same pair was observed copulating 14 June with their unfledged chick present. On 10 August, the male was observed in his same territory engaged in distraction behavior, typical of adults protecting chicks, when two chicks (~20 days old) emerged from the surrounding vegetation. No adult female was present. All other known broods were accounted for, indicating that this was a newly discovered brood. This male and the two chicks (newly fledged) were observed 16 August 1 km away from the last sighting. These observations compelled the technicians to believe that this bird helped produce two successful broods.

Observations at both sites indicate that Piping Plover can successfully raise two broods in a single breeding season. This may have been facilitated by predator exclosures around nests or a decrease in predators in the nesting areas. In past years, heavy nest predation at these locations could have been potentially limited the success of a second brood. It is also possible that the adults that produced and reared double broods were more experienced and physically mature (banded birds were at least four years old) than most of the existing population. In addition, increased availability and/or access to feeding areas may have contributed to reproductive success.

The authors believe it will be difficult to ascertain the extent of double brooding in Piping Plovers. Banding of Piping Plovers ceased in 1989 and therefore the number of living banded Piping Plover is decreasing annually which will make it more difficult to determine individual birds. The ability to raise successfully two broods may be a factor in the management and recovery of this species which is currently listed by the USFWS under the Endangered Species Act.

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**Response of six species of Hawaiian forest birds to a 1991–1992 El Nino drought.**—El Nino-Southern Oscillation events (ENSO) are known to effect reproduction and survival of various bird species and other animals (Barber and Chavez 1983, Grant and Grant 1987, Hall et al. 1988, Massey et al. 1992). Although severe storms resulting from ENSO can directly cause bird mortality, primary effects appear to be influences of weather on food resources. During ENSO, precipitation is enhanced in some regions and diminished in others (Philander 1992). Enhanced rainfall may cause abundant seed crops and high arthropod populations, resulting in prolonged breeding seasons for some bird species (Gibbs and Grant 1987) or, along with reduced temperatures, decreases invertebrate populations resulting in breeding failure and reduced adult survival in other bird species (Miskelly 1990).

In Hawaii, ENSO generally causes rainfall to diminish (Philander 1992). Between 1941 and 1983, Hawaii has experienced six major ENSO droughts (Chu 1989). However, despite the periodic occurrence of ENSO droughts, few data are available about the effects on Hawaiian bird species. Here, we report a short-term effect of the 1991–1992 ENSO drought on capture rates, fat scores, and active nests of six resident Hawaiian forest bird species.

*Study area and methods.*—We conducted this study on the Island of Hawaii in the dryland mamane (*Sophora chrysophylla*)-naio (*Myoporum sandwicense*) forest near Puu Laau (19°50'N, 155°35'W) on the southwestern slope of Mauna Kea. Vegetation in the study area was described by van Riper (1980a) and Scowcroft and Giffin (1983). In 1991–1992, an ENSO throughout the Hawaiian Islands chain resulted in a nine-month drought from October through June. Total rainfall (<67 mm) in our study area was approximately 17% of average (Juvik et al. 1993; NBS, unpubl. data). The result of this drought was a general failure of flower and mamane seed set in our study area during 1992 (NBS, unpubl. data). Green seeds from mamane pods are a major food source for the endangered Palila (*Loxioides bailleui*); birds also use the nectar and flowers of mamane for food.

From April through September 1991–1993, we operated 10 mist nets at each of four fixed banding stations to capture birds within the study area. Nets were opened 1–4 days monthly at each banding station. Each bird captured was identified to species, marked with a USFWS aluminum band, and scored for visible fat within the furcular region before being released. Fat scores ranged from zero for no visible fat to four for the interclavicular fossa bulging with fat. We searched for active nests by walking 24 strip transects (each 40 m × 1 km) at monthly intervals during the same six-month period each year. A nest was considered active if eggs or nestlings were found. Capture data were compared by the paired comparison *t*-test and fat scores by the Mann-Whitney *U* test (Sprent 1993).

*Results.*—The overall capture rate (number of birds per 100 net-h) for the six species combined was 49.9 for 1991 ($N = 2913$ net-h), 19.2 for 1992 ($N = 4361$ net-h), and 47.5 for 1993 ($N = 3439$ net-h). During 1992, the overall capture rate was 60% lower than in 1993 and 62% lower than in 1991. Mean monthly capture rates for 1992 were lower ($P < 0.05$) than those for 1991 for Hawaii Amakihi (*Hemignathus virens*), Palila, Japanese White-eye (*Zosterops japonicus*), and House Finch (*Carpodacus mexicanus*) (Table 1). Mean monthly capture rates for 1993 increased ($P < 0.05$) compared to 1992 for Hawaii Amakihi and House Finch. Capture rates for 1993 for Japanese White-eyes did not return to predrought levels, but remained lower ($P < 0.05$) compared to 1991.

Fat scores in 1992 were less ($P < 0.05$) for Hawaii Amakihi, Palila, Elepaio (*Chasiempis sandwichensis*), and Japanese White-eyes when compared with fat scores from 1991 (Table 2). For Red-billed Leiothrix (*Leiothrix lutea*), fat scores in 1992 were similar to those of 1991 and larger ($P < 0.05$) than those in 1993.

During 1992, Hawaii Amakihi and Palila nesting attempts decreased 96% and 93%, respectively, compared with 1991 data (Table 3). Sample sizes for the remaining four species were low, but data suggests that nesting attempts for the Red-billed Leiothrix and House Finch may also have been reduced.

*Discussion.*—Environmental perturbations caused by ENSO have significant short- and

TABLE 1

MEAN MONTHLY CAPTURE RATES (NUMBER BIRDS PER 100 NET-H) FOR SIX RESIDENT BIRD SPECIES ON MAUNA KEA, HAWAII, APRIL–SEPTEMBER, 1991–1993[a]

| Species | Year | | |
|---|---|---|---|
| | 1991 | 1992 | 1993 |
| Hawaii Amakihi[b] | 38.7a | 15.5 | 44.8a |
| Palila[b] | 2.3a | 0.9b | 1.9ab |
| Elepaio[b] | 1.3a | 0.4a | 0.5a |
| Japanese White-eye[c] | 3.4 | 0.9a | 1.0a |
| Red-billed Leiothrix[c] | 2.4a | 1.0a | 0.9a |
| House Finch[c] | 1.2a | 0.1 | 0.7a |

[a] Between October 1991 and June 1992, the study area experienced a nine-month ENSO drought. Means with the same letter are not significantly different (paired comparison *t*-test, $P < 0.05$).

[b] Native Hawaiian species.

[c] Alien species.

long-term effects on the demography of both marine and terrestrial bird species (Barber and Chavez 1983, Schreiber and Schreiber 1984, Hall et al. 1988). Field biologists studying terrestrial species must be aware that ENSO may effect study regions and species far removed from marine ecosystems (Schreiber and Schreiber 1984) and could be an important selective determinant of life-history traits (Hall et al. 1988).

During an El Nino drought in Panama in 1983, Karr et al. (1990) reported that bird capture rates in his study area were the most extreme ever recorded during eight years of sampling. In two relatively dry study plots, capture rates were the lowest recorded, while one wetter study plot had the highest capture rate recorded for a dry season sample. In our study area, the 1991–1992 ENSO drought reduced capture rates for four species, reduced fat levels for four species, and reduced nesting attempts for at least two species. The primary

TABLE 2

MEAN MONTHLY FAT SCORES FOR SIX RESIDENT BIRD SPECIES ON MAUNA KEA, HAWAII, APRIL–SEPTEMBER, 1991–1993[a]

| Species | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1991 | | 1992 | | 1993 | |
| | N | Mean (SE) | N | Mean (SE) | N | Mean (SE) |
| Hawaii Amakihi | 673 | 2.25 (0.78) | 568 | 1.93 (0.99) | 960 | 2.19 (0.96) |
| Palila[b] | 64 | 2.23 (0.77) | 33 | 1.97 (0.88) | 61 | 2.43 (0.83) |
| Elepaio[b] | 21 | 1.62 (0.80) | 18 | 1.00 (0.84) | 17 | 1.65 (1.00) |
| Japanese White-eye[c] | 49 | 2.20 (0.73) | 26 | 1.61 (1.13) | 27 | 2.11 (0.80) |
| Red-billed Leiothrix[c] | 36 | 1.58 (0.98)a | 30 | 1.60 (1.10)a | 25 | 1.12 (1.36) |
| House Finch[c] | 16 | 1.81 (0.98) | 5 | 2.40 (0.55) | 19 | 1.58 (1.43) |

[a] Between October 1991 and June 1992, the study area experienced a nine-month ENSO drought. Means with the same letter not significantly different (Mann-Whitney *U*-test, $P < 0.05$).

[b] Native Hawaiian species.

[c] Alien species.

TABLE 3

NUMBER OF ACTIVE NESTS FOR SIX RESIDENT BIRD SPECIES FOUND IN 24 TRANSECTS (EACH 40 M × 1 KM) ON MAUNA KEA, HAWAII, APRIL–SEPTEMBER 1991–1993[a]

| | Year | | |
|---|---|---|---|
| Species | 1991 | 1992 | 1993 |
| Hawaii Amakihi[b] | 163 | 6 | 27 |
| Palila[b] | 71 | 5 | 70 |
| Elepaio[b] | 1 | 0 | 0 |
| Japanese White-eye[c] | 1 | 1 | 4 |
| Red-billed Leiothrix[c] | 12 | 5 | 4 |
| House Finch[c] | 12 | 4 | 8 |

[a] Between October 1991 and June 1992, the study area experienced a 9-month ENSO drought.
[b] Native Hawaiian species.
[c] Alien species.

effect of this ENSO drought on resident birds in our dryland forest was presumably caused indirectly through food resources being reduced. From other studies, the number of nesting attempts by Palila is known to be influenced by annual differences in precipitation and availability of immature mamane pods (Van Riper 1980b; NBS, unpubl. data). Adult Palila had lower survival in years when mamane seed production was low (Lindsey et al. 1995).

On Mauna Kea, the Hawaii Amakihi population is intrinsically tied to its food supply, particularly nectar resources (van Riper 1984, 1987). Hawaii Amakihi has a protracted nesting season from November to July, but initiation of the breeding season is variable and coincides with major mamane flowering periods. Between breeding periods, most Hawaii Amakihi pairs undergo postbreeding dispersal which corresponds to the cessation of mamane flowering. Our data indicated fewer active nests for Hawaii Amakihi in 1993 than in 1991. However, Hawaii Amakihi nesting peaked in the winter and early spring following the El Nino drought, as indicated by the large number of juvenile birds captured and vacant nests found in the spring and summer of 1993 (NBS, unpubl. data). This peak in nesting coinciding with the peak mamane flowering period for that period.

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**Daily variation in activity and flock size of two parakeet species from southeastern Brazil.**—Psittacids are wide-ranging birds usually occurring in large flocks, making direct density estimates of parrots difficult. Researchers often are obliged to rely on indirect methods to estimate their abundances (see Terborgh et al. 1990, Pizo et al. 1995). These estimates are based on the number of flocks contacted in a given period (average encounter rate) and on the mean flock size of the species considered. However, both measures can vary on a daily basis (Blake 1992, Cannon 1984, Chapman et al. 1989), implying that parrot counts should be concentrated in a given period of the day to save time and to ensure a more realistic estimate (Blake 1992). Some attempts have been made to assess daily variation in detectability of Neotropical parrot species (Blake 1992). This author noted that detections of canopy bird species, such as parrots, tend to increase from the first to second hours after sunrise in a tropical wet forest in Costa Rica. Hourly variation in flock sizes of parrots, however, has hitherto received little attention. Chapman et al. (1989) observed that mixed-species flocks of parrots in Costa Rica were significantly larger during late afternoon, just before they move to a communal roosting site, than at other times of the day.

Here we report on the daily activity and flock size of two common parakeet species occurring in the Atlantic forest of southeastern Brazil, the Maroon-bellied Parakeet (*Pyrrhura frontalis*) and the Plain Parakeet (*Brotogeris tirica*). We address the following ques-