

- JUDAY, C., 1940. The annual energy budget of an inland lake. *Ecology* 21: 438-450.
- LACK, D., 1954. *The natural regulation of animal numbers*. Clarendon Press, Oxford.
- LOTKA, A. J., 1925. *Elements of physical biology*. Williams & Wilkins, Baltimore.
- NICHOLSON, E. M., 1957. *Britain's nature reserves*. Country Life, London.
- ODUM, E. P., 1959. *Fundamentals of ecology*. 2nd edition. Saunders, Philadelphia & London.
- PARK, T., 1962. Beetles, competition and populations. *Science* 138: 1369-75. (A compact summary of a vast amount of work.)
- PEARSALL, W. H., 1964. The development of ecology in Britain. *Brit. Ecol. Soc. Jubilee Symp.*: 1-12. (With a valuable list of references.)
- P.E.P. [Political and Economic Planning], 1955. *World population and resources*. Allen & Unwin, London.
- PETERSON, C. G. J., 1918. The sea bottom and its production of fish-food. A survey of work done in connection with valuation of the Danish waters from 1883-1917. *Rep. Danish Biol. Sta.* 25: 1-62.
- SHELFORD, V. E., 1913. Animal communities in temperate America. *Bull. Geogr. Soc. Chicago* 5: 1-368. (Reprinted 1937, Univ. Press, Chicago.)
- SOLOMAN, M. E., 1964. Analysis of process in control of insects. In *Advances in ecological research*, vol. 2. Ed. Cragg, J.B. Academic Press, London & New York. (A critical evaluation of work done on insect population dynamics and control.)
- TALBOT, L. M., and TALBOT, M. H., 1963. The high biomass of wild ungulates on East African savanna. *Trans. 28th N. Amer. Wildlife Conf.*: 465-76.
- THIENEMANN, A., 1926. *Limnologie*. Jedermann, Breslau.
- VARLEY, G. C., 1947. The natural control of population balance in the knapweed gallfly (*Urophora jaceana*). *J. Anim. Ecol.* 16: 139-87.
- WYNNE-EDWARDS, V. C., 1962. *Animal dispersion in relation to social behaviour*. Oliver & Boyd, Edinburgh & London.

## FOOD OF THE OPOSSUM *TRICHOSURUS VULPECULA* IN PASTORAL AREAS OF BANKS PENINSULA, CANTERBURY

D. P. GILMORE

*Zoology Department, University of Canterbury\**.

### INTRODUCTION

Previous work on the foods of the brush-tailed opossum (*Trichosurus vulpecula*) in New Zealand has been concerned with the choice of plants taken in indigenous bush. Although clover was sometimes recorded as a preferred food the conclusion was reached that opossums "are not grass-eating animals" (Mason 1958), and that "the opossum is not, and will never become an important grassland pest" (Howard 1963).

Present research on Banks Peninsula, Canterbury, from November 1963 to August 1964 shows that although opossums appear to be more numerous close to favourable bush, they often occur many miles from any native or exotic forest. Under these circumstances opossums feed largely, if not exclusively, on plants serving as food or shelter for domestic stock. Clover, grass and pasture plants form a large part of their diet throughout the year.

Opossums are very numerous on Banks Peninsula. By day they often shelter in such places as gorse hedges, old willows, macrocarpa shelter belts and rock crevices, and emerge at night to forage in nearby fields; they also cause much annoyance by raiding gardens and orchards.

Much of Banks Peninsula is rugged with many peaks up to 2500 ft. and ample cover is available on the rocky hillsides. Although the peninsula supports large dairy and beef cattle herds as well as many sheep, there is still much bush including totara (*Podocarpus totara*), lacebark (*Hoheria angustifolia*), konini (*Fuchsia excorticata*), fivefinger (*Neopanax arboreum*), and mahoe (*Meliclytus ramiflorus*).

The original bush is now mainly restricted to gullies, shaded slopes and scenic reserves, although there is some secondary growth.

\* This work is part of a Ph.D. study carried out under the tenure of a Research Fund Fellowship of the University Grants Committee.



There are many places alongside the roads on the peninsula with small patches of bush, mainly fivefinger, konini, mahoe, broadleaf (*Griselinia littoralis*) and manuka (*Leptospermum scoparium*), which provide both shelter and food for the opossums. Gorse (*Ulex europaeus*) is very widespread and such exotics as willow (*Salix* spp.), pines (*Pinus* spp.), poplars (*Populus* spp.) and macrocarpas (*Cupressus macrocarpa*) are very common.

Banks Peninsula has a mild climate well suited for farming. The mean annual rainfall recorded at Akaroa is 43 in. and the mean annual temperature 46°F.

METHODS OF STUDY

Most of the opossums obtained for this study came from Banks Peninsula (Fig. 1), and all were from pastoral lands where pasture plants were readily available for food; most of the paddocks have been oversown with introduced grasses.

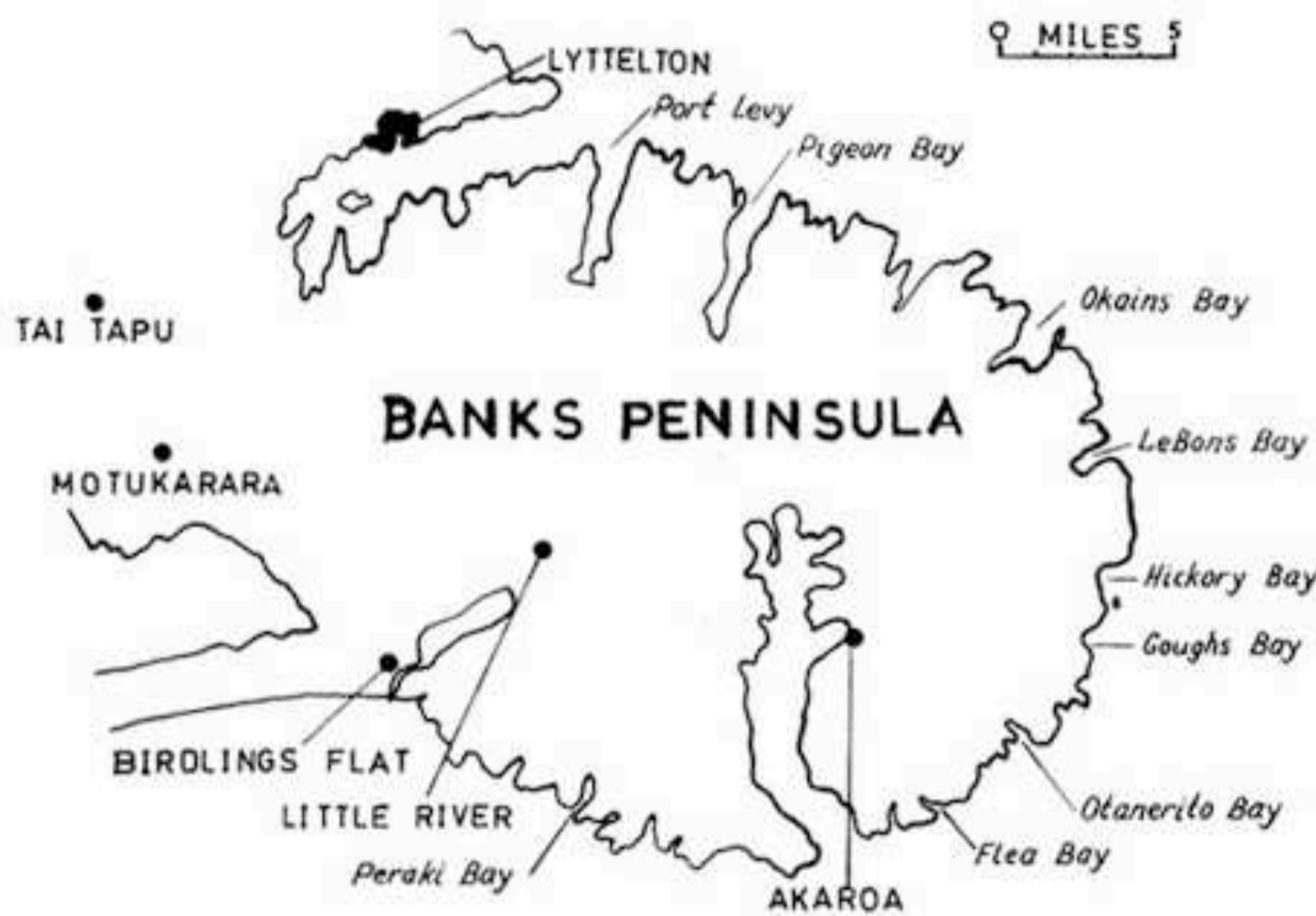


FIGURE 1. Map of Banks Peninsula, the main collecting area for this study.

Of the opossums collected from the peninsula most came from the vicinity of Pigeon Bay and the roads about Hickory and Le Bons Bay along which are extensive areas of pasture, small patches of bush and many acres of gorse. Blackberry and broom are less common. About the farmhouses there are usually orchards and shelter belts of pines and macrocarpas while willows grow along many of the streams. A smaller number of opossums was picked up from the roads about Motukarara, Tai Tapu

and Birdlings Flat on the Peninsula, and Dunsandel, Methven and Woodend on the Canterbury Plains.

The Banks Peninsula Rabbit Board began operations against the opossum in the Kaik Lighthouse area on the south-east side of the peninsula in July 1963, and regular collections of animals destroyed by the Board began in the following November. The Board uses cyanide, followed by dogs, trapping and shooting with spotlights to reduce the opossum population.

By visiting the area once a month where the Board was operating, a number of opossums were collected, weighed, measured and dissected. The amount of food eaten by an opossum varied with the size of the animal, but the average weight of the stomach contents of 100 animals was 4.3% of the body weight.

STOMACH CONTENTS

The stomach contents contained a surprisingly high proportion of grass and clover, these two often being the only plants present. Grass was frequently eaten, even when many other plants including konini and fivefinger were available; "dandelion" flowers were also very often eaten particularly in summer and autumn. Tables 1 and 2 show the foods occurring regularly in the stomachs of the animals examined.

TABLE 1. Pasture plants recorded in the stomachs of 217 opossums.

Plant species	Frequency of occurrence
<b>LEAVES</b>	
<i>Grasses</i>	
Sweet vernal <i>Anthoxanthum odoratum</i> .....	2
Meadow grass <i>Poa pratensis</i> .....	3
Ryegrass <i>Lolium perenne</i> .....	25
Cocksfoot <i>Dactylis glomerata</i> .....	10
Unidentified species .....	116
<b>Total grasses</b>	<b>156</b>
White clover <i>Trifolium repens</i> .....	100
"Dandelion" .....	18
Yarrow <i>Achillea millefolium</i> .....	3
Sorrell <i>Rumex acetosella</i> .....	3
<b>FLOWERS</b>	
"Dandelion" .....	47
White clover .....	5
<b>SEEDS</b>	
Grasses, unidentified spp. ....	9
White clover .....	2

NOTE. "Dandelion" included unidentified spp. of yellow-flowering flatweeds of the family Compositae.



TABLE 2. *Non-pasture plants recorded in the stomachs of 217 opossums taken in pastoral areas.*

Species	Leaf	Flower	Fruit
Konini <i>Fuchsia excorticata</i>	X	X	X
Fivefinger <i>Neopanax arboreum</i>	X		
<i>Muehlenbeckia australis</i>	X		
Bush Lawyer <i>Rubus</i> spp.	X		
Broadleaf <i>Griselinia littoralis</i>	X		
Lacebark <i>Hoheria angustifolia</i>	X		
Manuka <i>Leptospermum scoparium</i>	X		
Mahoe <i>Meliccytus ramiflorus</i>	X		
Totara <i>Podocarpus totara</i>	X		
Matai <i>Podocarpus spicatus</i>	X		
Pigeonwood <i>Hedycarya arborea</i>			X
Pokaka <i>Elaeocarpus hookerianus</i>			X
Poroporo <i>Solanum laciniatum</i>			X
<i>Coprosma</i> spp.			X
<i>Myrtus pedunculata</i>			X
Willow <i>Salix</i> spp.	X		
<i>Eucalyptus</i> spp.	X		
Macrocarpa <i>Cupressus macrocarpa</i>	X	X	
Pine <i>Pinus</i> spp.	X		

Konini and fivefingers were highly preferred foods when available, and fruit and flowers were readily eaten. Macrocarpa was found in many stomachs in July and August, the staminate cones being especially favoured.

Apples, acorns, walnuts, tomatoes and blackberries were also found in the stomachs and a mushroom and a toadstool were each recorded once. Only one stomach contained bark, and another the remains of six adults of the grass grub *Odontria* sp. One animal taken in July had eaten five faecal pellets.

Where root crops were grown as winter feed for stock opossums travelled long distances to feed on them. In Le Bons Bay there were well-defined tracks, often through long stretches of grass, made by opossums travelling from bush and gorse to feed on the crops. Many animals killed in this area had swede, turnip and chou moellier in their stomachs. Poison laid for two nights in a swede patch at Peraki destroyed 208 opossums.

Although the number of animals eating clover and grass varied from month to month, the proportion with these foods in the stomach was generally very high. Table 3 shows the percentage of stomachs containing clover and grass over the ten months in which collections were made.

TABLE 3. *Percentage of stomachs containing clover and grass.*

Month	N.	D.	J.	F.	M.	A.	M.	J.	J.	A.
Clover	33	27	36	55	7	42	52	60	56	83
Grass	66	100	73	75	53	50	38	55	64	67
No. of animals examined	15	11	11	20	15	36	21	20	38	30

In autumn many stomachs contained berries and fruit; "dandelion" flowers, earlier eaten very frequently, occurred far less often towards winter.

Table 4 shows the estimated proportion by volume of the stomach contents made up by grass and clover for 78 animals collected during June, July and August. In general clover was eaten in larger quantities than was grass. However, the latter occurred more frequently in the stomach contents.

TABLE 4. *Estimated volume of clover and grass in the stomach contents of 78 opossums.*

Estimated fraction of stomach contents by volume	Percentage frequency of occurrence	
	Clover	Grass
Nil	13	24
Up to $\frac{1}{4}$	28	36
$\frac{1}{4}$ to $\frac{1}{2}$	24	22
$\frac{1}{2}$ to $\frac{3}{4}$	23	9
> $\frac{3}{4}$	12	9
Total	100	100

#### DISCUSSION

Although it was previously considered that opossums do not eat grass in any quantity, an examination of the food of animals on Banks Peninsula shows that this is not so. Opossums graze frequently on grass and clover, throughout the year, even when other suitable foods are plentiful, as they were in most areas from which the sample was collected. Opossums collected in January 1964 from Summerhill, near Cust, as well as others from the roads in various pastoral districts in Canterbury, showed similar feeding habits to those on Banks Peninsula. With few exceptions, all the animals examined were in extremely good condition.

However, this finding does not necessarily warrant a vigorous extermination policy in pastoral districts. There are many farming districts where the opossum population is very small and where the damage caused by them is never likely to give rise to concern.



## ACKNOWLEDGEMENTS

I wish to thank Dr. B. Stonehouse for his generous help and constructive criticism throughout. I am also very grateful to the Banks Peninsula Rabbit Board, particularly to Mr. J. Phillips, for willingly arranging collection of animals; to Mrs. M. J. A. Bulfin and Messrs. C. J. Burrows and N. C. Lambrechtsen for help in identifying plants; and to Miss M. M. Büchler and Mr. W. P. Thomas for their ideas and help.

## REFERENCES

- HOWARD, W. E., 1963. Rabbit control—time for a change? *N.Z. Farmer* 83 (27): 2-5.
- MASON, R., 1958. Foods of the Australian opossum (*Trichosurus vulpecula* Kerr) in New Zealand indigenous forest in the Orongorongo Valley, Wellington. *N.Z. Journ. Sci.* 1: 590-613.

**MARINE BIRDS AND MAMMALS AT KAIKOURA**

B. STONEHOUSE

*Zoology Department, University of Canterbury*

## INTRODUCTION

The Kaikoura peninsula ( $42^{\circ}25'$  S.  $173^{\circ}42'$  E.) and neighbouring coastline are a centre of attraction for marine birds and mammals on the north-east coast of New Zealand's South Island. The area is noted for its resident sea birds, including flocks of 6000-8000 red-billed gulls\* and almost as many white-fronted terns. Large flocks of spotted shags, fluttering shearwaters and other non-breeding species appear

regularly off-shore. There is a rapidly growing population of New Zealand fur seals (*Arctocephalus forsteri*), and schools of dolphins are frequently visible within one or two miles of the shore. No other area within fifty miles of the peninsula, on either side, so consistently attracts large concentrations of marine birds and mammals.

\* Specific names of birds appear in the species list.

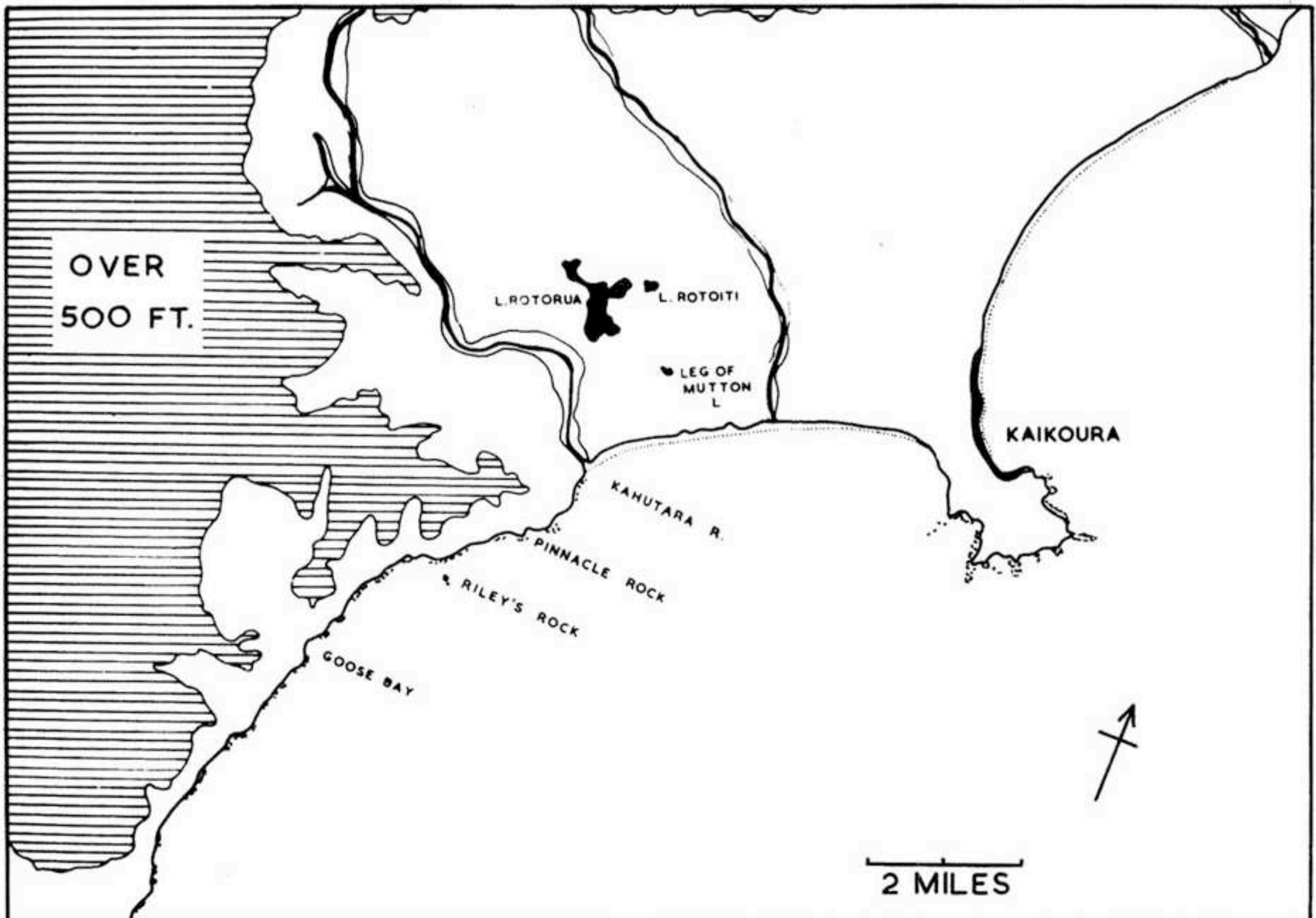


FIGURE 1. *The Kaikoura coast.*