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ABSTRACT—Protection Island, Washington, is one of the most important nesting sites for Glaucous-winged Gulls (*Larus glaucescens*) in the Puget Sound area. Changes in the numbers and distribution of nests in a Glaucous-winged Gull colony on Violet Point, Protection Island, were tracked from 1980 to 2010. The colony grew steadily until the early 1990s, then declined to about half its former level. The main nesting sites also shifted from the relatively vegetated central and eastern portions of the point to the sparsely vegetated land near the marina, which had previously been almost completely unused for nesting. This shift was correlated with steady expansion of tall grasses on the central and eastern point. The expansion of the tall grass appears to be displacing the gulls, which is an unusual situation. Further, in the early years of this study the edges of the tall grass areas were prime nesting habitats, but these locations were mostly avoided by 2010. We suggest that predation by Bald Eagles (*Haliaeetus leucocephalus*) may also be affecting the numbers and locations of gull nests and may be the prime reason that few gulls now nest in the edges of the tall grass areas. Together, the tall grass and eagle predation appear to be carrying out a pincer movement which may be forcing the gulls into suboptimal nesting habitat and driving the decline of the gull colony.

Key words: Bald Eagle, competition, Dune Grass, Glaucous-winged Gull, *Haliaeetus leucocephalus*, *Larus glaucescens*, *Leymus mollis*, nesting, population, predation, Protection Island

Protection Island, Washington, off the mouth of Discovery Bay (UTM: Zone 10, 506183E, 5330517N, WGS84) is the site of the largest seabird nesting colony in the Puget Sound region (Larsen 1982). Located near the east end of Juan de Fuca Strait and close to the entrance to Puget Sound, the island has abundant marine habitats within foraging distance. In 1982 it was estimated that more than 70% of the breeding seabirds in Washington State east of Cape Flattery nested on the island (Larsen 1982). The island provides nesting space for many seabirds (Richardson 1961; Wilson 1977; Wilson and Manuwal 1986), including Glaucous-winged Gulls (*Larus glaucescens*) (Galusha and others 1987). The Glaucous-winged Gull colony on Protection Island is one of the largest colonies in the state for this species, which is the most abundant and widespread gull in Washington State (Speich and Wall 1989).

The island was farmed from the 1860s until the 1950s but was not noted for large seabird colonies until at least the 1940s (Power 1976). By the 1960s, however, the Glaucous-winged Gull colony had become substantial (Richardson 1961). In 1968, the island was sold to developers and divided into 1098 recreational lots. A marina was excavated on Violet Point and about 13 km of dirt and gravel roads were created. Meanwhile, the bird colonies continued to grow. By 1982 the gull colony had grown to 4300 nesting pairs (Larsen 1982), and to 6785 by 1984 (Galusha and others 1987). With the large and growing seabird populations and the lack of potable water on the island, controversy arose over whether development should continue or whether the island should be reserved for seabirds. In 1975 the western end, including Kanem Point, was purchased by the Washington State Department of Game and became the Zella M Schultz Seabird Sanctuary. In the 1980s most of the rest of the island, including Violet Point, was purchased by the US Fish and Wildlife Service and became the Protection

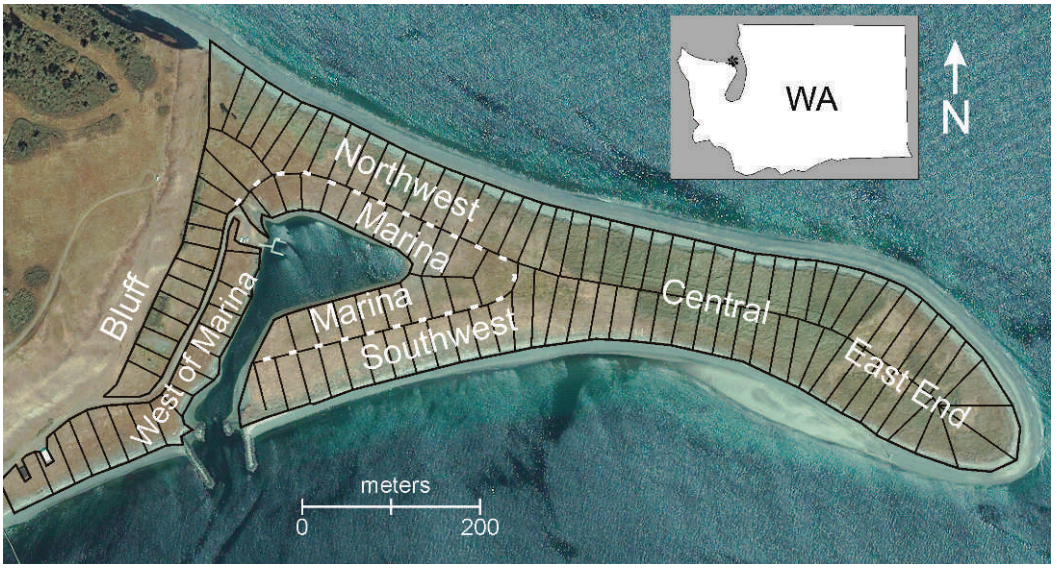

FIGURE 1. Satellite view of Violet Point, July 2005 (Copyright Carterra). Black lines outline the boundaries of the lots surveyed for development in the 1960s, as modified for this study. Lot boundaries were extended to the high tide line and to the middle of unused portions of roads to account for gull nests in those areas. The bluff to the west and regions of the point are identified by white text. The white dashed line near the marina delimits the Marina region from adjacent regions. Inset shows the location in Washington State.

Island National Wildlife Refuge in 1988. Since establishment of the National Wildlife Refuge the island has been largely uninhabited except for a caretaker. Even though it currently experiences little human disturbance, lingering effects of previous disturbances, including fires and livestock trampling (Cowles and Hayward 2008), may continue to affect bird nesting on the island. Bald Eagles (*Haliaeetus leucocephalus*) are also more abundant now on the island than they were in recent decades and their interactions with the gulls have become more frequent (Hayward and others 2010).

Violet Point, a long, low, gravelly point of land jutting out 900 m from the base of the eastern bluffs of Protection Island (Fig. 1), is the main location of the gull colony. The point lies just a few meters above high tide level and is covered with grass and other low vegetation. It is bounded on the west by steep, 60-m tall bluffs and by the ocean on the other 3 sides. A 1962 fire and extensive development in the late 1960s, including excavation of the marina, building a road down the length of the point, laying out many lots with underground utilities, and the construction of several cabins (since removed) have altered the area. Nevertheless, during each breeding season for decades the point has harbored thousands of nesting pairs of gulls. In recent years (since the 1990s), however, the Violet Point gull colony has failed to reach the high numbers of nests seen in earlier years (before the 1990s). Here we report on changes which have occurred in the size and structure of this gull colony since 1980. Specifically we show: (1) shifts in the central location and nest density of the colony during the last several decades; (2) the effect the growth of tall grass on Violet Point has had on the colony; and (3) effects that Bald Eagle predation have likely had on the colony.

Methods

Thirteen summer censuses of active Glaucous-winged Gull nests on Violet Point, Protection Island National Wildlife Refuge, Jefferson County, Washington were made between the years 1980 and 2010. Counts were conducted within the period from the 3rd week of June through the 1st week of July. By that time period each year nearly all nests had been established and most eggs had been laid, but few chicks had yet hatched, so disturbance and displacement

of the chicks were minimized. Each census was conducted by a squad of 8 to 12 people walking abreast throughout each lot of the entire nesting area (Fig. 1), with individual participants walking 5 to 10 m apart. The line extended from the high tide line to the edge of the central road, or to the middle of the road if that section of the road was no longer maintained and was being used for gull nesting. Each person counted nests between themselves and the person to the right as the squad passed through the colony. Nests were identified as well-formed, bowl-shaped depressions, usually lined with dead grass or algae, and most containing eggs. Nest scrapes from the previous season were sometimes visible but could be distinguished by their disorganized and weathered appearance. When possible, counts were totaled and recorded for each individual lot so that spatial and temporal changes in nest distribution patterns could be tracked. In the early years, lot boundaries were clearly distinguishable by corner posts. In later years, some corner posts had decayed or had been removed and patches of tall grass had overgrown others. Thus it was sometimes necessary for the count to include nests on several adjacent lots because some lot boundaries could not be clearly distinguished. In later years, indistinct lot boundaries were located and marked by GPS, which facilitated later counts. Some lot areas became inaccessible due to dense overgrowth by tall grass. For these lots, the census focused on any remaining open areas and along the upper beach, with special attention paid to the borders of the tall grass into which the gulls tunneled to establish nests. The few gulls that nested deep within the patches of tall grass were counted when the gulls flew up during disturbances, such as during overflights by eagles. Each such gull was counted as representing a nest because these counts were made during the incubation period, when 1 adult gull normally attended the nest while the other was away feeding.

Geographic Information Systems (GIS) analysis of the colony was accomplished using ArcView 3.2. Satellite or aerial photos of Violet Point that were available at approximately 10-y intervals (1980, 1991, 1999, and 2010), plus a satellite photo from 2005 (copyright Carterra) were used as GIS layers. Each photo was taken within a few weeks of 1 July. By that time, vegetation on Violet Point had reached nearly its full growth and some grasses were beginning to dry out.

Areas of tall grass were identified from each photo by their darker green color or rough texture and by ground truthing. These areas were traced from each photo using GIS polygons. The total area occupied by tall grass from each photo year was calculated in square meters using the Arcview Area function.

The numbers of gull nests present on each lot were plotted for 1980, 1991, 2002, and 2010 based on the ground censuses. If a count included nests on several adjacent lots, the nest count was divided evenly among the lots. The area function of Arcview was used to determine the area of each lot. For this area calculation, lot edges were extended to the high tide line because gulls used the upper beach for nesting. To the west of the marina the lot edges extended only to the edge of the road because the road was still being maintained and was not used for gull nests. To the north and east of the marina, however, the unmaintained road was actively used for nesting, so lot edges were extended to the middle of the road to represent the full area used for gull nesting.

Violet Point was divided into 6 regions (Fig. 1). The West of Marina region was at the far west end and extended from the base of the bluff to the marina or beach. Ground cover in this area consisted of a mixture of tall and short grasses along with a few herbs and small shrubs. A gravel road from the marina to the upper part of the island bisected the area (Fig. 1). This road was actively maintained by the US Fish and Wildlife Service and gulls never nested on the road or in the lots between the road and the bluff. Lot areas for this region were therefore measured only between the high tide line and the edge of the road. The Northwest region extended along the northwest margin of the point from the base of the bluff on the west to approximately the eastern end of the marina. This region consisted of relatively open ground with small patches of the tall grass *Leymus mollis* (Dune Grass) along the beach margin alternating with areas of short grass, herbs, and small shrubs such as *Ambrosia chamissonis* (Silver Burweed) and *Grindelia integrifolia* (Gumweed) (Cowles and Hayward 2008). The region was

delimited from the Marina region to the south by the unused road and from the Central region to the east by the edge of a very large patch of tall grass. As this tall grass expanded in later years, the boundary between the Northwest and Central regions moved westward along with the tall grass margin. The Central region occupied the central portion of the point and was dominated by large patches of tall grass, primarily Dune Grass. In the early years, the tall grass only partially covered the lots in this area and was bisected by the gravel road which had been created during development. The East End region was a relatively open area with scattered patches of tall grass, mainly Dune Grass but with patches of other tall grasses such as Blue Wild Rye (*Elymus glaucus*) interspersed with shorter grasses. The Southwest region occupied the south margin of the point between the tall grass-dominated Central region to the east and the entrance to the marina on the west. This region had sparse vegetation which quickly dried out in summer, along with a few scattered larger plants such as Gumweed, Sow Thistle (*Sonchus oleraceus)*, and Common Orache (*Atriplex patula*). The Marina region consisted of the lots bordering the south, east, and north sides of the marina. Vegetation here was sparse like that of the southwest region.

Because Bald Eagle activity has come to be intense on the east end of Violet Point, on 10 July 2008 a survey was made of the condition of all 31 gull nests in the East End region, compared with a total of 201 nests at 5 different sites selected within the Northwest, Southwest, and Marina regions to represent different mixes of the available nesting habitats. Each nest was designated as either having eggs, chicks, or both, or as having been destroyed as evidenced by fresh eggshells or chick remains in or close to the nest cup. Only nests with eggs, live chicks, or both, or with destroyed eggs or chicks were counted. Nests with destroyed eggs exhibited features typical of eagle predation (Hayward and others 2010).

Basic statistics and comparisons among regions were calculated using an Excel spreadsheet and SPSS 12 statistical software. Nest density for each lot was calculated by dividing the number of nests on the lot by the lot's area in hectares, including the nesting areas on the upper beach and on unoccupied roads. Peak nest density was determined by calculating nest density of the 5 lots most densely occupied by nests in any particular year.

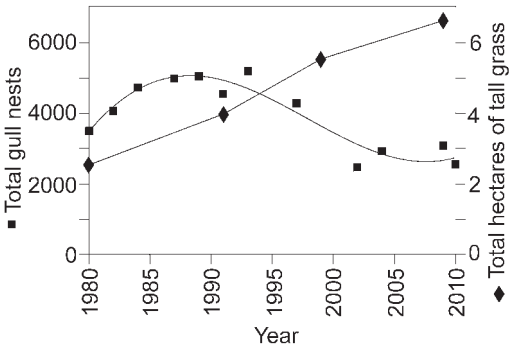

FIGURE 2. Curved line and squares: Total Glaucous-winged Gull nests counted on Violet Point, 1980–2010. Segmented line and diamonds: Changes in total coverage of tall grass on Violet Point, 1980–2010.

Results

Throughout the 1980s the number of active nests in the colony on Violet Point increased steadily from about 3500 in 1980 to nearly 5200 in 1993 (Fig. 2). The colony ceased growing in the early 1990s, and then declined sharply to around 2500 nests by 2002. Active nest counts fluctuated between 2000 and 3000 since that time, values only about half the earlier peak count.

Spatial changes in the distribution of nests in the colony reflected encroachment by tall grasses, especially Dune Grass. During the time of this study, tall grass cover increased steadily at about 1400 m^2/y and more than doubled in extent from 2.5 ha (14% of Violet Point) in 1980 to 6.6 ha (39% of Violet Point) by 2009 (Fig. 2). This expansion was not evenly distributed across the point (Fig. 3). In 1980, the tall grass existed mainly in patches in the Central region of the point and in small patches along the beach edges. By 1991, many of these patches had expanded but there were still many patch edges next to open space. By 1999, most of the patches in the Central region had fused together into a larger patch which had overgrown most of the road (Fig. 3). Many of the patches along the beaches had also grown and merged together, especially at the east end. Fewer edges of tall grass patches could be found near open space because the grass had overgrown many of

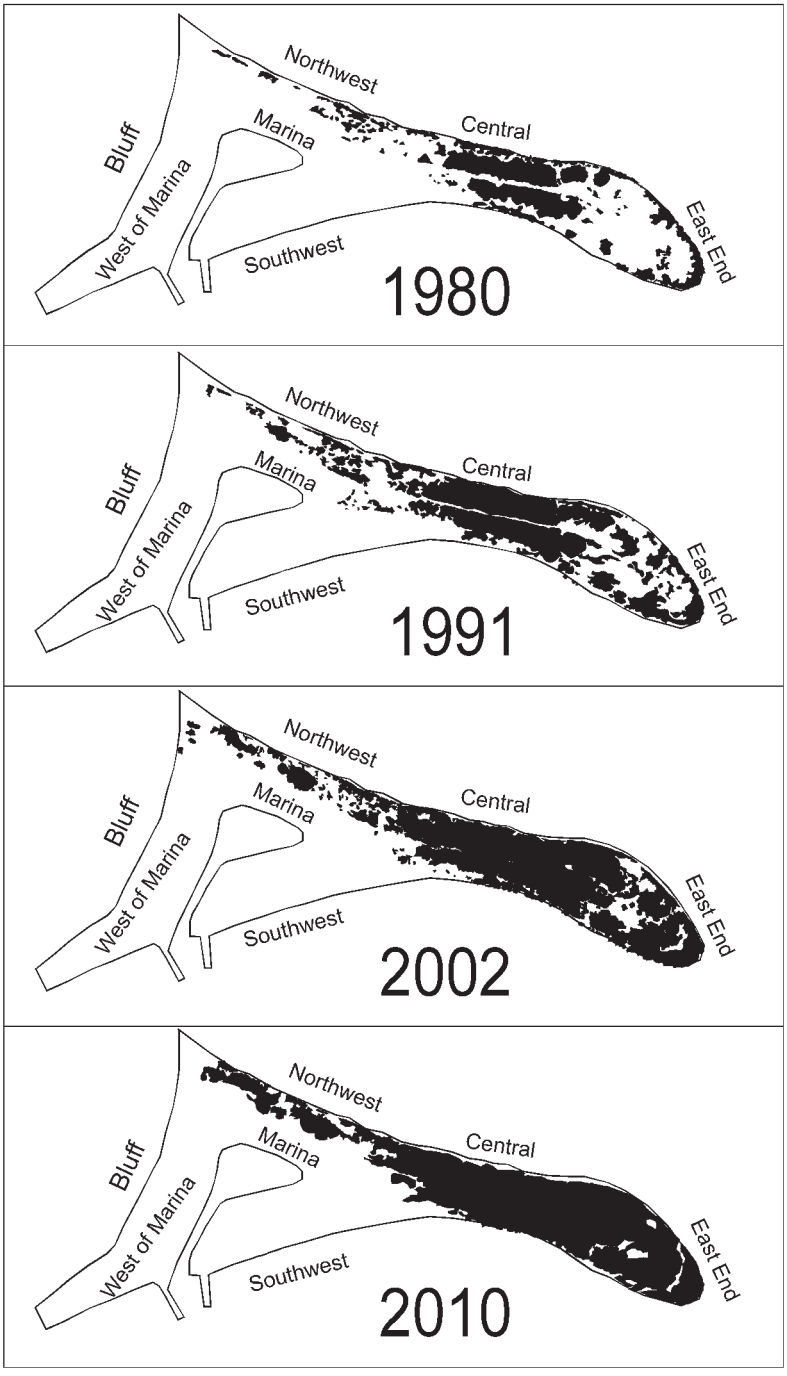

FIGURE 3. GIS plots of the areas of Violet Point covered by tall grass (mostly Dune Grass, *Leymus mollis*), based on 1980–2009 aerial photos.

the previous open spaces. By 2009, most of the patches in the Central and East End regions had merged into one large patch, with few open spaces left. Tall grass patches in the Northwest region continued to expand and occupied about half the available space in that region by 2009. The Southwest and Marina regions, however, remained open and nearly free of tall grass, and the West of Marina region remained a mixture of tall and short vegetation.

Gulls nested preferentially where low to moderate cover was available, but the majority avoided nesting in the interior of tall grass patches (Fig. 4). In 1980, for example, most nests were distributed across the distal 2/3 of the point in the well-vegetated Central and Eastern regions. Nests were especially abundant along the interface between the tall grass patches and the shorter grass or open ground, such as around tall grass patches and along the edges of the road in the central area and along the upper beach margins. Few gulls chose to nest in the sparse vegetation of the Southwest and Marina regions and none nested in the West of Marina region. By 1991, with large patches of tall grass closing over the central road, nests were less common along the road but were becoming increasingly abundant farther west in the Northwest and Southwest regions (Fig. 4, Fig. 5). By 2002, the tall grass had fully overgrown the road and there were few nests in the Central region except along the edges of the beach. Nests in the Eastern End region, where the grass was also closing in, were also less common. Meanwhile, the sparsely vegetated Southwest and Marina regions experienced sharp increases in numbers of nests (Fig. 4, Fig. 5) even though the total colony size had decreased (Fig. 2). The increase in nests occurred primarily in the sparsely vegetated areas at the west end of the Southwest region and near the marina, land which had been almost entirely ignored by the gulls during earlier years when there was plenty of space available in the more vegetated areas to the east. By 2010, nests were virtually absent in the previously densely populated Central and East End regions, but were abundant in the Southwest and Marina regions (Fig. 4, Fig. 5). Nests even had begun to appear west of the marina, including on the beach south of the bluffs on the extreme southwestern portion of the point. The primary nesting regions thus shifted west from the central and eastern point in the 1980s to the sparsely vegetated Southwest and Marina regions by 2010 (Fig. 4, Fig. 5).

Besides shifting west, by 2010 the gull nests had become more crowded into a smaller area. In 1980, the nests were widely distributed across the point, with no more than 30% of the nests occurring in any particular region. In contrast, by 2010 over half of the nests were concentrated in the Southwest region and nearly 30% more were adjacent to them near the marina. Further, even though the total nest count in the colony was smaller by 50% in 2010 than in some of the earlier years (Fig. 2), the nests in the 5 most densely populated lots were crowded together to 50% higher density than had occurred previously (Fig. 6) (Kruskall-Wallis test, $\chi^2 = 11.26$, $df = 3$, $P = 0.010$). At the same time, broad areas of mixed tall and short vegetation near the base of the bluff still remained almost completely unused (Fig. 4).

On 10 July 2008, 18 (58.1%) of the 31 nests at the east end of Violet Point had been destroyed, presumably by eagles, whereas only 4 (2.0%) of 201 nests sampled in the main colony had been destroyed ($\chi^2 = 92.0$, $df = 1$, $P < 0.000001$); all remaining nests were intact.

Discussion

In the ongoing competition for space between tall grass and gulls on Violet Point, tall grass has been the clear winner. As the tall grass spread across the Central and Eastern regions of the point, gull nesting areas moved west to the short grass habitat in the Southwest and Marina regions. A habitat especially favored early in this study was the interface between patches of tall grass and the shorter grasses nearby. Gulls nested densely in the edges of the tall grass at the end of tunnels burrowed up to several meters into the grass patch. When disturbed, they ran through these tunnels into open areas and took flight. Nesting in or near tall vegetation has been associated with larger clutch size and higher hatching and fledging success in Glaucous-winged and Western Gulls (*Larus occidentalis*) in Washington (Good 2002), and in several other species of gulls and terns (Saliva and Burger 1989; Yorio and others 1995; García-Borboroglu and Yorio 2004). In the early years when areas such as these were abundant on

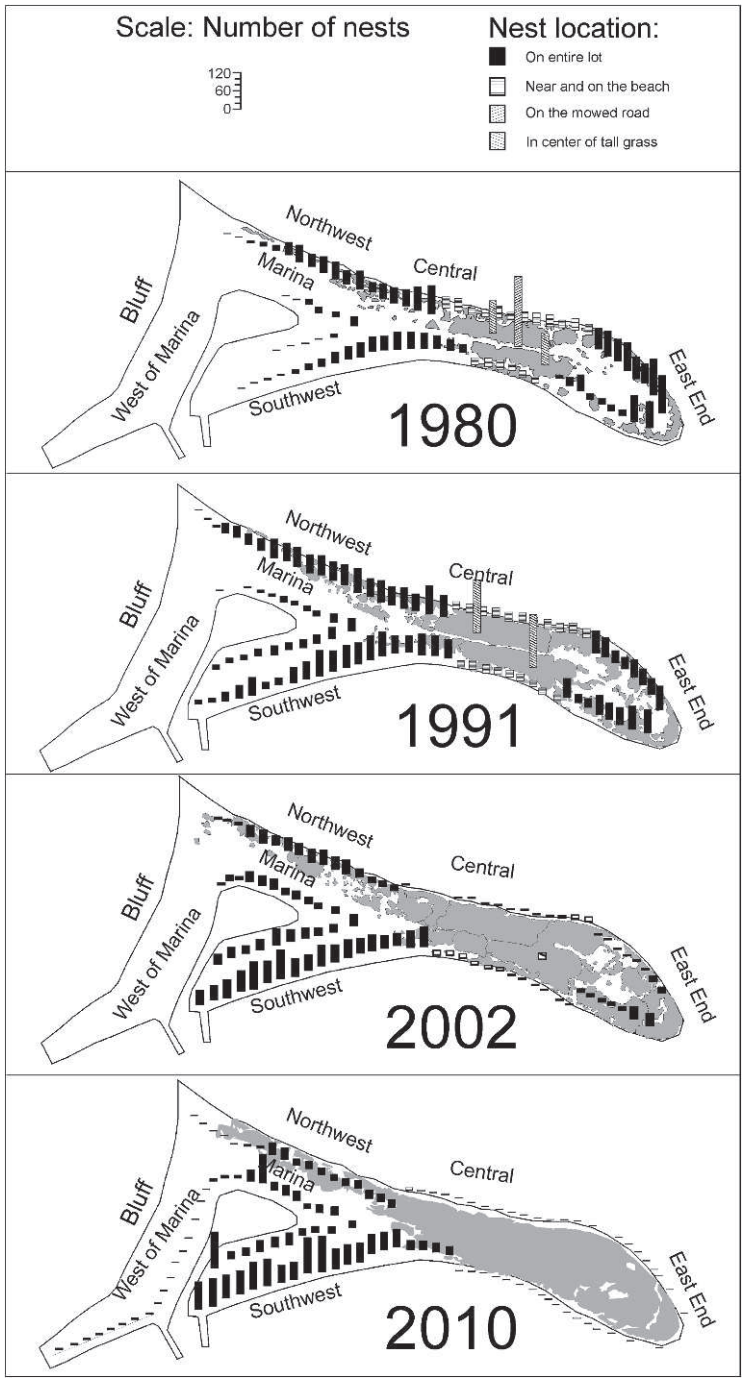

FIGURE 4. GIS plots of gull nest counts by lot on Violet Point, 1980–2010. The gray overlay shows the changes in tall grass cover (Fig. 3). Counts for nests along the road and for the central grass area could not be assigned to individual lots and so represent more than 1 lot.

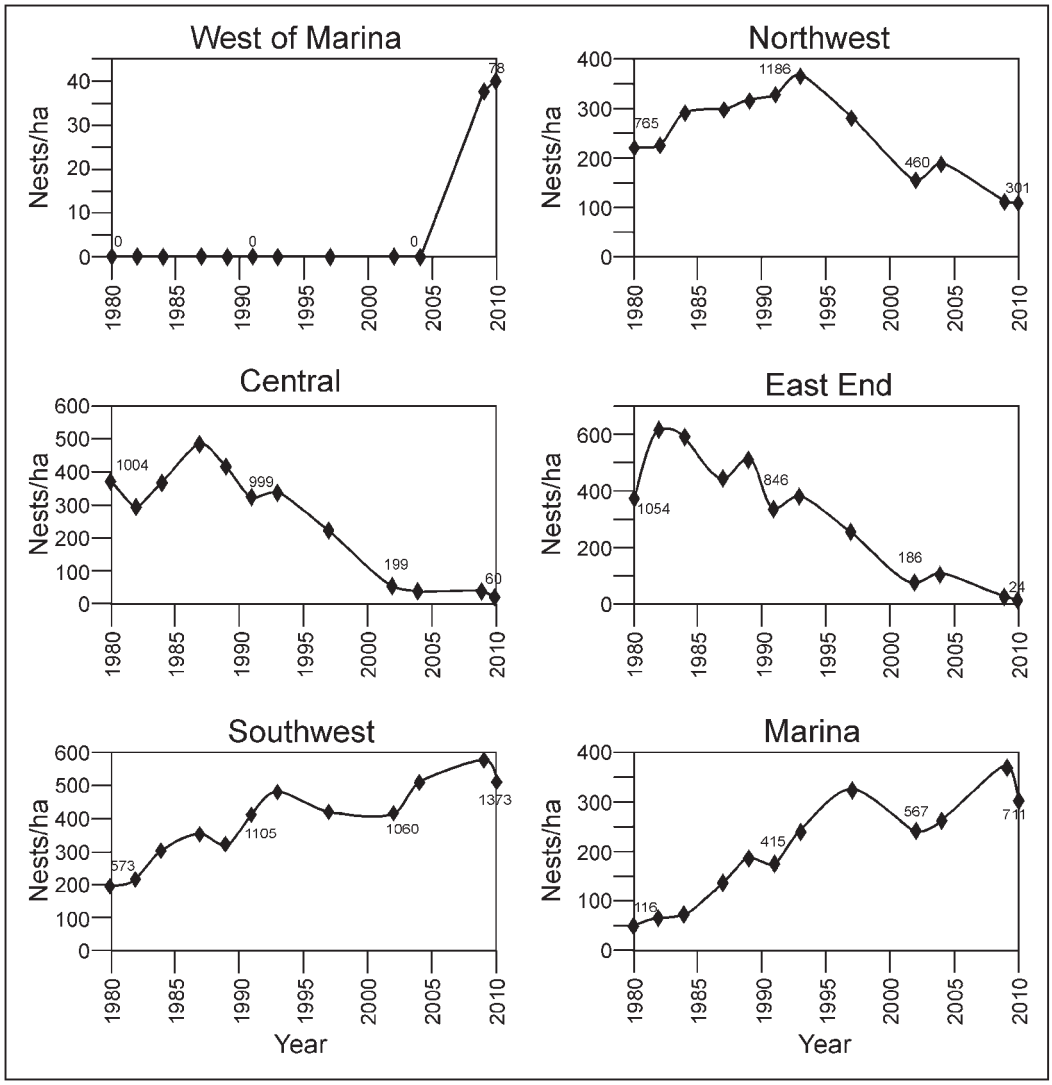

FIGURE 5. Density of gull nests by region on Violet Point, 1980–2010. The numbers next to the years 1980, 1991, 2002, and 2010 are the actual counts of nests in each region in those years. Since the boundaries of the regions shifted as tall grass patches expanded on the point, the relationship between nest density and nest counts is slightly different in different years.

Violet Point, few nests occurred on the open, unshaded land at the west end of the Southwest region and around the marina. Also, prior to the 1990s a few gulls nested in the central parts of large patches of tall grass, though they had to struggle to take flight from within the tall grass. As tall grass patches enlarged and merged, however, the number of available edges decreased and an increasing number of gulls began nesting in the open, unshaded areas in the southwest and near the marina. By 2002, nesting in the central parts of large patches had virtually ceased (Fig. 4). By 2010, most gulls avoided the tall grass entirely and crowded into the bare land near the marina, with a few nests even spilling over onto the previously ignored land west of the marina.

The displacement of seabirds from nesting areas by the expansion of grass patches as we observed here is an unusual observation. Many

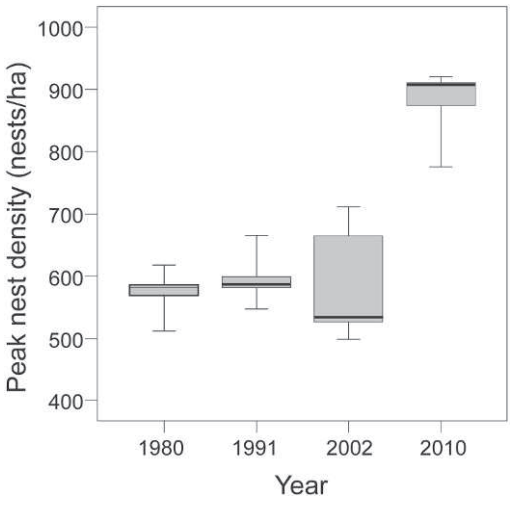

FIGURE 6. Box plots of nest density on the 5 most-densely covered lots on Violet Point in the years 1980, 1991, 2002, and 2010. Solid bar = median nest density. Box height = 25th to 75th percentile. Error bars = range.

studies have been made of the interaction between seabirds and vegetation, but the more common result is that seabird activities gradually diminish the larger, perennial vegetation, which is sometimes replaced by annual grasses and ruderal vegetation (Sobey and Kenworthy 1979; Ellis 2005). A few cases have been reported of perennial species becoming more common around seabird colonies (Anderson and Polis 1999; Garcia and others 2002). However, those studies took place on islands with poor soil in hyper-arid or Mediterranean climates. They observed that nutrients from the bird colony appeared to favor certain plant species, but the plants did not increase to such an extent that the birds were driven off the territory as seen here. The presence of the gulls in this study may actually enhance growth of Dune Grass, however, and contribute to their exclusion. Dune Grass is a vigorous species commonly found near cold-water seabird colonies (Ushakova 2007). It responds to moderate fertilization by more rapid growth of seedlings and by increases in aboveground and belowground biomass (Deshaies and others 2009). Gull droppings, food remains, and dead gulls may contribute to nutrient enhancement of nesting territories and facilitate Dune Grass growth. Morover, Dune Grass is quite resistant to trampling (Boudreau and Faure-Lacroix 2009). These characteristics suggest that gull nesting in one of the most-preferred sites, the edges of the tall Dune Grass, may actually have hastened the expansion of the Dune Grass and contributed to the displacement of the gulls from those areas.

Although many changes in the colony can be attributed to expansion of the tall grass, interactions with Bald Eagles have likely also had an important impact. Although a few 20th century reports were made of eagle predation on gulls elsewhere (Murie 1940; Campbell 1969; DeGange and Nelson 1982; Todd and others 1982), eagles were often regarded as only a minor threat to gulls (Yeager 1950; Wright 1953). Early accounts of Bald Eagles near Pacific Northwest gull colonies reported few predation events. Retfalvi (1970) found some gull remains in eagle nests on San Juan Island, Washington, but did not observe predation. Hayward and others (1977) reported seeing only one confirmed (and unsuccessful) predation attempt during many eagle visits to a gull colony at Colville Island, 35 km to the north of Protection Island. On Mandarte Island, British Columbia, Verbeek (1982) reported seeing an eagle prey on adult gulls; but the main effect of eagles on the gull colony was overflight disturbance which allowed crows to steal eggs. Watson and others (1991) found a small amount of summer predation on seabirds by eagles near the mouth of the Columbia River and an increased impact in winter. Fish, however, were the eagles' primary diet. Although several eagles were present on Protection Island in the 1980s, few eagle disturbances were observed in the Violet Point gull colony during many weeks of observation (Hayward and others 2010). Thompson (1989) reported eagle predation on several gull eggs on Bird Rocks in the San Juan Islands and concluded that eagles may have been responsible for egg predation found in several other colonies in the San Juan Islands as well. At that time he was unaware of any previously published reports of such behavior. Although we have studied gulls in the colony on Violet Point since 1980, we never observed eagle predation on gulls or eggs there until 6 June 1990. However, Bald Eagle abundance has been increasing in the coastal Pacific Northwest (Parrish and others 2001). With their increasing

abundance we have begun to observe increasing predation on gulls. Beginning in the early 1990s, eagle activity near the Violet Point gull colony became much more common. Several predations on chicks and at least one attempted predation event on an adult were observed (Galusha and Hayward 2002). Eagle presence and interaction with gulls gradually increased through the 1990s and in the years following (Hayward and others 2010). The year 2005 was a year of unusual abundance for eagles on Violet Point. On 18 June, 38 eagles were present at one time on or over the point, the highest number we ever counted.

We have observed eagles preying on the Violet Point gulls in several different ways. Eagles frequently moved from gull nest to gull nest eating eggs or taking chicks, especially along the edges of tall grass habitats. Surveys of nests in these areas showed many eggs damaged in a manner consistent with eagle predation. The remains of many gulls were found near nests and near eagle roosting sites. We recorded at least 42 verified instances of eagle predation on gull chicks or adults between 1996 and 2002, with numerous other probable but unverified events (Hayward and others 2010). During the 2005 surge in eagle numbers a large number of adult gulls and eggs were taken by eagles in May and June, and many chicks were taken in July.

This Bald Eagle activity likely has had a negative impact on the gull colony. Eagle overflights cause large disturbances and flights by adult gulls in the colony, leaving nests vulnerable to predation (Verbeek 1982; Good 2002; Hayward and others 2010). Eagles on Violet Point especially prey on gulls and eggs in tall grass. In recent years, eagles have regularly congregated along the upper beaches and edges of the tall grass in the Central and Eastern regions of the point. Eagles also sometimes dive from the bluff on the west end of the point and capture chicks from open grassy areas nearby (Hayward and others 2010). This eagle predation may be partly responsible for the decline in numbers of gull nests and shifts in nest location since the 1990s. For example, in the 2008 survey, more than half of the nests found on the east end of the point where nest count has declined sharply contained no eggs. Of those in which eggs had been laid, most of the eggs or chicks had been eaten by eagles. Multiple remains of adult gulls killed by eagles were also present on the east end, although it was not clear whether these adults had been killed near their nests or had been carried there from elsewhere. In the area near the marina, on the other hand, where nests have recently become more abundant, most nests surveyed contained 2 to 3 eggs or chicks, and few eggs or gulls predated by eagles were found. Farther west, on the beaches west of the marina where a few gulls have begun nesting in recent years, nests were about equally divided between those with no eggs and those with 1 or more eggs. These nests were near the bluff where eagles often perch, however, and several nests had eagle-predated eggs.

Several features of the changes we observed in gull nesting patterns on Violet Point may reflect the effects of Bald Eagle predation. Nests in the center of tall grass patches, while never abundant, are now virtually absent. Gulls tending these nests seem especially vulnerable to predation by eagles as the gulls struggle to take flight. Similarly, nests in the edges of tall grass next to open areas were formerly very abundant but are now much less so (Fig. 4), and we observed that eagles seemed to focus on such nests for predation. Eagles which land on open areas of the colony are mobbed by gulls which may repeatedly dive and strike their heads. This mobbing behavior typically has a protective effect in gull colonies (Götmark and Andersson 1984). In and along the edge of the tall grass, by contrast, the eagles are relatively protected from diving gulls by the overhead vegetation. The effect of concentrated eagle predation can be seen especially prominently along the edges of the grass next to the beach in the Central and East End regions of the point. Nests were formerly highly abundant in this habitat, but now that eagles are spending a great deal of time there the nests have become sparse (Fig. 4). Instead, gulls are increasingly crowding into unshaded, previously little-used open areas away from the tall grass to the east and away from the bluff to the west; habitat which is probably otherwise less than optimal for gull nesting (Good 2002). Nests which in recent years have begun appearing west of the marina will probably face continued eagle predation from the bluff above, especially those along the beach to the west of the marina, which is close to the bluff.

Predation is known to influence the dynamics and outcome of interspecies competition (Paine 1977; Wootton 2002; Schmitz and others 2006) and can be a factor which enhances the growth of grasses (Chase 1996). However, most of these studies have focused on the effect of predation on competition between species at similar trophic levels or on the effect of direct trophic cascades. In this study the tall grass and the gulls occupy different trophic levels and are not even part of the same food chain, yet they are competing with one another for space. Predation by the eagles may be further decreasing the ability of the gulls to compete. However, the tall grass was expanding at the expense of the gull colony even before eagle activity became common in the area, and gull nesting may actually enhance the growth of Dune Grass (Boudreau and Faure-LaCroix 2009; Deshaies and others 2009). Therefore, while eagle predation may be having a detrimental effect on the gulls it is unlikely to have provided any competitive advantage to the Dune Grass.

The Violet Point Glaucous-winged Gull colony is not the only seabird colony in the area which has begun to experience increasing impact from Bald Eagles. Eagle predation on Rhinoceros Auklets (*Cerorhinca monocerata*) on Pine Island, British Columbia, was associated with early termination of chick feeding and earlier fledging (Harfenist and Ydenberg 1995). Some Common Murre (*Uria aalge*) colonies on Tatoosh Island, at the other end of the Strait of Juan de Fuca from Protection Island, recently suffered such intense Bald Eagle predation that they experienced complete reproductive failure (Parrish 1995), and murre colonies on the island in general have been declining due to increasing Bald Eagle predation (Parrish and others 2001). Even in areas as far distant as the Aleutian Islands, increases in Bald Eagle predation on Glaucous-Winged Gulls and other seabirds has been noted (Anthony and others 2008).

In conclusion, the influence of several different species on Violet Point appears to be negatively affecting the number and location of nests in the Glaucous-winged Gull colony there. As tall grass spreads across the point, the gull colony is being pushed into increasingly marginal areas. Further, as eagle numbers have increased in the area, their predation impact on the gull colony appears to have increased as well. Together, these 2 interspecies interactions seem to be squeezing the gull colony from the east and from the west into a crowded occupation of the bare land in the Southwest and Marina regions of the point.

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