fall when weather conditions included precipitation and low visibility for nocturnal migrants (Hüppop et al. 2006). An offshore oil platform study in the Gulf of Mexico found migrant mortality from collisions with platforms and associated structures in spring to be 34% (n = 261) of all mortalities, which included starvation, predation, collision and other mortalities. The majority of spring collisions occurred over a 4-day rain and wind storm event (Russell 2005). In fall, a mortality rate of 48% (n = 315) from collisions was the highest source of avian mortality documented. Collision mortality was thought to be higher in fall, because there are more hours of darkness during fall migratory movements (Russell 2005). Other studies also show that nocturnal migrants fly at lower altitudes on dark nights (new moon), in poor weather (precipitation and fog) and during headwinds, which contribute to higher light attraction and collision risk (Avery et al. 1977, Bruderer and Liechti 1998, 2004).

6.5 Outside Audio-Visual Observations

6.5.1 Oil Platform Deck Visual Observation Periods

Although the platform deck visual observations did not record a large number of birds being attracted to platform lights overall (other than Western Gulls), the detections that were made were significant to this study. No birds were observed being attracted to lights on Grace in the spring, but several light attraction observations were made in the fall on Hermosa. Only one bird was observed to have temporarily grounded itself on Platform Hermosa (Red-necked Phalarope on 7 October), which exhibited the disorientation effects caused by attraction to the platform lights. The bird eventually flew off after colliding with the platform twice. Two other birds were observed flying erratically just above Platform Hermosa (1 Cassin's Auklet on 30 September and 1 Leach's Storm-Petrel on 4 November), which also suggested attraction to the platform lights by these birds.

While no birds were detected on Platform Grace exhibiting attraction to lights, passerines were heard calling while transiting above the platform on multiple occasions during the spring survey sessions along with one instance of waterfowl being heard. These observations, along with the small flock of kingbirds seen on the platform during the spring, suggest that both landbird and waterbird migration takes place over the platforms in the Santa Barbara Channel, and that oil platforms may offer over-water rest stops for some of these species. The abundance of moths and their attraction to the platform lights may also offer a food source for some of these avian migrants.

Of the birds observed attracted to the lights of Platform Hermosa, two of the observations were on clear night with visibility > 5,000 m (3.1 mi) while one of the observations (Cassin's Auklet) took place on a foggy night with limited visibility.

Visual observations of birds being attracted to lights indicated that, in the fall, three species may be at most risk. These included the Cassin's Auklet, Leach's Storm Petrel and Red-necked Phalarope. Results from the grounded bird searches confirm two of these species as light attraction victims, the Cassin's Auklet and Red-necked Phalarope. The lack of observations of grounded birds or birds being seen attracted to the lights on Grace may be due to the lower light emittance from the Grace Platform. The analyses of night satellite imagery conducted for this study indicates that, based on integrated light density values, different oil platforms emit very different light levels. Hermosa was 125% brighter than Grace. Heritage, the control, was 166% brighter than Hermosa and 207% brighter than Grace. Future studies of light attraction will need to take the relative differences in the light emittance levels of different platforms into account when designing a sampling strategy or analyzing their results. Therefore, the lack of light attraction observations of Scripps's Murrelets or groundings of this species on Platform Grace in the spring cannot be taken to infer that this species does not experience mortality from platform lights when birds are present in the POCS region. Future studies of light attraction of Scripps's Murrelets in the POCS should sample a range of platforms with different light emittance values, including those with some of the highest values in this region. The same philosophy would apply to studies of light attraction in the Ashy Storm-Petrel.

6.5.2 Grounded Seabirds

Grounded seabirds were rarely encountered overall throughout the study. Platform Grace did not have any detection of grounded birds during the spring and summer survey sessions. Platform Hermosa, however, had 4 detections of grounded birds during the fall survey session. One of these detections was the temporary grounding of the Red-necked Phalarope on 7 October, which was described in the visual observation period section (Figure 18). The other 3 grounded birds found on Platform Hermosa suggested that the lower decks of oil platforms may present the greatest chance for light attraction and bird collisions. In all three cases (Rhinoceros Auklet on 28 September, Red-necked Phalarope on 3 October, and Cassin's Auklet on 29 October), the grounded birds were found below the top Main deck of the platform. This may just be a coincidence, or it may suggest that light intensity is relatively brighter on the middle decks of the platform, and therefore the chance of detecting grounded birds on these levels is greater. Or, it might be that these seabirds are transiting closer to the surface of the ocean during the night and thus are more likely to be grounded on the lower decks of the platform.

While the Rhinoceros Auklet on 28 September and the Red-necked Phalarope did not exhibit any visible signs of collision with the platform, the Cassin's Auklet detected on 29 October was discovered upside down and appeared dead when first found, suggesting that it had collided with the platform at that location (Figure 19). After waking up, the auklet was visibly stressed, and did not attempt to fly away from its location (Figure 20). All observations of grounded birds on Platform Hermosa were recorded on nights that were clear and with good visibility. The total adjusted rate of 1.28 light attracted and grounded birds detected per night in this study during fall indicates that light attraction of birds at oil platforms in the POCS may be a persistent problem. Approximately 20% (1 level in 5) of Platform Hermosa was not accessible to conduct ground searches, so the fall rate is likely an underestimate.

6.5.3 Rafting and Transiting Seabird Surveys

The focus of this study was on Scripps's Murrelets and Ashy Storm-Petrels, both of which were seen foraging and transiting in the vicinity of the study platforms during the 60-day study period. Scripps's Murrelets were documented rafting and foraging off of Platform Grace in the spring and Platform Hermosa in the fall. Ashy Storm-Petrels were observed foraging and transiting off of Platform Grace in the summer. Observations of both species in close proximity to the study platforms suggested that these were adequate platform choices to sample from for the light attraction study. Information from telemetry studies and at-sea surveys on these species within the POCS may help guide which platforms to survey from in the future during different seasons.

6.5.4 Peregrine Falcons and Other Raptors

Peregrine Falcons and Burrowing Owls have been documented using other platforms within the POCS before. Recent avian studies in the Santa Barbara Channel suggest that use of oil platforms by Peregrine Falcons is widespread (Johnson et al. 2011). Oil platforms in the POCS offer excellent roosting opportunities for falcons along with a consistent local prey source. Not only is there an abundance of seabirds found throughout the Santa Barbara Channel and surrounding waters, but an influx of migratory land and shorebirds in the spring and fall provides Peregrine Falcons with a steady supply of prey options.

Peregrine Falcons have been documented hunting and roosting on oil platforms in the Gulf of Mexico for a number of years (Russell 2005). Lights on the platforms within the POCS offer the falcon the ability to hunt at night, which was documented in this study on Platform Hermosa. This night time hunting behavior, although rare for the species, has been documented before (DeCandido and Allen 2006, Johnson et al. 2011). The discovery of an unsuccessful nesting attempt on Platform Gina in recent years (Johnson et al. 2011) suggests that it may be a matter of time before Peregrine Falcons are not only hunting and roosting on platforms within the POCS but breeding as well.

Six different species of birds (Scripps' Murrelet, Red-necked Phalarope, Cassin's Auklet, Western Meadowlark, Sabine's Gull, and Green-winged Teal) were documented to have been taken by Peregrine Falcons immediately before or during the six 10-day survey sessions. Another 3 birds were unidentified to species, including 2 unidentified gulls and an unidentified shorebird. The most commonly taken species was the Scripps' Murrelet, in which 17 carcasses were found on Platform Grace during the spring survey session. During the fall survey sessions on Platform Hermosa, Cassin's Auklets and Red-necked Phalaropes were the most common species taken by the Peregrine Falcons with 14 and 7 individuals found below roost sites respectively.

From the number of Scripps's Murrelet carcasses recorded below roost sites in spring on Platform Grace, the number of murrelets taken by Peregrine Falcons in spring on offshore oil platforms in the Channel Islands may be significant. Unfortunately, due to the short time of each survey session, we were unable to calculate the number of murrelets taken per day. However, it is clear that the presence of the offshore platforms likely makes it much more efficient for these falcons to hunt Scripps's Murrelets at-sea since the platform provides: 1) a location to launch hunting forays close to rafting murrelets; 2) roost sites to rest after each hunt and; 3) a location to eat prey without needing to return to the mainland or Channel Islands. By not needing to fly back and forth between the mainland or Channel Islands after each successful hunt, falcons can spend more time hunting and capturing prey. Platform Grace was located 16.9 km (10.5 mi) offshore while Platform Hermosa was 10.9 km (6.8 mi) offshore. These would be significant distances for these falcons to transit after each successful hunt since a round trip flight to and from the mainland from Platform Grace and Hermosa would entail flying 33.8 km (21.0 mi) and 21.8 km (13.6 mi) respectively. In addition, large rafts of Scripps's murrelets were observed in the spring around Platform Grace indicating the falcons had an abundant supply of this species during this time of year.

The lack of other species (except a Western Meadowlark) recorded taken by these falcons in the spring on Platform Grace indicates they were concentrating their hunting effort on Scripps's Murrelets. The falcons were not seen on Platform Grace again after 5 April, and after 12 March rafts of Scripps's murrelets were no longer observed around the platform. In addition, Peregrine Falcons were not seen around Platform Grace during the July and August survey when Scripps's Murrelets had mostly dispersed from the area. With a number of other POCS platforms located near primary breeding and foraging grounds of the Scripps' Murrelet, it is likely that similar magnitude of spring Scripps' predation by Peregrine Falcons is occurring at these sites. From the prey carcasses recorded in the fall on Platform Hermosa, Peregrine Falcons concentrated their hunting effort on Cassin's Auklets and Red-necked Phalaropes.

The discovery of Burrowing Owls on oil platforms in the POCS was another finding made during the light attraction study. The number of crew member sightings of a Burrowing Owl on Platform Hermosa suggests that at least one owl was a frequent visitor to the platform. A Burrowing Owl was also documented on Platform Gina in the fall of 2013 (Ojai Raptor Center 2013), which may indicate a more widespread use of oil platforms by this species. Oil platforms within the POCS may offer important stopover sites for Burrowing Owls dispersing from the mainland to the Channel Islands. Breeding has been documented in recent years on Santa Barbara Island (Collins and Jones in press).

6.6 Future Study Efforts and Methods

6.6.1 Constraints of Surveillance Radar

The use of surveillance radar to detect birds is a widely used technique to help quantify the collision risk of diurnal birds and nocturnal migratory birds at wind farms, transmission lines, communication towers and other man-made structures throughout the United States. Radar works well in these situations where dozens of wind turbines or other structures over a large area need to be surveyed and monitored for bird flight activity and flight heights at a landscape scale. However these radar systems do not work as well at small scales. This study found three constraints to using radar technology to detect birds at night that are attracted to lights from offshore oil platforms. One constraint of using surveillance radar for studies at offshore oil platforms is the inability of the radar to detect avian targets within ~180 m of the radar itself. This area is a solid echo (corona) on the radar monitor where birds cannot be detected. Therefore, for this study, visual identification of radar targets in close proximity to the study platforms were hindered by the effect of the corona, since the observers could not see the radar targets on the radar monitor as they approached within 180 m of the platform. All these powerful radar systems have a corona, including the S-Band radars. However, the corona did not affect our measurement of light attraction events since we defined light attraction as a bird flying toward the platform at 650 meters or closer. However, due to the difficulties discussed above on visually observing and identifying birds as they approached the platform at night, even if the radar could have detected the birds to 0 meters, we may not have identified any more radar targets visually.

The second constraint was that ocean-based surveillance radar studies must also contend with ever-changing sea conditions resulting in changes in wave heights. Larger waves show up on surveillance radar as clutter and can affect the ability of the radar to detect targets where wave interference is greatest. The effect of wave clutter can be reduced by changing the tilt of the radar antenna, though wave clutter could not be completely eliminated on nights with high seas. In these instances, adding exclusion zones to areas of high sea clutter by the radar analysis software used in this study resulted in a reduced viewable area by the radar. However, by adjusting the radar tilt and using exclusion zones for nights with larger amounts of wave clutter, rougher sea conditions never resulted in the inability of the radar to collect data on bird activity.

A third constraint with using surveillance radar for light attraction studies was the inherent difficulty of interpreting the radar data to identify the genera or species of the targets detected. This was true for both species of focus for this study, the Scripps's Murrelet and Ashy Storm-Petrel. As mentioned in the discussion section on radar light attraction events, the flight speeds and echo sizes of several other species of seabirds found using the offshore platforms overlapped with the Scripps's Murrelet (Hamer et al. 2005). In addition, during the spring and fall migration periods, there were many species passing over the platforms all night long, which likely included multiple species of waterfowl and shorebirds on migration. Therefore, identifying Scripps's Murrelet radar targets from other species of seabirds during radar study was not attempted. Also, there was currently no known information on the flight speeds and echo sizes of Ashy Storm-Petrels to currently try to identify these targets on radar. Sampling with radar at a known Ashy Storm-Petrel nesting colony would solve this problem. In addition, even at night, due to the lights, there was constant flight activity of birds around the platforms (mostly Western Gulls) that showed up on the radar.

However, even with these constraints, radar does have the advantages of being able to detect birds at night and even in heavy fog. Even small birds the size of passerines can be detected hundreds of meters away. The flight paths of all birds detected can be tracked and mapped. Information on their flight speeds, flight behavior, timing of activity, passage rates, flight directions and flight heights can be obtained. However, this data is best analyzed at a larger scale (hundreds of meters) as exemplified by the nocturnal avian migration activity recorded and mapped around the offshore oil platforms in this study.

6.6.2 Suggestions for Future Light Attraction Studies

One technique for future light attraction studies would be to install the surveillance radar on an oil platform within the POCS and have that radar survey for light attraction targets on a nearby platform. The neighboring platform would need to be relatively close (within ~1 km) to the radar platform, but this survey method would eliminate the effect of the corona. Another similar method would be to use surveillance radar mounted on crew/cargo transport boats that are sometimes moored overnight within a few hundred meters of offshore oil platforms, thus also eliminating the problem of the corona.

One promising method that could be used in conjunction with the surveillance survey method described above, or in a stand-alone study, would be the installation of digital video cameras on oil platforms to try and document light attraction events. A digital video camera was approved for use during the final 10 day survey session of this study on Platform Hermosa. A GoPro Hero 3 digital camera was installed near the surveillance radar and was adjusted to attempt to capture birds flying above the platform and near the platform lights at night. So that no birds were missed, the camera was set on time-lapse and took a digital image every 0.5 seconds (120 images per minute) and relied on the bright lights from the platform for lighting. Flash photography was not allowed due to the risk of triggering the fire alarm system on the platform. The camera captured digital photographs for the entire radar survey session with the observer needing to change batteries only once through the night. The camera was installed with a 64GB Micro SD memory card, to ensure that enough space was available to incorporate the number of digital photographs captured each night. Although this data has not yet been analyzed, in a typical survey night, more than 70,000 digital images were taken.

One of the limitations of using digital video cameras to capture nocturnal bird activity was battery life. However, the use of solar panels or an external power source would solve this problem and allow for cameras to be installed on multiple platforms. An additional limitation would be the need to replace the Micro SD memory card when reaching capacity, but with Micro SD cards of 128GB in size available, one would only need to replace the memory card every 5 days (70,000 pictures/day @ 300KB/picture). Due to the large quantities of digital photographs taken by the camera each night, analyzing the photographs would be too time consuming to be practical. However, new software designed to detect birds as they appear in digital images now exists that would extract and mark only images that contain birds in flight. Using this type of software technology would make the review of images extremely efficient and cost effective. The advantage of using digital video technology is that the areas near the platform lights could be monitored all night long and in multiple locations without the need for an observer to be present. In addition, birds recorded could likely be identified to species and genera. Due to the bright lights of the platforms, the observers in this study could usually readily identify the species of birds flying near the platform lights. In addition, unlike the grounded bird searches, the exact time of the night and the visibility conditions present when the detections occurred would be documented.

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Appendix A. Daily Radar and Observer Survey Effort

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector (°)	Weather/ Comments
Spring 1	Mar 6-7	Waning Crescent, set: 1356, rise: 0414	Grace	1929	0534	1929 -0129	20°	345 - 75	Drizzle at survey start, Cloudy wind avg. 2.0 mph from east to southeast
Spring 1	Mar 7-8	Waning Crescent, set: 1501, rise: 0459	Grace	1930	0533	1930 - 0130	25°	345 - 75	No radar data collection due to light rain throughout survey, wind avg. 9.3 mph from east to southeast
Spring 1	Mar 8-9	Waning Crescent, set: 1607, rise: 0539	Grace	1930	0531	1930 - 0130	30°	345 - 75	Partly cloudy with high winds avg. 32.0 mph from west
Spring 1	Mar 9-10	Waning Crescent, set: 1712, rise: 0617	Grace	1931	0530	1931 - 0131	30°	345 - 75	Clear skies with 8.5 mph avg. wind from south to southwest; Time change on March 10
Spring 1	Mar 10-11	Waning Crescent, set: 1816, rise: 0652	Grace	1932	0629	1932 - 0132	30°	345 - 75	Clear skies with avg. 14.4 mph winds from west to southwest
Spring 1	Mar 11-12	New Moon, set: 1918, rise: 0726	Grace	2033	0627	0027 - 0627	30° - 25°	345 - 75	Clear skies, wind avg. 9.7 mph from west to southwest
Spring 1	Mar 12-13	Waxing Crescent, set: 2019, rise: 0801	Grace	2034	0626	0026 - 0626	30°	345 - 75	Clear skies, wind avg. 3.5 mph from west to northwest
Spring 1	Mar 13-14	Waxing Crescent, set: 2118, rise: 0836	Grace	2034	0625	0025 -0625	30° - 20°	345 - 75	Foggy night with cloudy skies, wind avg. 6.0 mph from west to southwest
Spring 1	Mar 14-15	Waxing Crescent, set: 2216, rise: 0914	Grace	2035	0623	0023 - 0623	30° - 20°	345 - 75	Foggy night with cloudy skies, wind avg. 3.5 mph from north to southwest
Spring 1	Mar 15-16	Waxing Crescent, set: 2313, rise: 0953	Grace	2036	0622	0022 - 0622	20°	345 - 75	Foggy at start with overcast to clearing skies, variable winds avg. 5.9 mph from north to west
Spring 2	Apr 4-5	Waning Crescent, set: 1359, rise: 0338	Grace	2052	0554	2052 - 0252	20° - 30°	345 - 75	Weather out – no usable radar data, cloudy and rainy with high winds avg. 26.2 mph with gusts to 40.0 mph from west.
Spring 2	Apr 5-6	Waning Crescent, set: 1503, rise: 0416	Grace	2052	0553	2052 - 0252	30°	345 - 75	Clear windy night, winds avg. 19.0 mph but as high as 28.4 mph from west to southwest

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector	Weather/ Comments
Spring 2	Apr 6-7	Waning Crescent, set: 1605, rise: 0451	Grace	2053	0552	2053 - 0253	30°	345 - 75	No outside radar observations due to high winds, clear skies, winds avg. 26.7 mph with gusts to 36.1 mph from west to southwest
Spring 2	Apr 7-8	Waning Crescent, set: 1707, rise: 0525	Grace	2054	0550	2054 - 0254	30°	345 - 75	No outside radar observations due to high winds (up to 60.0 mph), clear skies, winds avg. 33.4 from west to southwest
Spring 2	Apr 8-9	Waning Crescent, set: 1807, rise: 0559	Grace	2055	0549	2055 - 0255	30°	345 - 75	Clear skies, windy night with winds avg. 25.6 mph from southwest to northwest
Spring 2	Apr 9-10	Waning Crescent, set: 1906, rise: 0634	Grace	2056	0548	2348 - 0548	30° - 25°	345 - 75	Clear skies, variable wind avg. 7.3 mph from west to east
Spring 2	Apr 10-11	New Moon, set: 2004, rise: 0710	Grace	2056	0546	2346 - 0546	30° - 25°	345 - 75	Clear skies with light, variable wind avg. 2.2 mph from east to west
Spring 2	Apr 11-12	Waxing Crescent, set: 2101, rise: 0749	Grace	2057	0545	2345 - 0545	30° - 25°	345 - 75	Radar power issue – no usable data, clear skies, variable light wind avg. 1.9 mph
Spring 2	Apr 12-13	Waxing Crescent, set: 2157, rise: 0831	Grace	2058	0544	2344 - 0544	30°	345 - 75	Radar data corruption – no usable data, clear to cloudy skies, variable wind avg. 5.4 mph from east to west
Spring 2	Apr 13-14	Waxing Crescent, set: 2250, rise: 0916	Grace	2059	0543	2343 - 0543	30°	345 - 75	Cloudy skies, wind avg. 4.7 mph from southwest
Summer 1	Jul 2-3	Waning Crescent, set: 1539, rise: 0227	Grace	2059	0506	2059 - 0259	30°	345 - 75	Foggy, cloudy skies with moderate winds avg. 7.8 mph from south to west
Summer 1	Jul 3-4	Waning Crescent, set: 1633, rise: 0308	Grace	2059	0506	2059 - 0259	30°	345 - 75	Foggy and cloudy with moderate winds avg. 8.4 mph from southeast to southwest
Summer 1	Jul 4-5	Waning Crescent, set: 1725, rise: 0352	Grace	2059	0506	2059 - 0259	30°	345 - 75	Light fog and cloudy with light winds avg. 3.3 mph from southeast to southwest

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector	Weather/ Comments
Summer 1	Jul 5-6	Waning Crescent, set: 1815, rise: 0440	Grace	2059	0507	2059 - 0259	35° - 30°	345 - 75	Cloudy skies, with light winds avg. 3.1 mph from southeast to southwest
Summer 1	Jul 6-7	Waning Crescent, set: 1902, rise: 0530	Grace	2059	0508	2059 - 0259	30°	345 - 75	Cloudy skies, with moderate winds avg. 5.8 mph up to 13.0 mph from west to southwest
Summer 1	Jul 7-8	Waning , set: 1945, rise: 0623	Grace	2058	0508	2308 - 0508	35°	345 - 75	Cloudy skies, with strong winds avg. 12.6 mph from southwest to west
Summer 1	Jul 8-9	New Moon, set: 2024, rise: 0717	Grace	2058	0509	2309 - 0509	35°	345 - 75	Cloudy skies, strong winds avg. 13.6 mph from southwest
Summer 1	Jul 9-10	Waxing Crescent, set: 2101, rise: 0812	Grace	2058	0509	2309 - 0509	30° - 25°	345 - 75	Cloudy skies, variable winds from 0 to 11.4 mph from southwest
Summer 1	Jul 10-11	Waxing Crescent, set: 2135, rise: 0907	Grace	2058	0510	2310 - 0510	30° - 25°	345 - 75	Cloudy skies, variable winds from 3.2 to 13.7 mph from southwest to west
Summer 1	Jul 11-12	Waxing Crescent, set: 2207, rise: 1004	Grace	2057	0510	2310 - 0510	30°	345 - 75	Cloudy skies, moderate winds avg. 8.8 mph from southwest
Summer 2	Aug 2-3	Waning Crescent, set: 1659, rise: 0326	Grace	2043	0525	2043 - 0243	30°	345 - 75	Partly cloudy, moderate winds avg. 11.2 mph from west
Summer 2	Aug 3-4	Waning Crescent, set: 1743, rise: 0418	Grace	2043	0533	2043 - 0243	30°	345 - 75	Partly cloudy, moderate winds avg. 11.8 mph from west
Summer 2	Aug 4-5	Waning Crescent, set: 1824, rise: 0512	Grace	2043	0527	2043 - 0243	30°	345 - 75	Partly cloudy, moderate winds avg. 10.8 mph from west
Summer 2	Aug 5-6	Waning Crescent, set: 1901, rise: 0606	Grace	2048	0528	2048 - 0248	30°	345 - 75	Partly cloudy, moderate winds avg. 11.1 mph from west
Summer 2	Aug 6-7	New Moon, set: 1937, rise: 0702	Grace	2049	0528	2049 - 0249	30°	345 - 75	Partly cloudy, variable strong winds from 4.5 to 17.5 mph from west

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector	Weather/ Comments
Summer 2	Aug 7-8	Waxing Crescent, set: 2010, rise: 0759	Grace	2043	0529	2329 - 0529	30°	345 - 75	Clear skies, strong wind avg. 12.9 mph from west
Summer 2	Aug 8-9	Waxing Crescent, set: 2043, rise: 0856	Grace	2040	0530	2330 - 0530	30°	345 - 75	Clear skies, strong wind avg. 15.4 mph from west to northwest
Summer 2	Aug 9-10	Waxing Crescent, set: 2115, rise: 0954	Grace	2030	0531	2331 - 0531	30°	345 - 75	Clear skies, variable winds 2.2 to 12.8 mph from northeast to west
Summer 2	Aug 10-11	Waxing Crescent, set: 2149, rise: 1053	Grace	2036	0531	2331 - 0531	30°	345 - 75	Clear skies, variable winds 0 to 16.4 mph from north to west
Summer 2	Aug 11-12	Waxing Crescent, set: 2224, rise: 1154	Grace	2028	0532	2332 - 0532	30°	345 - 75	Clear skies, variable winds from 4.5 to 14.2 mph from east to west
Fall 1	Sep 28-29	Waning Crescent, set: 1456, rise: 0149	Hermosa	1935	0610	1935 - 0135	30 - 35°	18 - 138, 170 - 210	Clear skies, strong wind avg. 14.4 mph from northwest
Fall 1	Sep 29-30	Waning Crescent, set: 1533, rise: 0244	Hermosa	1933	0611	1933 - 0133	30 - 35°	18 - 138, 170 - 210	Clear skies, strong winds avg. 17.9 but up to 24.3 mph from northwest to northeast
Fall 1	Sep 30-Oct 1	Waning Crescent, set: 1608, rise: 0340	Hermosa	1932	0612	1932 - 0132	35°	18 - 138, 170 - 210	Clear skies but foggy for periods, strong winds avg. 18.8 mph from northeast
Fall 1	Oct 1-2	Waning Crescent, set: 1642, rise: 0437	Hermosa	1930	0612	1930 - 0130	35°	18 - 138, 170 - 210	Clear skies, strong winds avg. 17.8 mph from northeast
Fall 1	Oct 2-3	Waning Crescent, set: 1715, rise: 0535	Hermosa	1929	0613	1929 - 0129	35°	18 - 138, 170 - 210	Clear skies, variable winds from 9.3 to 22.1 mph from northeast
Fall 1	Oct 3-4	Waning Crescent, set: 1749, rise: 0635	Hermosa	1928	0614	0014 - 0614	30 - 35°	18 - 138, 170 - 210	Clear skies, high winds avg. 24.2 but up to 26.7 mph from northeast
Fall 1	Oct 4-5	New Moon, set: 1825, rise: 0737	Hermosa	1926	0615	0015 - 0615	30°	18 - 138, 170 - 210	Clear skies, light winds avg. 2.1 mph from north

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector	Weather/ Comments
Fall 1	Oct 5-6	Waxing Crescent, set: 1903, rise: 0841	Hermosa	1925	0616	0016 - 116	30°	18 - 138, 170 - 210	Clear skies, light winds avg. 3.0 mph from northeast
Fall 1	Oct 6-7	Waxing Crescent, set: 1945, rise: 0945	Hermosa	1923	0616	0016 - 116	30° - 35°	18 - 138, 170 - 210	Clear skies, strong winds avg. 16.8 mph from northeast
Fall 1	Oct 7-8	Waxing Crescent, set: 2031, rise: 1048	Hermosa	1922	0617	0017 - 617	35	18 - 138, 170 - 210	Clear skies, moderate winds avg. 13.3 mph from northeast
Fall 2	Oct 28-29	Waning Crescent, set: 1439, rise: 0223	Hermosa	1857	0635	1857 - 0057	30°	18-138, 170-210	Cloudy skies, light winds avg. 4.8 mph from west
Fall 2	Oct 29-30	Waning Crescent, set: 1512, rise: 0320	Hermosa	1856	0636	1856 - 056	30°	18-138, 170-210	Partly cloudy, variable winds 5.0 to 14.6 mph from northwest
Fall 2	Oct 30-31	Waning Crescent, set: 1545, rise: 0419	Hermosa	1855	0637	1855 - 0055	30°	18-138, 170-210	Clear skies, moderate winds avg. 12.1 mph from northwest
Fall 2	Oct 31-Nov 1	Waning Crescent, set: 1620, rise: 0520	Hermosa	1854	0638	1854 - 0054	30°	18-138, 170-210	Clear skies, moderate winds avg. 13.8 mph from northwest
Fall 2	Nov 1-2	Waning Crescent, set: 1657, rise: 0624	Hermosa	1853	0639	1853 - 0053	30°	18-138, 170-210	Clear skies, moderate winds avg. 13.0 mph from northwest
Fall 2	Nov 2-3	Waning Crescent, set: 1738, rise: 0729	Hermosa	1752	0540	2340 - 0540	30°	18-217	Active drilling reduced radar coverage, Partly cloudy skies, variable strong winds 12.0 to 20.2 mph from northwest, Time change on Nov 3rd
Fall 2	Nov 3-4	New Moon, set: 1823, rise: 0835	Hermosa	1751	0541	2341 - 0541	30°	18-217	Active drilling reduced radar coverage, Clear to partly cloudy, moderate winds avg. 14.4 mph from northwest

Session	Survey Dates	Moon Phase	Platform Name	Radar Start Time*	Radar End Time*	Radar Observer Time	Radar Tilt	Blind Sector	Weather/ Comments
Fall 2	Nov 4-5	Waxing Crescent, set: 1914, rise: 0939	Hermosa	1745	0542	2342 - 0542	30°	18-217	Active drilling reduced radar coverage, Clear skies, moderate winds avg. 13.4 mph from northeast to northwest
Fall 2	Nov 5-6	Waxing Crescent, set: 2011, rise: 1040	Hermosa	1744	0543	2343 - 0543	30°	18-217	Active drilling reduced radar coverage, Clear skies, variable light wind from 0 to 4.2 mph from northwest
Fall 2	Nov 6-7	Waxing Crescent, set: 2113, rise: 1135	Hermosa	1748	0544	2344 - 0544	30°	18-217	Active drilling reduced radar coverage, Clear skies, variable light wind from 0 to 5.9 mph from east to northwest

*Radar start time was 45 minutes after sunset and radar end time was 45 minutes before sunrise.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under US administration.

The Bureau of Ocean Energy Management

As a bureau of the Department of the Interior, the Bureau of Ocean Energy Management's (BOEM's) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner.

The BOEM Environmental Studies Program

The mission of the Environmental Studies Program (ESP) is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.