EXPLOITATION OF FLUCTUATING FOOD RESOURCES BY WESTERN GULLS

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FOOD resources that are irregular in either spatial or temporal distribution are theoretically most efficiently cropped by birds that nest colonially in a central location (Horn 1968). Lack (1968), Emlen (1971), Siegfried (1971), Ward and Zahavi (1973), and others have provided evidence, based on changes in foraging patterns or growth of young, that information exchange and enhanced foraging success may accrue to colonially nesting or roosting birds that utilize fluctuating food resources. Colonial nesting in gulls may in part be an adaptation to improve exploitation of fluctuating food resources.

For gulls that may use a wide variety of intertidal organisms as well as unpredictable foods such as swarming insects or schooling fish (Mendall 1939, Ingolfson 1967, Hunt 1972), large colony size may have both advantages and disadvantages. Individual gulls that scavenge and forage for invertebrates in the intertidal zone usually defend feeding territories (Drury and Smith 1968). Dependence upon this foraging strategy would be incompatible with large colony size if the area of shoreline were restricted.

Small isolated islands that have restricted shoreline areas may however support large populations of gulls. Santa Barbara Island, Santa Barbara County, California, has a small area of shoreline habitat, is isolated from stationary sources of food such as garbage dumps, and supports a population of over 1500 pairs of Western Gulls (*Larus occidentalis wymani*). In this study we wished to determine the relative importance of fluctuating food resources for young Western Gulls prior to fledging.

STUDY SITE AND METHODS

Santa Barbara Island is a 260 ha (1 square mile) island 61 km (38 miles) from the nearest mainland and 39 km (24 miles) from the nearest island, Santa Catalina Island. Philbrick (1972) provides an account of the history and flora of the island, while the avifauna is described by Hunt and Hunt (1974). Other aspects of the reproductive ecology of the Western Gull on Santa Barbara Island are discussed by Hunt and Hunt (1973, 1975).

The colony of Western Gulls is divided into three separate segments: two-thirds of the 1510 pairs in 1972 nested on the western plateau, while another 25% used the southern third of the eastern slopes and plateau. The remaining pairs nested on the northeast corner of the island.

We obtained foods from 141 chicks in several areas on the east side during 7 days

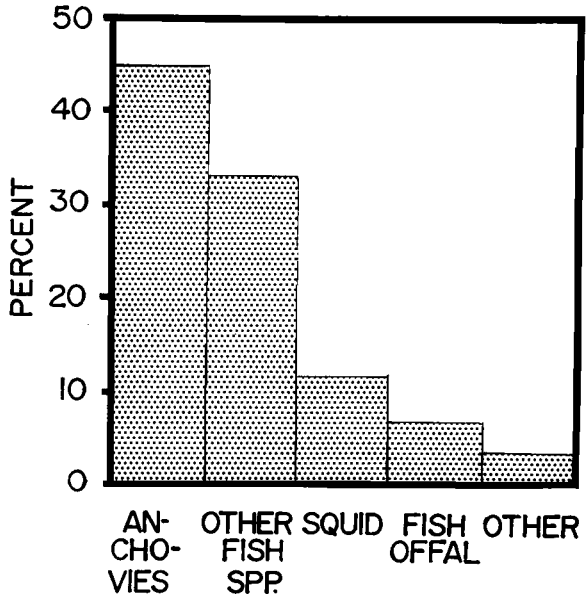

Fig. 1. Percent composition by weight of foods sampled from chicks.

between 15 June and 15 July 1972. Chicks weighing more than 150 g were sampled without harming them by inserting an index finger to the bottom of the proventriculus and extracting all food present (Hunt 1972). When sufficiently intact, fish were identified by reference to Miller et al. (1965).

In order to assess the relative importance of food types, the results have been expressed as the percentage by weight of each food type in the total sample of foods obtained. Although in some instances more than one chick in a family contributed to a day's sample, and six families yielded food samples four or more times during the summer, these possible biases have apparently not distorted the overall picture of what the colony was using for food. In each day's sampling we obtained food from 10 or more chicks that, because of their dispersion, belonged to different families.

We collected data on the length of foraging trips of adults by timing their departures and arrivals at their territories from two blinds on the west side of the island. We watched from 17 to 22 pairs for 7 periods, from 7⅔ to 15⅓ h in length (mean = 12 h), between 10 June and 16 July. Data were gathered for pairs with chicks of all ages (day old to fledging), for a total of 1605.7 pair hours of observations.

RESULTS

We sampled 141 chicks between 1 and 6 times for a total of 254 chick samplings, of which 181 yielded food. The food obtained consisted of 89% schooling organisms by weight. These were primarily anchovies

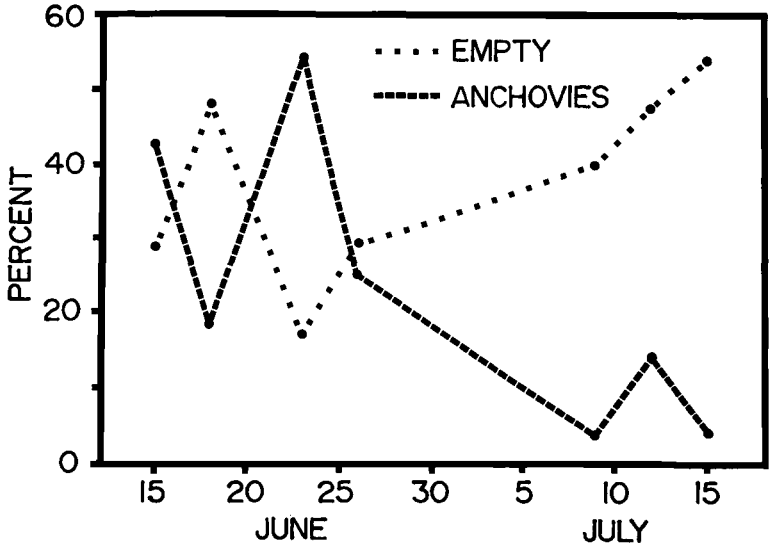

Fig. 2. The percentage of chicks found empty and the percentage of food samples containing anchovies, vs. the date of sampling.

(*Engraulis mordax*) and unidentified species of squid (Fig. 1). On the basis of partially digested specimens, other species of small fishes were tentatively identified as Jack mackerel (*Trachurus symmetricus*, 5.2%), Pacific saury (*Cololabis saira*, 2.8%), and midshipman (*Porichthys* sp., 1.9%). Squid were obtained in all four of the morning samplings; none was found in the afternoon samplings.

Intertidal organisms were very scarce in the chicks sampled, there being only two occurrences of gooseneck barnacles (*Pollicipes polymerus*) and one of mussels (*Mytilus* sp.).

None of the chicks sampled yielded material that could be traced to the California sea lions (*Zalophus californicus*) that breed on the shoreline at the base of the cliffs around the island. Once we saw an adult gull unsuccessfully trying to feed its young a large portion of a sea lion placenta. It was too tough for the chick to tear apart and too big for it to swallow whole. Several times we saw adults eating sea lion placentae, which may be an important supplementary food for them.

Very few of the samples appeared to have originated from man. Of the 181 samples only 2 contained garbage and 11 contained fish offal, 8 of which were obtained on a day when sportsfishermen on a commercial boat were cleaning their catch near the island. The food samples gave no indications that the birds exploited dumps on either Santa Cata-

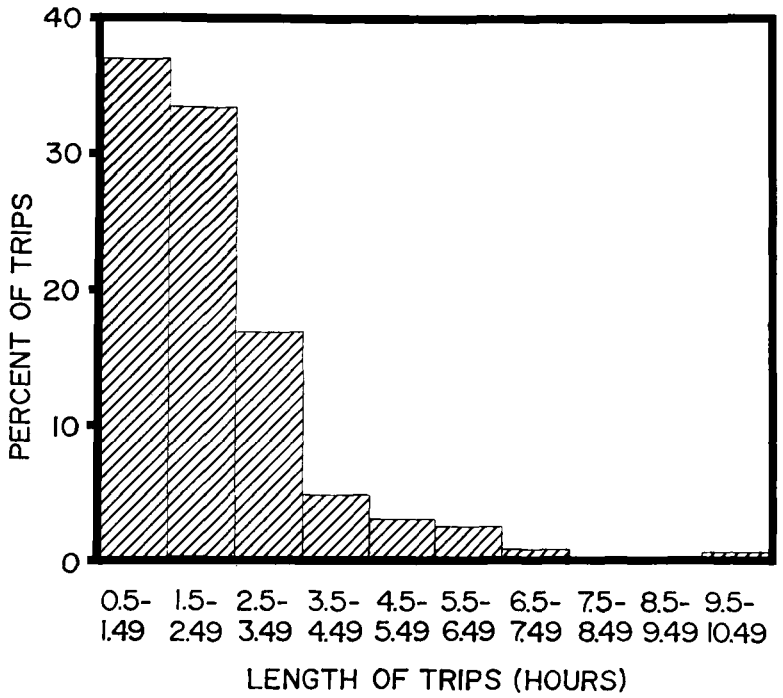

Fig. 3. Distribution of parental trip lengths $\geqslant$ 0.5 h.

lina Island or the mainland in order to feed their chicks, although small numbers of paper wrappers and cut bones were present in "club" areas (Tinbergen 1960) used mainly by subadult gulls.

A strong negative correlation existed between the percentage of food samples containing anchovies on any given day and the percentage of chicks that were found empty ($r = 0.87$, $P < 0.05$, see Fig. 2). While there was an apparent increase in the percentage of empty chicks with date (Fig. 2), this relationship was not statistically significant ($r = 0.59$, $P > 0.05$). Thus when the birds were able to locate and track a source of food such as anchovies, more of the individuals in the colony had food than was the case when the items used required individual search and locating.

Foraging trips by parent gulls were defined as absences from the territory of 30 min or longer. For each of 41 pairs we documented between 3 and 15 such absences, a total of 370, for which the time of both the departure and return of the parent were known. The mean length of absence was 2.13 $\pm$ 1.44 h (range = 0.5–9.7 h, see Fig. 3). These data

indicate that on the average adults were obtaining food within a maximum distance of 55 km (34.4 miles) from the colony. This estimate assumes at least 0.75 h devoted to foraging and the remaining time spent flying to and from the foraging grounds at 40 km/h (Pennycuick 1969, see Hunt 1972).

Discussion

The availability of schooling fish is needed for the Santa Barbara Island gulls to feed their young adequately. When no anchovies were brought to the chicks (and hence apparently were not available), the adults failed to provide their chicks with large quantities of alternative foods (Fig. 2). While some intertidal organisms were used, they made up less than 5% by weight of all food items (Fig. 1). This indicates that the intertidal zone of Santa Barbara Island cannot produce enough food stuff for the entire Western Gull colony there. Fishes such as the midshipman, which usually live at depths lower than gulls can reach, may have been obtained from cormorants (Hubbs et al. 1970).

The persistence through time of a colony that is dependent on temporally or spatially variable prey populations may provide a measure of the predictability of these resources. The Santa Barbara Island Western Gull colony is almost the same size as it was three decades ago, despite large tracts of additional suitable space for expansion. In April 1939 Sumner (MS) estimated that 2500–3500 individual gulls were present; in July 1972 we counted 1510 pairs on territory. As space for more nests is available on the island, this population is probably limited by food resources (Ashmole 1963, 1971), and its size reflects food availability.

Often large flocks of Western Gulls, cormorants (*Phalacrocorax auritus* and *P. penicillatus*), and Brown Pelicans (*Pelecanus occidentalis*) foraged on schooling prey within a mile of the island's east side. When prey were at the surface, the birds congregated and repeatedly plunge-dived (Ashmole 1971). Periodically when the prey were too deep for birds to reach, the flock dispersed over a wide area. When a single bird recommenced plunge-diving, other birds soon converged on the new center of foraging activity.

Scott (1973) has discussed how large, mixed species flocks of seabirds may enhance successful exploitation of schools of fish by surveying for food over a large area. He believes that the Western Gull in Oregon is a key species in locating schools of fish because the gulls search for food from a great height, and he reasons that the probability of detecting these schools of superabundant prey is increased by having complete coverage over a large expanse of ocean. Members of a large colony of

gulls may thus enjoy greater efficiency in exploiting fish schools than the fewer birds from a small colony. This increased efficiency in prey location may result in a dependence on the spatially or temporally variable resource if colony size surpasses the carrying capacity of nearby stable resources (i.e. those in the intertidal zone).

Schreiber (1970) reported adult Western Gulls on nearby San Nicolas Island feeding on the placentae of newborn California sea lions. He also found placental tissue in a small number of gull regurgitation samples. In noting that the peak of gull hatching was synchronous with the peak of sea lion pupping, Schreiber suggested that further information on the ecology of both species was needed before any relationship between these events could be establishd. As no sea lion placentae were present in any food samples obtained from gull chicks on Santa Barbara Island, we feel it is improbable that the Western Gulls on Santa Barbara Island have timed their breeding to synchronize chick hatching with sea lion pupping. More likely both events are related to the seasonal availability of food fishes.

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SUMMARY

Samples of food were obtained from young Western Gulls (*Larus occidentalis wymani*) on Santa Barbara Island, California. Schooling organisms, including anchovies, other small fish and squid, constituted 89% by weight of the foods sampled. A negative correlation existed between the presence of anchovies in food samples and the number of chicks that were found empty. While colonial nesting may enhance the exploitation of fluctuating food resources, large colonies may become dependent upon these resources for reproductive success.

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