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MOUNT ST. HELENS ASH: ITS IMPACT ON BREEDING RING-BILLED AND CALIFORNIA GULLS

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ABSTRACT.—The 18 May 1980 eruption of Mount St. Helens deposited about 3.5 cm of ash on a nesting colony of Ring-billed (*Larus delawarensis*) and California (*L. californicus*) gulls at Sprague Lake, Washington. No adult mortality was noted, but adults of both species apparently left their nests unattended during the ashfall, with the result that their eggs became buried beneath the ash blanket. Using both their feet and bills, significantly more California than Ring-billed gulls excavated their ash-covered nests. The success of Ring-billed Gulls at excavation varied with habitat. Of the gulls not excavating, few California Gulls renested, but most Ring-billed Gulls renested within 6 weeks, although with lower than normal success. Inspection of two other affected gull colonies suggested that reproductive success varied inversely with ash depth. Large breeding populations at the colony sites in 1981 indicated that the nesting substrate had not become so altered by the previous year's ash deposit that these sites were avoided by the gulls for nesting. *Received 8 January 1982, accepted 26 May 1982.*

VOLCANIC ashfalls have punctuated earth history numerous times and continue to affect the planet. Associated physical phenomena are well-documented, but few pre-1980 descriptions of ash effects on surviving nonhuman animals exist (but see Worcester 1912; Martin 1913; Griggs 1917, 1918, 1921; Burt 1961; Wille and Fuentes 1975). The 18 May 1980 eruption of Mount St. Helens, Washington provided a rare opportunity to examine the influence of volcanic ash on a variety of animals (Akre 1981, Butcher 1981, Cook et al. 1981, Gibson and Hanegan 1982, Lang 1982, Phinney 1982, Preston 1982, Rees 1982, Stober et al. 1982). Here, we detail the impact of volcanic ash on Ring-billed and California gulls (*Larus delawarensis* and *L. californicus*) breeding in a colony at Sprague Lake, Washington and also report on post-ashfall observations at two other eastern Washington gull colonies. Mount St. Helens' eruption occurred during the second year of a 3-yr study of nest-site selection and reproductive success of Ring-billed Gulls at the Sprague Lake colony (Hayward 1982).

MATERIALS AND METHODS

The study colony is located on Harper Island in Sprague Lake near Sprague, Washington, 330 km east-northeast of Mount St. Helens (Fig. 1). The gulls nested in four unevenly distributed habitats separated by narrow ecotones and visibly distinct from one another to the human observer: rocky beach (RB);

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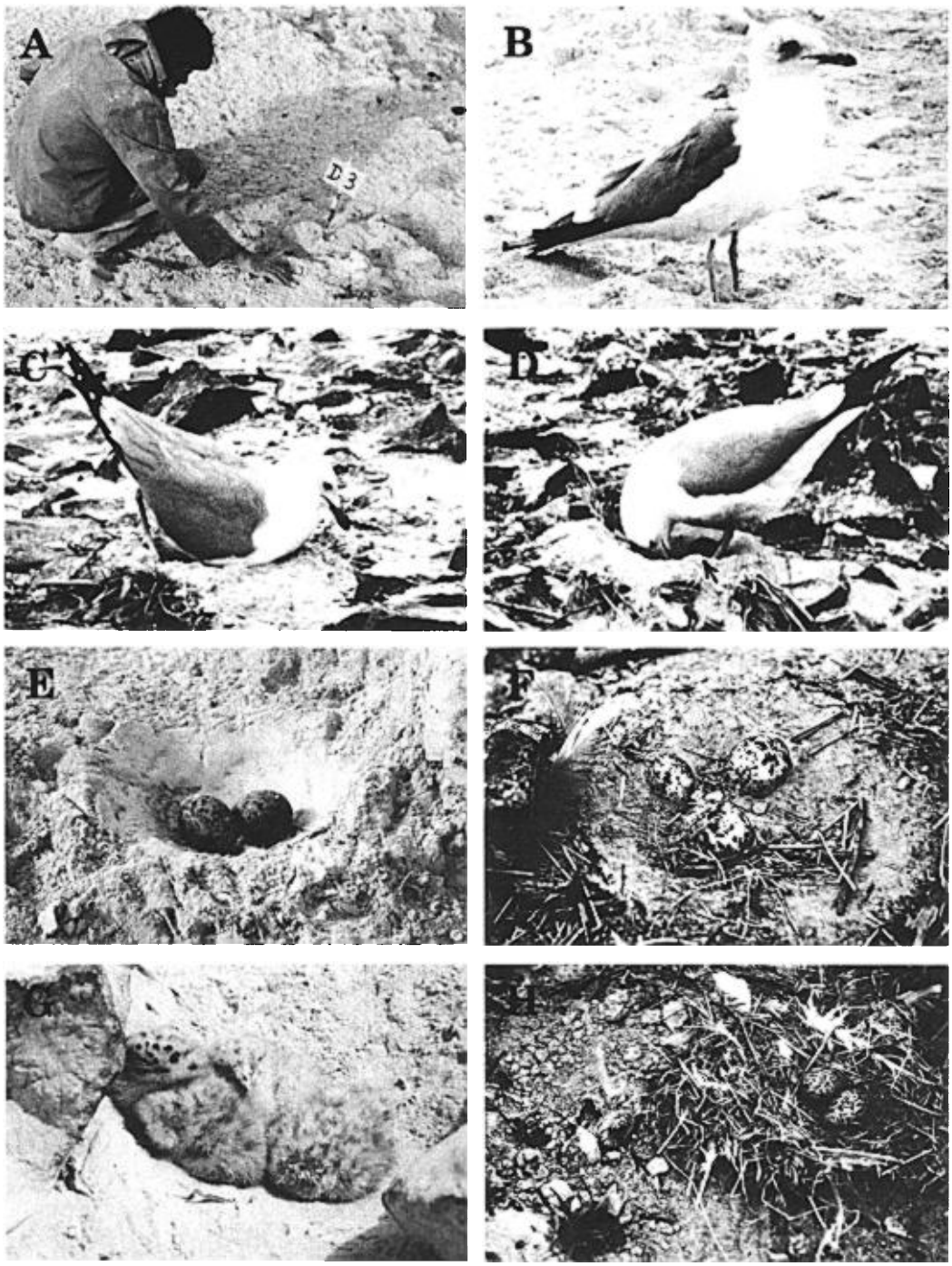

Frontispiece. (A) Site of a Ring-billed Gull nest with eggs completely covered by ash. (B) California Gull with ash-induced conjunctivitis. (C) Ring-billed Gull scraping ash from an experimentally-covered nest. (D) Ring-billed Gull "bill-digging" for an ash-buried egg (see arrow) in an experimentally-covered nest. (E) Excavated nest. (F) Nest with three cemented eggs. (G) Newly-hatched California Gull chicks in an excavated nest. (H) Post-ashfall Ring-billed Gull nest built directly over an ash-buried nest. The new nest was moved to the right for the purposes of the photograph and the ash-buried eggs (see arrow) exposed by the photographer.

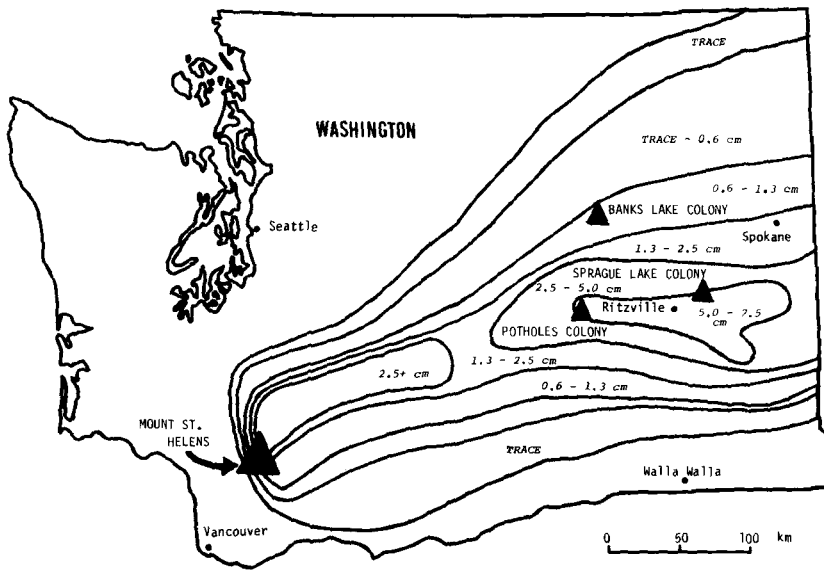

Fig. 1. Locations of the Sprague Lake, Potholes reservoir, and Banks Lake gull colonies in relation to ash depths in Washington following the 18 May 1980 eruption of Mount St. Helens. (Based on Korosec et al. 1980.)

tall (0.5–2.0 m) rye grass (TG); low (<0.5 m) dense herb (LD); and sparse vegetation (SV) (Hayward 1982).

A pre-ash census of the entire colony was made on 16 May 1980. Species, clutch size, and habitat type were recorded for each nest. On 2 May, a sample of 196 Ring-billed Gull nests was marked with numbered wooden blocks, and from 2 to 18 May egg gains and losses were recorded for each nest.

During the first 4 weeks following the 18 May ashfall, counts were made of active Ring-billed Gull nests in the sample and of all active California Gull nests in the colony. Numbers of completely excavated eggs, eggs cemented to the ash, pipped eggs, and live and dead chicks were recorded. New nests and their contents also were counted. On 27 June and 3 July, the entire colony was surveyed, and all eggs and chicks from new nests of both species were counted.

From 11 to 18 May, 31 counts were made of adult Ring-billed Gulls occupying a subarea of the colony within SV, chosen for its visibility from our observation tower. Adults occupying this subarea were also counted during the first 3 weeks following the ashfall.

To examine closely the initial responses of gulls to an ash blanket on their nests and eggs, we experimentally covered 15 nests of each species with 3.5 cm of ash between 24 May and 1 June 1981. The behavior of tending birds was observed from a blind for 30 min following ash deposition. Thereafter, each nest was checked daily until 11 June 1981. The Ring-billed Gull nests were located in TG, RB, SV (four nests each), and LD (three nests). The California Gull nests were located solely in SV. The nests, containing only nonpipped eggs, were selected without prior observations of the behavior of tending birds.

Post-ashfall inspections also were made at Banks Lake and Potholes gull colonies (Fig. 1) on 4 July 1980.

RESULTS

Pre-ashfall census.—The results of the colony-wide nest count on 16 May 1980 are shown in Table 1. Larger numbers of the 969 Ring-billed Gull nests were located in TG and RB than in SV and LD. Of the California Gull nests, 96% were located in SV, with the rest in LD.

The ashfall and its initial consequences.—Shortly after 0832 on 18 May 1980, we heard the muffled sound of the erupting volcano. By 1100, the ash plume could be seen approaching the island from the southwest. By 1330, the light intensity was reduced to that of dusk, and we left the island. At about 1430, ash began to fall, resulting in complete darkness 6 h before sunset. Darkness continued until sunrise the following morning.

We returned to the island at 0800 on 19 May. The colony site, including nests and eggs, had been covered by about 3.5 cm of gray ash (Frontispiece, A). A maze of gull tracks in the ash covered large areas outside the colony at

TABLE 1. Numbers of Ring-billed and California gull nests found in the four habitats at the Sprague Lake Colony on 16 May 1980, before the ashfall.

Habitat	Ring-billed Gull nests	California Gull nests
TG	304 (31%)	0
RB	305 (31%)	0
SV	137 (14%)	153 (96%)
LD	209 (22%)	7 (4%)
Other	14 (1%)	0
Total	969	160

the island's north end, where congregations of gulls never were seen before or after the ashfall.

More than half of the California Gulls observed showed signs of conjunctivitis (i.e. swollen eyelids, feathers around the eyes soiled by ash clinging to exudate, higher than normal rate of blinking), but no Ring-billed Gulls with these signs were observed (Frontispiece, B). By 20 May eye irritation was not evident in any gulls.

Nest excavation.—By 0800 on 19 May, 45% of the California Gulls and 27% of the sampled Ring-billed Gulls had already excavated the ash from their nests (Table 2 and Frontispiece, E). By 22 May, the percentages had increased to 69% and 39%, respectively, a significant difference between species ($\chi^2 = 31.34$, df = 1, $P < 0.001$).

On 22 May, the proportion of excavated to unexcavated Ring-billed Gull nests varied significantly with habitat (Table 3). The highest incidences of excavated nests occurred in RB and SV. Relatively fewer nests in TG, and especially LD, were excavated, and many of the remaining nests were covered not only with ash, but also with ash-laden grass. In SV, the proportion of excavating California Gulls (69%) exceeded that of Ring-billed Gulls (46%) ($\chi^2 = 7.07$, df = 1, $P < 0.01$).

TABLE 2. Cumulative numbers and percentages of ash-excavated California and Ring-billed gull nests between 19 and 22 May 1980 at the Sprague Lake Colony. Percentages are based upon the total number of pre-ashfall California Gull nests and a sample of Ring-billed Gull nests.

	Excavated California Gull nests	Excavated Ring-billed Gull nests
Date		
19 May	72 (45%)	48 (27%)
20 May	96 (60%)	54 (30%)
21 May	111 (69%)	70 (39%)
22 May	111 (69%)	70 (39%)
Total pre-ashfall nests in sample	160	179

TABLE 3. Numbers and percentages of Ring-billed Gull nests, by habitat, excavated and not excavated from beneath the ash by 22 May 1980 at the Sprague Lake Colony. ($\chi^2 = 31.74$, df = 3, $P < 0.001$.)

	Number of nests		
Habitat	Excavated	Not excavated	Totals
TG	16 (32%)	34 (68%)	50
RB	35 (64%)	20 (36%)	55
SV	16 (46%)	19 (54%)	35
LD	3 (8%)	36 (92%)	39
Totals	70 (39%)	109 (61%)	179

Excavation behavior (1981 experiment).—After ash was experimentally deposited on their nests, all but one of the tending birds returned to their territories within 1 min. Ring-billed Gulls tended to spend more time than California Gulls in erratically wandering around the nest-site area before excavating or abandoning.

Table 4 compares the primary behaviors shown by gulls during the 30-min observation period following ash deposition. Individuals of

TABLE 4. Numbers of excavating and non-excavating Ring-billed and California gulls showing various behaviors during a 30-min period following experimental deposition of 3.5 cm of volcanic ash on their nests. PN = preen; NM = gather and arrange nest material; SS = scrape and settle; and BD = bill-dig.

		Number of birds using behaviors			
Gull species	Number of birds	PN	NM	SS	BD
Ring-billed Gulls					
Excavating	6 (40%)	6	4	4	2
Not excavating	9 (60%)	7	5	0	0
Totals	15	13	9	4	2
California Gulls					
Excavating	12 (80%)	11	9	10	5
Not excavating	3 (20%)	2	1	0	0
Totals	15	13	10	10	5

TABLE 5. Phenology of hatching in 24 excavated Ring-billed Gull nests in 1980 compared to analogous data from 254 sample nests in 1981. Data for both years are from nests for which fates of all eggs were known through 5 June.

	18 May		21 May		22 May		29 May		5 June	
	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981
Number of eggs in nests	67	614	55	571	52	534	8	223	5	84
Number of new eggs since previous count	—	—	1	17	0	4	2	31	1	9
Number of eggs lost since previous count	—	—	4	26	0	2	6	67	1	62
Number of chicks hatched since previous count	0	7	9	34	3	39	40	275	3	86
Cumulative number of chicks hatched	0	7 (1%)	9 (13%)	41 (7%)	12 (18%)	80 (13%)	52 (78%)	355 (58%)	55 (82%)	441 (72%)

both species commonly engaged in preening and collecting nest material, behaviors that often occur after experimental egg removal (Moynihan 1953).

Also observed were "scrape and settle" (SS) movements (Frontispiece, C) used by larids and other ground-nesters to form nest scrapes (Lorenz 1938; Palmer 1941; Moynihan 1953, 1955, 1962; Tinbergen 1953). All birds excavating nests during the 30-min observation period used SS, and the four birds excavating afterward produced similar scrapes. The mean latency in minutes for the onset of SS in gulls showing this behavior was 12.75 ± 8.77 (n = 4) for Ring-billed Gulls and 5.10 ± 3.28 (n = 10) for California Gulls (two-tailed t = 2.47, df = 12, $P <$ 0.02).

Another action pattern, "bill-digging" (BD) (Frontispiece, D), was similar to the egg-retrieval pattern shown by ground nesters (Lorenz 1938, Manning 1967). Bill-digging was used only half as frequently as SS by both species. Median latencies for BD were 24.5 (n = 2) for Ring-billed Gulls and 12.0 (n = 5) for California Gulls ($P < 0.05$, Mann-Whitney U-test).

In one instance, a California Gull flipped its bill sideways while still penetrating the ash, throwing ash into its eye. The bird shook its head, then rubbed its face and eye on its wing converts, resulting in further eye irritation.

All but two of the excavated nests of each species were at least partially uncovered by 30 min, and all were completely excavated within 24 h. By 24 h, 6 (40%; 2 in TG, 2 in RB, 1 in SV, and 1 in LD) of 15 Ring-billed Gull nests, as opposed to 12 (80%; all in SV) of 15 California Gull nests, had been excavated (χ^2 = 5.0, df = 1, $P < 0.05$).

Fates of eggs and chicks of excavated nests.— None of the eggs that remained covered by the 1980 ashfall was known to hatch. At some nests where excavation was attempted the eggs remained partially buried beneath ash. Most such eggs became firmly cemented in place when ash was moistened by rain or by the wet undersides of parents returning from the lake (Frontispiece, F). On 29 May, two (3%) of a sample of 66 excavated Ring-billed Gull nests contained at least one cemented egg each, whereas 13 (15%) of 87 California Gull nests showed this condition (χ^2 = 6.10, df = 1, $P <$ 0.025). Cemented eggs failed to hatch.

The ashfall coincided with the hatching of the first chicks in both species. On 18 May we found eight pipped Ring-billed Gull eggs, and on 19 May three Ring-billed Gull chicks from excavated nests had hatched. California Gull eggs were not checked on 18 May, but on 19 May two chicks were found (Frontispiece, G).

Table 5 compares the progress of hatching in a 1980 sample of excavated Ring-billed Gull nests and in a 1981 sample of normal nests. Fates of all eggs in both samples were known through 5 June. Hatching phenology and success were similar in the two years, although the first hatching was earlier by 5 days in 1981.

Table 6 summarizes egg mortality and hatching success by habitat for 70 excavated Ring-billed Gull nests checked between 19 May and 5 June 1980. Undoubtedly, some unaccounted for eggs and hatchlings were preyed upon between counts and left no trace. Thus, numbers

TABLE 6. Fates of eggs by habitat in sample of excavated Ring-billed Gull nests between the 18 May ashfall and 5 June 1980. Within-habitat percentages are also shown. Eggs lost include those actually found that were preyed upon, addled, contained dead embryos, or were cemented to the ash.

	Habitat				
	TG	RB	SV	LD	Totals
Number of nests sampled	16	35	16	3	70
Total eggs on 19 May	46	102	46	9	203
Number of hatched chicks found	30 (65%)	44 (43%)	26 (57%)	2 (22%)	102 (50%)
Number of eggs lost	5 (11%)	14 (14%)	1 (2%)	2 (22%)	22 (11%)
Unaccounted for eggs or hatchings	11 (24%)	44 (43%)	19 (41%)	5 (56%)	79 (39%)

of eggs lost and chicks hatched represent minimum values. By 5 June, at least 50% of the excavated eggs had hatched, and 11% had been destroyed. No significant difference was found when the proportions of chicks hatched were compared by habitat ($\chi^2 = 4.84$, df = 3, $P > 0.05$). Likewise, no significant difference was observed among proportions of lost eggs in the four habitats ($\chi^2 = 5.51$, df = 3, $P > 0.05$).

The phenology and success of excavated California Gull nests were more difficult to quantify, because nests of this species were not marked before the ashfall. By 5 June, however, 95 (40%) of the 238 excavated California Gull eggs had hatched, and 48 eggs remained. Presumably, a number of these eggs hatched, thus raising the hatching-success rate above 40%.

On 20 May, a live California Gull chick was found with its beak and throat obstructed by a plug of hardened ash attached to its tongue. On 29 May a young Ring-billed Gull chick was found dead outside its nest with one foot cemented in the ash substrate. Otherwise, we observed no direct ill effects attributable to the ash on chicks hatching from excavated eggs. Behavioral interactions between parents and chicks appeared normal.

New nests.—During the 16 days preceding the ashfall, the numbers of Ring-billed Gulls counted at various times of the day in a subarea of the colony averaged 31.5 ± 3.43 (range = 25–38, $n = 31$). At 0815 on 19 May, 31 birds occupied this area. By the following day this number had dropped to 14 and held constant through at least 22 May. All of these birds were associated with excavated nests. By 29 May their number had increased to 16, and by 5 June it reached 25. This increase coincided with the onset of new nesting in the colony (Frontispiece, H).

We estimated that 597 (62%) of the original 969 Ring-billed Gull nests remained buried by ash after 22 May. A subsequent series of colony-wide censuses (Table 7) revealed that the number of new nests gradually increased to a high on 27 June of 548 nests, of which 122 (22%) were located outside the pre-ashfall perimeter of the colony. By 3 July, however, the number of eggs and chicks associated with these new nests had decreased by 59%, mostly owing to egg losses as indicated by data on laying phenology. In contrast, during the week of 12–18 May in both 1980 and 1981, egg losses were only 1.3% and 8.1%, respectively.

On 13 June only seven new California Gull nests, together containing 13 eggs [mean clutch

TABLE 7. Numbers of new nests, eggs, and chicks found in censuses of the entire colony from 29 May to 3 July 1981. Numbers in parentheses are increases (+) or decreases (−) from the preceding census date.

	Census date				
	29 May	5 June	13 June	27 June	3 July
Number of nests	7	176 (+169)	261 (+85)	548 (+287)	118 (−430)
Number of eggs	11	421 (+410)	642 (+221)	1,141 (+499)	251 (−890)
Mean clutch size	1.57	2.39 (+0.82)	2.46 (+0.07)	2.49 (+0.03)	2.13 (−0.36)
Number of chicks	0	0	0	180 (+180)	290 (+110)
Number of eggs and chicks	11	421 (+410)	642 (+221)	1,321 (+679)	541 (−780)

size (MCS) = 1.86], were located, and on 27 June only eight new California Gull nests, containing a total of 15 eggs (MCS = 1.88), were found. On 3 July six active new nests, containing 10 eggs (MCS = 1.43), were counted along with 11 chicks that had hatched from new nests. Thus, unlike Ring-billed Gulls, California Gulls showed a slight increase of eggs and chicks during the week of 27 June–3 July owing to a few more nests being established.

Effects of the ashfall on other colonies.—On 4 July 1980 the Banks Lake and Potholes Reservoir colonies were surveyed. Banks Lake colony had received only about 0.5 cm of ash from the 18 May eruption. Productivity appeared normal compared to previous years (Conover et al. 1979), with chicks of both species present. By contrast Potholes Reservoir colony had received ash deposits of about 7.5 cm, and ash-covered nests of both species were present. Only four large Ring-billed and at least 200 large California gull chicks, apparently from pre-ashfall eggs, were found. Also, 14 California Gull chicks less than 9 days old were present near new nests, but no similarly aged Ring-billed Gull chicks were found.

Colonies one year later.—A census on 19–20 May 1981 showed that the Sprague Lake colony contained 975 Ring-billed and 148 California Gull nests, numbers close to those obtained before the ashfall in 1980 (969 and 160, respectively). The four basic habitat types were virtually unchanged, except for the presence of ash covering low rocks and at the base of vegetation. During the 1981 season, 3,772 Ring-billed and 1,368 California gull nests were counted at the Potholes Reservoir colony (M. Conover pers. comm.).

Discussion

Initial Responses to and Effects of the Ashfall

Our discovery of ash-covered nests indicates that the gulls made a mass exodus from their nests during the ashfall. This reaction could have potentially resulted in a total loss of the season's reproductive investment up to that point. *En masse* exodus by gulls from the colony grounds during nighttime has been observed previously as an apparent reaction to visitation by nocturnal ground predators (Emlen et al. 1966, Patton and Southern 1977). That a similar exodus occurred in response to ashfall seems at first surprising, because gulls remain sitting on their nests even during severe rain, hail, or wind storms. Possibly the complete, premature darkness was the main inducing factor.

The abrasive, particulate ash posed a potential danger to the physical well-being of humans and animals alike (Reay et al. 1980). The only visible physical effect on the gulls, however, was the eye irritation shown by California Gulls. Similarly, ash-induced conjunctivitis and blindness was observed in bears, rabbits, and birds after the eruption of Mount Katmai on Kodiak Island, Alaska in 1912 (Martin 1913).

The presence of eye-irritation of California but not Ring-billed gulls suggests behavioral differences between the two species during or immediately following the ashfall. The development of eye irritation by a California Gull while excavating an experimentally covered nest in 1981 suggests that irritation was associated with excavation activity, including bill-digging, because members of this species engaged more intensively in this activity. Alternatively, Ring-billed Gulls may have bathed earlier in the lake, thus washing the ash from their eyes.

Subsequent Behavior and Events

Behavior by the gulls subsequent to the exodus partially alleviated the harmful effects of the ash on colony productivity.

Excavation.—The earliest alleviating behavior involved excavating nests from beneath the ash. The high incidence of scrape and settle and, to a lesser degree, bill-digging almost immediately following experimental ash deposition on nests in 1981 suggests that most 1980 excavation activity occurred as soon after the ashfall as nests could be located.

The greater latencies to scrape and settle and bill-dig exhibited by Ring-billed Gulls compared to California Gulls are consistent with expectations based on relative excavation frequencies by these species. California Gulls not only excavated a higher proportion of nests, but also excavated over a longer period of time. The 1980 excavation percentages of 69% and 39%, respectively, for California and Ring-billed gulls were reasonably close to those obtained experimentally in 1981 (80% and 40%, respectively). Conceivably, this difference could have been due to nest-habitat variation, but,

when excavation frequencies for the two species were compared for SV only, excavation frequencies for California Gulls were still significantly higher. Moreover, the habitats were not differentially altered by the ash during the 1981 experiments as they were during 1980; yet differing excavation proportions by species still occurred. Thus, the species difference in excavation frequency appears directly related to behavioral differences rather than to habitat variation.

Differential excavation frequencies observed among Ring-billed Gulls were apparently due both to habitat and behavioral factors. Data collected during 1981 suggested that gulls nesting in TG and RB were, on the average, older birds occupying functionally superior habitats than those nesting in SV or LD (Hayward 1982). Excavation frequencies for Ring-billed Gulls must be interpreted with these differences in mind.

The relatively low excavation frequencies for Ring-billed Gulls in TG and LD can be accounted for in part by realizing that ash-laden grass was forced down over nests in these habitats. This had the consequence of making these nests more difficult to find due to alteration of surface topography. It also may have made excavation activity more difficult. The lower proportion of excavated LD and TG nests was probably due to the younger age of birds nesting in LD.

The highest proportion of excavated Ring-billed Gull nests was located in RB, followed by SV. General topographic features were preserved in both these habitats, and nests were not covered by ash-laden vegetation. Predictably, the presumably younger SV birds excavated at a lower frequency than the RB gulls. Habitat variation should have had no influence on excavation frequencies for experimental nests in 1981, because nest habitats were not altered during ash deposition. Hence, any differences in excavation frequency should have been due to behavior differences alone. Thus, higher frequencies of excavation would be predicted for gulls in TG and RB compared to those in SV and LD, because gulls in TG and RB were otherwise more successful breeders. The frequencies obtained are small but consistent with this prediction.

The fact that more California than Ring-billed gull eggs remained cemented to the ash may indicate that these birds were less thorough in excavation efforts, that their eggs were moved less frequently allowing them to bind to the ash, and/or that their nest cups were deeper making complete excavation difficult. Habitat variation (e.g. moisture gradients) cannot account for this difference.

Hatching success of excavated Ring-billed Gull eggs was at least 50% (nest yielding incomplete data) to 82% (nests yielding complete data) by 5 June. The higher percentage agrees favorably with hatching success in 1981, which, in equivalent areas and time period, averaged 72% for eggs present on 18 May 1981. Also, the progress of hatching in 1980 did not appear delayed when compared with that of 1981. Thus, the ash appeared to have no severely adverse effects on the viability of uncemented, excavated Ring-billed Gull eggs. Less complete data on hatching phenology and success of California Gulls are more difficult to interpret but, in general, seem consistent with those obtained for Ring-billed Gulls. Following hatching, chicks of both species evidently suffered little ill effect from the ash.

Renesting.—The appearance during June of high numbers of Ring-billed Gull nests indicates that a large proportion of birds that failed to excavate their ash-covered nests established second nests, many adjacent to the original colony. As high an incidence of renesting as was observed was unexpected in view of Vermeer's (1970) failure to induce renesting experimentally in this species. The comparatively lower incidence of new California Gull nests in the colony indicates yet another difference between the responses to the ash by the two resident species.

Success of the second nests of Ring-billed Gulls appeared abnormally low. Clutch sizes were lower in these second nests, but the reduced success apparently was largely due to egg loss. Several factors may have entered into this loss. If it is assumed that the new nests were renest attempts, considerable energy had already been invested, especially by the female, up to the point when the first clutch was destroyed. The additional energy required to produce a second clutch and, in some cases, establish another territory may have been excessively demanding. This demand perhaps, in turn, may have led to a greater proportion of time spent foraging at the expense of incubating, thus leaving the eggs exposed to predation by other gulls. Any detrimental effect

of the ash on food sources, which even normally might be dwindling late in the breeding season, would compound the problem by prolonging foraging time. Moreover, gulls that had successfully excavated their original nests and reared their chicks to an advanced stage would be expected to take quick advantage of opportunities to cannabalize eggs within the colony. An alternative hypothesis is that a second hormonal cycling this late in the breeding season was insufficient in many cases for sustained incubation, resulting in a high incidence of abandonment, followed by egg predation.

The apparent failure of Ring-billed Gulls to renest at the Potholes colony, where more ash fell, eludes explanation. Conceivably, the adults in this colony were too far advanced into the chick stage for hormonal recycling to occur. Previous studies (Emlen and Miller 1969) of this species have shown that adults losing their entire broods eventually desert.

Conclusion

Aside from temporary eye irritation in some adult California Gulls, the ashfall from Mount St. Helens appeared to have little serious physical effect on gulls breeding in the path of the ash plume. The most serious effect was evidently to induce the gulls to leave their nests uncovered during the fallout. The lack of noticeable reproductive failure at the Banks Lake colony indicates that colonies receiving only light ashfall on the fringe of the plume were largely unaffected, either because no exodus occurred during the ashfall or because eggs and/or chicks were readily uncovered. The almost total failure of Ring-billed Gulls apparent at the Potholes Reservoir colony is suggestive of a disastrous impact on this species' reproductive output in the pathway of heaviest ash fallout. In areas receiving somewhat less fallout, such as the Sprague Lake colony, the impact was moderated somewhat by excavation of ash-covered nests and by renesting. The large numbers of gulls breeding at these same colony sites in 1981 indicates that the ash caused no long-term reduction in nest substrate attractiveness at these sites.

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