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Field study of *Ctenotus lancelini*

Preliminary Report

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Summary

Survey of Lancelin Island reptile fauna have been undertaken in the Islands three main habitat types using eleven grids of nine traps (5 in rocky habitats, 4 on the large central dune, and 2 on the eastern foredune). Fifty-three *C.lancelini* have been trapped during seven trapping periods of 2-4 days duration conducted between mid-December 1993, and early March, 1994. A total of 59 *C.lancelini* have been marked, and 61 captures recorded (one animal dropped before marking, one recaptured once). Preliminary results suggest that all species of reptiles use all major habitat types, but there is considerable between-grid variation in capture rates. Adult *C.lancelini* have been caught on nine grids, and recent hatchlings on five grids.

Ctenotus species (*C.lancelini, C.fallens*) have been caught most frequently (85% of captures). Relative *Ctenotus* capture rates show a trend for some grids to have higher capture rates for both *Ctenotus* species. One grid on the eastern foredune stands out as having the highest capture rates for both *Ctenotus* and invertebrates. It is further characterised by having the largest amount of vegetation and, in common with other grids with relatively high *C.lancelini* capture rates, a protected north-eastern aspect. Capture rates for traps in rocky areas were generally quite low, except for one grid on the north-eastern slope of the large south-western patch of limestone. One trap in this grid had the highest capture rate of all traps, having caught 9 individuals. The only two grids with no *C.lancelini* captures were in rocky areas (one on the northern limestone patch, and one on the large southern patch).

Temporal variation in capture rates of *C.lancelini* was substantial, with adult capture rates declining since early January. Invertebrate capture rates also declined over this period. Recent hatchling *C.lancelini* have been caught since 20.1.94. Similar but less dramatic patterns are apparent for *C.fallens*. There appears to be some sexual dimorphism in *C.lancelini*, with larger females tending to have greater snout-vent length (SVL) than larger males. No *C.lancelini* captured have had SVL between 40 mm and 65 mm, suggesting that young animals attain SVL of ca. 65-70 mm during their first year.

Preliminary results suggest the species is not in immediate danger of extinction. A more comprehensive understanding of *C.lancelini* population biology is required before attempting an assessment of the impact of the decline of in the rocky areas on the viability of the Island population.

Introduction

This document reports on the progress of field studies of *Ctenotus lancelini* on Lancelin Island. The studies commenced in late November 1993, and are expected to continue for at least another 12 months (although the current contractual arrangements bwetween CALM and BJ are only relevant for the period November 1993 to June 1994).

This report gives details of the trapping programme and evaluation of its performance based on the first few months of captures. Descriptions of grid and trap array are provided for the benefit of any subsequent island workers. Comments are made on field observations of *C. lancelini*, and on the preliminary view of the species breeding biology, status, distribution and habitat on the Island. Some results relating to *C.lancelini* biology are contrasted with data for *C.fallens.* Details relating to *C.lancelini* captures from the commencement of the study up to March 11, 1994 are given in Appendix, as are some field notes on Silver Gull activity. Two documents provided by the contracted field biologist (BJ) to CALM are presented as appendices. These documents are provided to clarify the context of this report.

The earlier hypotheses relating to the apparent decline of *C.lancelini* are evaluated with regard to preliminary results, and comment is provided regarding the potential for *C.lancelini* abundance to be altered as a consequence of habitat treatments outlined in the current Interim Management Guidelines (Burbidge 1993). Since the primary function of this report is to inform people of the progress of the study no statistical treatments of data have been undertaken.

Those who may wish to use the information presented herein should bear in mind that this report was prepared when the field study was at a very early stage. While the information about trap and grid locations will be of relevance throughout the study, other information or conclusions should be considered as tentative, and their validity checked by reference to subsequent reports (or to the authors) before being quoted or otherwise used.

The trapping programme

Description of the traps used is given in a previous report (Jones 1994).

Trapping schedule

This report is based on seven trapping periods, which are referred to throughout this report as Trip 1, Trip 2, etc. The dates of the trips are as follows:

Trip 1: 22-23 Dec., 93; Trip 2: 17-20 Jan., 94; Trip 3: 29-31 Jan.; Trip 4: 4-6 Feb., Trip 5: 14-16 Feb.; Trip 6: 25-27 Feb.; Trip 7: 9-11 March.

During trapping periods, traps were cleared throughout the day. Grids with higher capture rates were cleared more frequently (usually twice daily). Lizards in such small pits together cannot avoid each other, and there may be predation by larger individuals, so a major aim of the clearing schedule has been to minimise the duration of an individuals stay in 'popular' pits. Grids with lower capture rates have usually been cleared only once each day.

Invertebrate numbers were recorded after all pits have been opened for a period of 24 hours on each trip. Not all grids could be cleared at the same time, so this period was somewhat variable (22-28 hrs). Invertebrate numbers have been quantified according to the following rules: only animals with body length > 3mm are dealt with; classification is usually at the level of Order, but for groups with obvious species diversity the animals are further classified as big, small or tiny. Counts of the number of individuals of each group in the pit were of individuals if there were less than ten individuals, but if more than ten, numbers have been estimated in units of five (only 15 and 20 used to date). Some small rare taxa have not been counted during later trips (e.g. Pseudoscorpions). These counts are most easily done if there is very little soil/litter in pits. The aim of this data is to generate an index of relative invertebrate activity for comparisons between seasons or between sites.

Trap array

Initially ten grids of traps were used to sample reptile populations in different areas representing the three major habitat types, which together account for more than 90% of the Island's area. Preliminary results for these grids were used to evaluate the requirements of trapping in other areas. Subsequently three further grids were added during January and February, 1994. The position of the 13 grids is shown in Figure 1.

Preliminary results indicated that *C.lancelini* occurred in areas with either rocky or sandy substrates, and with a range of vegetation types. The proposal to place single traps or lines of three traps within minor habitat units (e.g. the rocky slopes) was abandoned in favor of employing further grids, since the grids were judged to be more likely to make useful contributions to the population studies.

The standard grid consists of nine traps, each about ten meters apart. Grids are numbered as Grid 0, Grid 10, Grid 20, etc., and traps numbered from 1-9 (e.g. trap # 1-9 are on Grid 0, 11-19 on the Grid 10, 21-29 on Grid 20, etc). Trap numbers start at the most southwestern corner of the grid (see Figure 1).

Additional traps are currently being added within some grids with higher capture rates for *C.lancelini* in an effort to more quickly increase the proportion of marked animals within such grids. Such traps have been placed on the basis of "this looks like a relatively good spot" and they are numbered with trap numbers appropriate for the grid number, but are identified by the prefix 'A' for additional. (e.g. A1-A5 are additional traps placed within Grid 0). (The position of additional traps should be checked by reference to subsequent reports, since more may be added in the future).

Over the summer period some traps were taken or pulled up (by recreational Island visitors), so not all traps could be used on each trapping period. Trap disturbance has been very low since late February, and hopefully the end of the summer holidays will be associated with a further decline in the abundance of children on the Island.

Evaluation of trapping techniques

A total of 60 *C.lancelini* have been captured and marked (57 were pit captures). Fourteen recently hatched *C.lancelini* have been trapped. For most of this period about eighty traps were in use. This result suggests the trapping design is functional for the study of the *C.lancelini* population as described in the first report.

Except for the problems of children being delighted to find little plastic buckets on their trips to the Island/beach, the traps have proved to be relatively easy to open, close and maintain. In some very exposed areas covers have needed a rock on top to ensure they don't blow off in strong winds, particularly when the traps are unattended for a week or so. The small size of the pits means that if the cover blows off while reptiles are in the pit it can get very hot very quickly, so covers must be windproof while traps are open.

The small pit size also means if there is more than one lizard in the pit they will be unable to avoid each other. I've observed one case of a *Morethia* with damage to a forelimb consistent with having been bitten by a much larger *C.fallens* in the same pit. There has been no evidence of larger lizards eating smaller ones in the pits, and no records of dead lizards in pits. There have been no birds found in pits.

Initially there was some doubt about the efficiency of the small pits to retain larger lizards. Observations of large *C.fallens* (the largest and most athletic species) suggest that the pits contain them well. Such animals can leap out of the uncovered pits when one puts one's hand in, but they seem only to do this successfully when covers are off and they're threatened. The pits work well for *C.lancelini* which, even when threatened, are not able get out of them. There have been no captures of the Island's gecko, which could probably escape the small pits, since there is a slight taper towards the pit's base.

The issue of the scale of the grids can not yet be evaluated with respect to it's appropriateness for population studies of *C.lancelini* due to the low recapture rates of adult *C.lancelini*. Initially this was probably due to the low rate of marked individuals in the population, but since mid-January capture rates for adults of all species have been lower than in late December-early January (see later for further details on activity). The placement of the additional pits within some grids will help evaluate the issue of the scale of grids.

Trapping results

Table 1 shows the captures recorded for each species on each grid. Only *C.fallens* was caught more frequently than *C.lancelini*. Of the total of 307 captures recorded: 65% were of *C.fallens*, 18% of *C.lancelini*, 13% of *Morethia*, and 4% of *E.bos*. Recapture rates were low for all groups except for *C.fallens* on some grids during later trips. Of the 201 *C.fallens* captures recorded there have been 151 first captures. One *C.lancelini* (an adult) has been captured twice. Hence, results presented here are based on capture rates. Capture rates refered to in the subsequent discussion are expressed as the number of captures (of the subject group) per trapday (one trapday (TD) corresponds with one trap being open for one day), and were derived for the relevant unit (trip/ grid or trap) by summing captures and dividing these by the appropriate number of trapdays.

The general distributional patterns apparent in the capture records suggests that the four reptile species each occur in all major habitat types (if not on all grids). Captures of *Cyclodomorphus branchialis* and *Egernia bos* were too few to provide useful clues as to relative abundance of these species in different areas. Only two *C.branchialis* have been caught in pits. The identity of the *Morethia* caught must be considered tentative: it seems likely that only *M.lineoocellata* has been caught, but some of my earlier identifications may have been questionable.

Several assumptions have been used in the discussion of trapping results which may prove to be unwise when more data is available to evaluate the assumptions. The primary assumption is that seasonal activity patterns are equivalent for all parts of the Island. It is possible that the between-grid variation, which is herein interpreted as geographic variation in habitat quality, may be contaminated by variation in seasonal activity patterns between different grids. For the purposes of this report, the assumption that capture rates are proportional to population density has been judiciously employed. It seems likely that capture rates reflect two aspects of variation: that associated with an area's population density, and that which is associated with the relative usage rate of the small area immediately adjacent to the pit. Generation of adequate recapture results should facilitate partitioning of these factors.

Ctenotus distribution and relative capture rates

There is substantial variation in the overall reptile capture rate (reptiles caught per TD) for different grids, and considerable variation in the relative capture rates for species on different grids (Figure 2). On all grids *C.fallens* capture rates exceed those for *C.lancelini*. There is a general trend of positive covariation in the relative capture rates of the two species. The relative capture rates of the two *Ctenotus* on Grid 110 differs from other grids by the combination of no *C.lancelini* captures and a relatively high *C.fallens* capture rate.

Ctenotus lancelini has been captured on nine grids representing all major habitat types. Two limestone grids (G60 & G110) had no *C.lancelini* capture records. The number of *C.lancelini* marked per grid ranged from 1 to 21, suggesting substantial variation in population density or relative usage rates between grids. Two grids had relatively high *C.lancelini* capture rates (G0, on the northern part of the white sand foredune, and G70, on the NE slope of the large southern limestone area).

On the four grids with relatively high *C.lancelini* capture rates (G0, G10, G20, G70) captures were not evenly distributed between pits (Figure 3). *C.lancelini* capture rates for T75 were the highest recorded for any trap. On Grid 0 there was an apparent trend for more northern pits to be associated with higher capture rates. A similar trend may be reflected in capture rates for Grids 0 and 10, since Grid 0 is north of Grid 10 (see Figure 1).

Temporal variation in *Ctenotus* capture rates

The capture rates for individuals per Trip are shown in Figure 4, and show a general decline in capture rates of *C.lancelini* and *Morethia* over subsequent trips.
Inspection of capture rates for recent hatchlings and adults shows more clearly the temporal patterns in activity over January to March (Figure 4b & c). For the purposes of this report any animal hatched prior to the summer of 1993-4 is considered adult.

Capture rates for adult *C.lancelini* and *C.fallens* were relatvely low after Trip 4, while *Morethia* capture rates were relatively constant. Capture rates for hatchling *C.fallens* increased steadily since Trip 4, and for hatchling *Morethia*, less dramatically after Trip 1. The first *C.lancelini* hatchling encountered was trapped on 20.1.94 (during Trip 2), and capture rates for these fluctuated between trips. The relative capture rates of adult *Ctenotus* suggest that both species tended to show similar seasonal patterns of variation in activity during mid to late summer.

The general seasonal trend described above for adult *C.lancelini* appears to override the importance of daytime temperature in determining activity, although on average, later trips were during warmer weather. There was a tendency for *C.lancelini* captures to be more frequent during the morning, but data is currently scarce. Only one adult *C.lancelini* was caught during the last two trips (6 & 7), and this was on a day which was overcast, humid, and cooler than all other days on these two trips (due to a degenerated cyclonic low). Capture records suggest, that in terms of temperature, 20-30 ° C provided suitable conditions for activity, though some activity was recorded above 30 ° C. Wind conditions also seemed to influence activity, and wind strength sometimes differed substantially between areas. Temperatures recorded at similar times on different grids indicated that the temperature may differ substantially between grids (most extreme example recorded was

44 88 12c

34° on one grid and 40° on another). Other environmental parameters may be influential in determining *C.lancelini* activity patterns. Casual observations suggest that, given temperatures are suitable, humidity and wind strength and direction may be important factors affecting activity.

Invertebrate activity (Figure 5) showed a pattern of temporal variation similar to that for captures of adult *Ctenotus* (Figure 4), with fewer pits containing invertebrates during later trips. There was a general trend for grids with higher capture rates for one or other *Ctenotus* species to have higher levels of invertebrate activity. Grid 0 was characterised by the highest capture rates for both *Ctenotus* species and for invertebrates.

Figure 5c shows the capture rates for individual pits on the four grids with higher *C.lancelini* capture rates. Grid 0 had the highest invertebrate activity. While there appeared to be a general trend for higher capture rates of *C.lancelini* and invertebrates to be positively associated, notable exceptions were Traps 8, 17 & 75. The position of Traps 17 & 75 are both such that they may have higher than average suitability as basking sites (good exposure to early morning sun). Trap 8 does not appear to have similar exposure, but is placed in the lowest part of a small hollow, and the area may be used as a 'track' or 'runway'.

Ctenotus lancelini

Population status of *C.lancelini*

No meaningful quantification of *C.lancelini* population numbers or density can be derived on the basis of the data in hand. The species' status is best evaluated with reference to several summary statements:

- 59 *C.lancelini* have been individually marked
- one marked adult has been caught twice
- the species has been caught on nine of the eleven grids being used throughout January and February
- 14 recent hatchlings have been caught on five different grids.

There is no robust numerical data which could be used to quantify the extent of decline of *C.lancelini* within the rocky areas.

Observations of *C.lancelini*

Only one *C.lancelini* was seen active during the course of the fieldwork. At least five of the trapped *C.lancelini* were seen to disappear into seabird burrows on release. One released individual disappeared into loose sand, the movement of which indicated the individual moved under about 5-7 mm of sand for about 20 cm before emerging into a patch of litter. An earlier report (Jones, Jan. 1994) highlighted the morphology of *C.lancelini* and hypothesised that the species' relatively short limbs may have been indicative of a lifestyle associated with foraging under 'things'. The above observations, and those of earlier workers who frequently found *C.lancelini* below rocks are consistent with the above hypothesis.

Some difficulty was encountered with the process of determining the gender of both *Ctenotus* species, especially during early trips. The recognition of gravid individuals was confident only for heavily gravid females. Problems associated with these issues have been exacerbated by the low recapture rates for *C.lancelini*, and the low capture rates on later trips. Further details about breeding in *C.lancelini* will need to await more trapping, and will only become clear after trapping throughout a whole spring-summer season.

Despite the paucity of data it is useful to inspect the plots of weight vs SVL for *C.lancelini* (Figure 6). The absence of any captures of animals with SVL between 40-60 mm suggests juveniles reach 60-70 mm SVL in their first year. The separation of males and females suggests that there is some sexual dimorphism in overall body size. The separation of males and females along the weight axis may be an artefact associated with higher body weights for females carrying eggs (caught during December and January). The curvilinear nature of the relationship between weight and SVL for females shows a tendency for an asymptotic SVL of 83-86 mm, but heavy females (>10g) were probably in later stages of egg production. All females with SVL of less than 80 mm had weights equivalent to males, and this might indicate that females do not breed at SVL < 80mm. It is thus a possibility that females do not breed until their second summer.

Habitat quality for *C.lancelini*

It may be premature to consider the trapping results in terms of habitat quality. Some general trends are apparent, though at this preliminary stage the suggestions made herein should be considered only as tentative hypotheses. Most of the observations of habitat mentioned below are based only on qualitative observations.

The four grids with most *C.lancelini* captures (Grids 0, 10, 20, 70) differ from all other grids in that they had an eastern to north-eastern aspect. Grids 0, 10 and 70 had a substantial rise behind the grid to the south-west. The southwestern traps on Grid 20 (T21-23) followed the line of small crest, and only pits on the north-eastern slope caught *C.lancelini* (Figure 5c). These grids were thus relatively well protected from southerly and westerly winds, and exposed to the early-morning sun. While Grids 0 & 10 were on the white sand foredune, grid 70 was on the north-eastern slope of the large southern patch of limestone. Grids 0 & 10 had contrasting vegetation, the most apparent aspect of difference was the abundance of vegetative matter. Grid 0 had the tallest shrubs on the Island (to 2m), and these grew in a small hollow between the beach and the large central dune. Several other grids had similar vegetative cover in terms of percentage cover, but Grid 0 was characterised by having more vegetation, and hence what appeared to be a larger amount of litter per unit area. Vegetation on Grid 0 was however, quite patchy, with small areas of open sand between patches of shrubs. Grid 0 had the highest invertebrate capture rate, and also the highest *C. fallens* capture rate.

The vegetation on Grid 70 was distinct from that on other limestone grids (30, 60, 90 & 110), and characterised by extensive thickets of low dense shrubs (to 40-50 cm) separated by narrow strips occupied by dead winter weeds and occasional small outcrops of limestone. Below the foliage of the thickets there was a substantial accumulation of litter. Surface rocks appeared to be rarer than on other limestone grids, but some were concealed within the thickets.

The distributional data for *C.lancelini*, taken together with the habitat observations suggests that *C.lancelini* can persist in most Island habitats, but that small areas exist which have the potential to support higher than average densities. Such small areas occurred within two of the three major habitat types. Quantitative analysis of trap results and indicators of *C.lancelini* abundance should help to unravel the relative importance of the above mentioned variables (topography, and the relative abundance of live vegetation, surface litter or cover, invertebrates, and *C.fallens*).

Discussion

The hypotheses for decline of *C.lancelini*

Prior to the commencement of this work *C.lancelini* was believed to be restricted to rocky Island habitats (Wilson and Knowles 1988). Anecdotal evidence indicated recent and significant decline of the species within this habitat type (Browne-Cooper and Maryan 1992). Subsequent workers could not successfully disprove either of these assertions (Rolfe 1993). On the basis of the above evidence it seemed possible that the risk of extinction of *C.lancelini* may have increased substantially in recent years, and further, that the possibility of extinction might have been unacceptably high. Consideration of possible reasons for decline led to the following hypotheses:

that increasing numbers of Silver Gulls were contributing to a decline in *C.lancelini* habitat quality by direct predation or indirect habitat disturbance;

that increasing winter weeds were responsible for lowering habitat quality for *C.lancelini*, especially in rocky areas;

that recent habitat changes in the rocky areas increasingly favoured *C.fallens*, tipping a competitive equilibrium to the disadvantage of *C.lancelini*.

These hypotheses are discussed below with reference to preliminary field observations.

47
85
117

Silver Gulls

Silver Gulls may impact on *C.lancelini* abundance by several means. Direct predation of lizards and disturbance to their habitat associated with intense use of nesting areas have been suggested as factors with the potential to limit *C.lancelini* abundance in rocky areas (implied by Burbidge 1993). Direct data for evaluating the importance of these factors would be difficult to obtain. However, if such factors are important in defining an area's habitat quality for *C.lancelini*, then presumably both are likely to be proportional to the relative rates of Silver Gull activity on different grids. The proposed habitat analyses require a meaningful numeric indicator of the relative usage rates of different areas for incorporation in analysis with other habitat variables. Field observations of relative levels of Gull activity and abundance are prerequisite for defining a numerically useful variable (Appendix 2).

Temporal variation in Silver Gull abundance may be associated with localised and intensive use of parts of the Island by nesting birds, or with the less intensive activities such as foraging or resting. Temporal patterns of variation associated with these two aspects contrast, foraging or resting patterns vary during the course of the day, while nesting activities result in intensive use for part of the year.

Observations of the small numbers of gulls seen feeding on the Island suggests that the Gulls 'natural' dietary component is composed of two main units: forage from the waterline and the mats of beached seagrass, and food associated with the Islands birds. Gulls were frequently observed in attendance near dense patches of nests or young birds (primarily Crested Terns and Fairy Terns). Fairy terns nested on the beach and sitting birds varied between 3-8 over nearly three weeks. No chicks were observed, and on one day I watched three successful attempts by the Gulls to take the eggs. Gulls also frequently stole food from adult Crested Terns attempting to feed their young. The information about the rarity of encountering *C.lancelini* active on the surface and observations of Gull activity during January and February predation of *C.lancelini* by Silver Gulls is likely to be relatively low during late summer.

During Trip 7 there were fewer Crested Terns on the eastern beach, and this facilitated observations of the Silver Gulls use of this area as a resting place during the late morning or afternoons. These observations are consistent with the suggestion that in late summer the impact of Silver gull's usage of the island on the *C.lancelini* population is likely to be low, especially when compared with the more intensive usage associated with nesting.

Sightings of isolated pairs of Gulls on the central dune during January and early February indicated that some nesting was occurring, but only in that habitat type. In late February and early March there were very few Silver Gull sightings in that area, but birds with sub-adult plumage accounted for about 10-40% of Silver Gulls seen on the eastern beach. Only one gull nest was recorded on any of the grids (since trapping commenced), but the eggs and adult disappeared about three weeks after the first sighting. Some grids have up to three identifiable old Silver Gull nests, suggesting usage of these areas may be intensive for several months of the year. The evaluation of the potential for Silver Gull activity to limit *C.lancelini* abundance is likely to be dependant on its coincidence with *C.lancelini* seasonal activity patterns. Quantification of the relative levels of Silver Gull activity based on nest characteristics (nest abundance, chick abundance) present the best opportunity to quantify the major aspect of Silver Gull activity which is likely to impact on *C.lancelini* populations.

A full season of data is required to be able to properly assess the impact of the activity or abundance of Silver Gulls on *C.lancelini* populations.

Weeds

The most extensive weeds are winter grasses which germinate in soil bearing most of the seabird droppings from the previous summer. These grasses occur in all of the Islands habitats, but are most abundant and extensive in the rocky areas. Within the areas with deep sand, weed growth is very patchy and usually associated with areas without woody shrub cover. In the areas with deeper sand the digging undertaken by burrowing seabirds may tend to limit weed abundance by burying patches of weeds.

The effects of the heavy weed infestation of the rocky areas appear to be complex. While there may a be direct response by *C.lancelini* to the reduction of basking sites associated with the period of maximum weed mass, there appears the potential for change in a suite of habitat characteristics.

Wind is a major feature of the Island's weather, and the limestone headlands front to the south-western winds. The winter weeds persist after their death and the fibrous root system firmly binds the soil throughout summer. The above ground stems and leaves provide an functional sand trap for particles blown in on the easterlies and north-easterlies of summer. The functional structure of the soil bound by the grass root mass is dramatically different to the loose surface sand common in the absence of such weeds. It is possible that this is a habitat characteristic of importance to *C.lancelini*, and to *E.bos* which, on Lancelin Island, digs its own burrows as well as using the seabird burrows.

In addition to soil changes, there seems to be the potential for the dense weed growth in rocky areas to dramatically change the vegetation, since small seedlings of the native plants may not survive if they germinate with dense patches weed seeds. The rapid growth rates of the annual weeds may well have changed seasonal patterns of soil nutrient availability which could be expected to influence patterns of flowering and fruiting of the original flora of these areas. If the rate of regeneration of the shrubby native species is substantially reduced the winter grasses may become the dominant feature of the Island's vegetation.

Evidence of the relative extent of weed cover in different areas is available throughout the year, since dead weeds persist throughout summer and autumn. There is substantial variation in weed height throughout the season, though this has been relatively constant to date. The extent (height and density) of weed cover will be recorded at two times: at its maximum, and when the *C.lancelini* activity is at a seasonal peak.

Ctenotus interactions

There was a trend in the pattern of *Ctenotus* captures on different grids suggesting that the two species tended to do well in the same areas and hence may have overlapping habitat requirements. Primary resources (food, shelter/exposure) which have the potential to limit *Ctenotus* abundance may be shared, hence the relative abundance of each species may be influenced by competitive effects. This suggests that further investigation of how the species might share or split resources may be crucial to determining the potential for improving habitat quality for *C.lancelini*.

Habitat manipulations

Earlier proposals referred to three habitat treatments aimed at improving habitat quality for *C.lancelini*: poisoning weeds in rocky areas (Rolfe 1993), poisoning Silver Gulls (Burbidge, 1993), and adding artificial cover in rocky areas (Jones 1994). All these proposals were considered at a time when the species was believed to be restricted to the rocky habitats.

Effective control of both weeds and Silver Gulls are logistically difficult and are likely to require ongoing funding for years. Further, killing of weeds in rocky areas may lead to a short-term decrease habitat quality for *C.lancelini* (due to the reduction of surface cover) which may not be overcome until native vegetation regenerates. The impact of spraying on lizards is apparently unknown (Peter Nilson, 'Crop Care Australasia', personal communication), as are possible effects on the invertebrate fauna. While it seems most likely that it is only coincidence, it must be noted that the only two grids with no *C.lancelini* captures were the only two grids which covered areas sprayed with dilute 'Fusilade' in 1993 (Rolfe, 1993). Poisoning of Gulls on the Island may lead to mortality for the Banded Rail, which seems on the Island, to eat a wide range of food including plant and invertebrate material (my observations of foraging activity and of characteristic egested pellets).

To date, there is no information to suggest that any of the proposed treatments would be likely to lead to the type of increase in *C.lancelini* population size which would significantly decrease the probability of the species extinction.

Further study

The extreme temporal variation apparent in the trapping results supports the necessity for a full year of trapping results. An understanding of annual patterns of activity and breeding is a prerequisite to reliable interpretation of estimates of population numbers. The extent of the temporal variation in activity, and observations of substantial geographic variation in microclimate prompts recognition of the possibility that *C.lancelini* activity patterns may not be synchronous on all grids. If this proves to be the case, then some between site variation referred to earlier may actually be due to climatic differences between grids. A full year of data will help clarify these issues by permitting identification of peak activity for each grid or habitat type. Information about breeding in females is fragmentary (since trapping seems to have started when there were a few heavily gravid females) and would be dramatically improved by trapping results for spring and early summer.

The general patterns starting to become apparent regarding important habitat parameters for *C.lancelini* suggests that further development of an understanding of factors associated with higher densities is likely to be productive. Given the contrasts between capture results for this study and previous attempts to locate *C.lancelini* individuals, it may well be that this animal may be more widespread than previously thought. The information available to date on habitats, seasonal activity patterns and trap design may well facilitate the success of surveys in other areas. The study of habitat factors associated with areas with higher densities may also lead to an understanding of the significance of the different aspects of habitat change associated with weed invasion.

Study of the diet of *C.lancelini* proposed in the original proposal has been amended. No *C.lancelini* faecal pellets have been found in traps, and only one *C.fallens* pellet has been found. Holding animals to collect pellets during the hottest months was considered unwise. Taking stomach contents from gravid females may influence the resources available for egg-production. Hatchling *C.lancelini* are too small for gut-flushing. The best option for the collection of a useful sample for dietary information is systematic retention of animals caught following a period of low seasonal activity, and during the cooler months. Such conditions are expected during spring or early summer. Selected individuals will be placed in calico bags and returned to the pit for up to 24 hours before being weighed and released. Collected pellets will be inspected over summer 1994-5.

Further consideration has been given to the proposal to undertake systematic rock-turning in rocky areas. The results of such an exercise are limited by a number of factors. Primarily, the paucity of surface rocks limits the likelihood of generating numerically robust data. A major source of variation in rock situation is associated with vegetation and rocks occur in three main vegetation types: among weeds, among low dense thickets of shrubby vegetation, and among low open shrubs. While trapping results are scant, I have come to suspect that the shrubby thickets may prove to be an important habitat feature for *C.lancelini*. Rock turning within these thickets would lead to a potentially damaging level of trampling and disturbance of vegetation, and dense adjacent cover is likely to impede confident identification or capture of reptiles sighted. For these reasons rock-turning results are unlikely to be of significant value to the population studies on Lancelin Island. The value of rock-turning as a quantitative survey technique is compromised by the same set of problems.

Management recommendations

The results in hand suggest that there is a rather low probability of extinction of *C.lancelini* on Lancelin Island during the next few seasons. An extensive fire or the introduction of a feral animal appear to be the only factors with the potential to cause dramatic and rapid decline. The CALM's original project outline (Burbidge 1993) recommended three strategies: field study of the population, the development of captive breeding techniques, and habitat treatments aimed at lowering numbers of Silver Gulls and the abundance of weeds aimed at maintaining or increasing the Island's *C.lancelini* population. The field studies are well underway and preparations have been made to initiate captive breeding in *C.labillardieri* (presumed to be a sister group to *C.lancelini*).

Since *C.lancelini* seems not to be in immediate danger of extinction, and with consideration of the possible implications of poisoning on the Island, it seems most prudent to delay such treatments. By next autumn the field study should be nearing completion and results will permit a more informed assessment of the probable value of such treatments. Continuation of work on Lancelin Island, and on studies of *C.labillardieri* is vital to the overall aim of efficiently ensuring the secure persistence of *C.lancelini*.

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Appendix 1 Capture records for *Ctenotus lancelini*

DATE	TRAP	NO	WT	SVL	TL	TO	HLL	HL	HW	GEN	TAIL	U	SC	REMARKS
25.2.94	A1	L										U		
15.12.93	H	L01		83			22	12.5		3	18/23			RPIII sh, IV no claw
16.12.93	H	L02		80			27	12.2		5	52			
16.12.93	3	L03		83			28	13.0		3	22/105			RFL no FA
22.12.93	27	L04	10.2	75			29	13.3		4	60/123			
22.12.93	39	L05	7.8	67	154		25	12.7		4				
22.12.93	29	L06	7.8	70	133		28	12.7		4				
23.12.93	8	L07		73	111		26	12.0		3				
23.12.93	26	L08	7.4	83			28	13.0		3	18/85			
23.12.93	36	L09	12.2	85			29	13.5		3	95/144			no RPII, LPI sh., RMIV dam.
20.1.94	6	L10	8.5	75	157		26	12	6.9	4				
23.12.93	6	L12	8.5	80	130		26	13.0		3				
23.12.93	8	L13	6.0	70	125		25	11.5		3				
17.1.94	4	L14	7.5	77			25	12.0	7.0	3	38/115			
3.1.94	27	L19	7.7	68			27	12.7		5	90/129			most tips missing LM
17.1.94	17	L20	9.2	74			25	12.0	7.3	2	104/133			
20.1.94	4	L21	5.8	76				12.3	6.7	4	18/88/91			RPIV sh., no V
18.1.94	75	L30	10.6	82			24	14.2	7.5	3	61/120			
23.12.93	11	L31	7.7	75			29	13.3		5	33/114			hd with dark spots
18.1.94	8	L32	6.8	73			28	13.2	7.2	4	35/102			tail regen kinky
18.1.94	75	L33	8.6	84			27	13.2	7.3	3	20/109			no RM
18.1.94	102	L37	8.8	72	152		26	12.5	7.0	4				
18.1.94	72	L39	6.6	68			26	12.3	7.4	4	31/91/105			
18.1.94	75	L40	11.7	81	161		25	13.4	7.5	3				
20.1.94	7	L41	9.4	83			26	13.5	7.6	3	59/120			
29.1.94	8	L42	0.6	34	60	2.7	15	7.3	3.8			U		
20.1.94	7	L43	0.9	34	61		15	7.0	4.2			U		
30.1.94	75	L44	13.2	86		8.0	28	13.8	8.0	3	32/111			
29.1.94	5	L47	0.8	33		3.0	14	7.0	4.0		93	U		
18.1.94	17	L48	8.4	77	128		29	12.6	7.0	3				
18.1.94	42	L49	12.6	85	164		28	13.5	7.3	1				
29.1.94	11	L50	8.7	78		7.3	27	13.0	7.5	3	103/106			RFA paralysed, t tip growing
14.2.94	7	L50	0.6	29	47	2.6	13	7.3	4.1					
20.1.94	8	L51	9.6	79	147		27	12.7	7.0	3				hd with dark spots
30.1.94	45	L52	6.7	68	136	6.4	25	11.8	6.2	3				
31.1.94	8	L53	0.9	33	59							U		
31.1.94	4	L54	0.8	35	66							U		
5.2.94	47	L57	9.7	72	156	7.5	27	13.0	7.5	4				
5.2.94	27	L58	7.5	67		6.4	27	12.0	6.8	3	74/139			
5.2.94	2	L59	8.2	73		7.2	25	12.3	7.2	3	75/133			
15.2.94	75	L60	0.7	32	56	2.7	14	6.8	3.9					
18.1.94	5	L61	9.6	85			28	13.5	7.4	4	42/109			LPIV sh., RPIII sh.
25.2.94	A2	L61	9.2	87		7.4	27	13.5	7.8		46/110			
4.2.94	17	L62	8.5	74		8.0	29	13.4	7.6	4	57/130			
4.2.94	8	L63	7.9	77		7.5	26	12.7	7.2	3	84/138			
4.2.94	75	L64	9.6	82		7.0	27	13.2	7.4	3	42/61/120			no LP
5.2.94	1	L67	7.1	74		6.3	25	12.0	6.5	1	78/133			
6.2.94	2	L68	9.9	80		7.6	28	13.0	7.7	3	25/87			
14.2.94	58	L69	0.5	34	65	2.5	15	7.2	4.0					
15.2.94	75	L70	0.5	30	56	2.6								45 mm tail in etoh
25.2.94	71	L70.80	0.6	32	59	2.4	13	7.1	4.2			U		
16.2.94	54	L71	10.1	73	109	8.3	28	13.4	7.7	4	19/109			
26.2.94	25	L75		34		2.8	16	7.4	4.2		13	U		
16.2.94	75	L80	0.6	33	60	3.2	15	7.0	4.2					
18.1.94	7	L81	9.7	82			26	12.5	7.0	3	17/44			LPIV sh.
9.11.94	126	L83	0.8	33	63	3.0	14	7.3	4.0			U		
27.2.94	75	L90	0.5	33	55	2.5	14	7.1	4.0					scar on RHS
20.1.94	94	L91	8.0	74				13.1	7.4	4	18/50/81			LPIII & IV sh.
20.1.94	72	L92	13.9	85	168			13.2	7.1	3				

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Appendix 2: Field notes on Silver Gulls

The notes provided are rough field notes: they were collected to help the process of derivation of reliable quantitative indicators of relative rates of usage of different areas by Silver Gulls. See main text for description of the selected variables. During the first two months of work we (BJ & CALM) believed an Honours student would undertake a more detailed study of Silver Gulls in the Lancelin area, but the student pulled out in early February.

Early day-trips: 8.12.93 8 of 12 gulls on southern beach showed some subadult (sa) plumage (1100 hrs); 1 nesting adult on area nr G110 (eggs not found); 1 adult sighted on G60 (1100). 3.12.93 2 nests with eggs in area of G60-90; 20-40 constantly overhead while in area of G60-90: seem to be coming mostly from southern slopes, where they are evenly spaced (10-20m) between birds or pairs.

Trip 1 Activity on southern slopes and area G60-90 similar to 3.12.93. Counts on eastern beach not possible due to abundance and activity of Crested Terns. 23.12.93 2-4 gulls in constant surveillance of nesting Fairy Terns (10-20 birds). They apparently worked together, one attacking and another sneaking in to steal egg. 2 successful attempts witnessed.

Trip 2 Eastern beach and southern slopes same as last trip. 18-20.1.94 1 subadult on beach in little cove: saw an adult delivering food sporadically, most frequently during late afternoon. The adult spent most of one morning attending/defending/eating a large dead cuttlefish.

Trip 3 29.1.94 nesting adult with 2 eggs nr T119.

Trip 4 About 10-20 regularly seen feeding amongst northern patches of beached seagrass, along with 4-6 Banded Rails. 4.2.94 nest nr T119 same as last trip.

Trip 5 Seems to be generally fewer gulls about vegetated parts of island. Still using northern seagrass patch. 15.2.94 nest nr T119 abandoned; 100-150 gulls on eastern beach (1300) (only a few Crested Tern runners left).

Trip 6 The gulls previously seen regularly on the southern slopes seem to have gone. 25.2.94 1 adult sighted nr G0, 2 nr G110, 1 nr G60 none on other grids (800-1100); 6 of the 25 gulls on eastern beach have some sa plumage (1300)

Trip 7 Nesting activity seems to be at a minimum: no eggs, chicks or nesting behaviour. Air defence elicited by me presumed to be associated with birds pair bonding or establishing nest areas. No more than 3 individuals seen on southern slopes at any one time. 9.3.94 4 gulls doing 'air defence' (AD) on G130, 1 doing AD on G20, 7 adults (3 pr +1) on G30, and no gulls on others (900-1200); 2 groups on eastern beach, 40 + 50 = 90, about 10% have sa plumage (0930); from G130, 1 gull on ground nr G60-90 (0950); 18 adults (all red) on G30 (1615). 10.3.94 4 adults on G30 (1310); 2 pr AD on G50 (1600); none on G30 (1810).

Appendix 3 The original research proposal for field study of *C. lancelini*

Barbara Jones,

October,1993

RESEARCH PROPOSAL: Field study of *Ctenotus lancelini* on Lancelin Island.

Background

The initial CALM brief specifies the following objectives for a two year project:

1. Develop suitable trapping techniques and conduct population estimates;
2. document the species (a) habitat requirements, (b) breeding biology and (c) natural history;
3. investigate the effects of (a) weed invasion, (b) increased gull numbers and (c) recreational use of the island on the skink's habitat and conservation status;
4. establish the reasons for the species decline in abundance;
5. assist with captive breeding and/or translocation;
6. recommend appropriate management of the skink population and the island.

Field studies of the population and its habitat can predictably provide responses to the first three aims of the CALM brief. However, it may not be possible to confidently establish the reasons for the apparent decline (#4). On the basis of the following project outline one would be able to generate informed hypotheses regarding factors associated with decline, but the testing of such may be beyond the scope of a two-season project. Monitoring of the effects of treatments outlined in the Interim Management Guidelines (Burbidge: 17/6/93) should permit evaluation of the two hypotheses referred to in the Guidelines. A third hypothesis to be tested relates to the possibility that the previously stable equilibrium resulting from competitive interactions between the island's reptiles has altered due to environmental change, and that *C. lancelini* has been 'disadvantaged' relative to one or several other species (this idea compliments of Ric How, John Dell and Dave Knowles). Should subsequent funding be made available, further experiments (e.g. restriction of public access to some areas, revegetation) may be warranted.

Previous assessments of the abundance of the species indicate recent decline (Burbidge: 17/6/93). However, given the apparently tight climatic and ecological constraints imposed on activity levels of *Ctenotus* (pers. comm. J. Dell), and the lack of systematic surveys, it is possible that the available picture of apparent decline may be deceptive. Given this uncertainty, and the range of possible hypotheses for the decline, the first part of this proposal is concerned with an intensive survey of the island's reptile fauna. This is crucial to determination of the current status of *C. lancelini*. Further, information about the relative abundance of reptile species in different habitat types is likely to be vital to the process of determining optimum habitat parameters for *C. lancelini*. Determination of the critical habitat parameters and their optimum ranges is the subject of the second year's study, and the outline given for 1994-5 assumes that the 1993-4 results will show that a substantial population of *C. lancelini* persists.

Project outline

This proposal outlines procedures for work over 2 seasons: 1993-4, 1994-5. In summary, the 1993-4 season is to be devoted to relatively intensive trapping on the island in order to: calculate estimates of the size of the *C. lancelini* population; collect basic information about individuals (size, weight) and the population (activity patterns, timing of appearance of hatchlings, and possibly gravid females); determine the relative abundance of reptile species in different habitat types. Should classical pit-trapping methods appear to be unrewarding additional trials will be carried out using baiting (tinned dog food and fresh water) and hand capture.

It is proposed that 5-6 trapping periods of 4-5 days be undertaken prior to February, 1994, and a preliminary write up of data be made available to CALM prior to the presumed decline of activity in autumn. Subsequent trapping would continue on the basis of 1-2 trap periods per month until May (dependant on activity patterns). Opportunistic observations of the species' natural history and the activity levels of visitors and potentially predatory birds would be recorded. Results of the seasons work would facilitate initial evaluation of hypotheses regarding decline, and may prompt more hypotheses. A complete report on the summers work (to be written up during winter, available August) would form a basis for re-evaluating priorities for the 1994-5 season.

By using population estimates based on relative rates of capture of marked and unmarked individuals (rather than on captures per unit effort) design of pits and fences can be altered sufficiently to ensure all substrate/habitat types are sampled. Should some areas be untrapable, different capture and census techniques can be attempted, and resultant numbers usefully compared to estimates based on trap results.

In 1994-5 further trapping would be targeted at *C. lancelini* and be carried out on a regular basis to: improve the sample sizes from the previous season for biological parameters; to generate a numeric indicator of habitat quality for *C. lancelini* (derived from population parameters such as body condition, relative abundance, growth rates); and to yield additional data on home range size and survivorship. A quantitative study of habitat variation and habitat quality for *C. lancelini* would be undertaken. Detailed numeric description of habitat variation (vegetation, substrate, dietary component or invertebrate abundance) would be supplemented with the information about relative abundance and condition of other reptile species to determine the relative importance of different habitat variables, and optimum conditions associated with high-quality habitat. Results of 1993-4 trapping would be vital to the process of selection of habitat plots for such analysis.

Should the 1993-4 results indicate the species is extinct, or the islands population is very small, the 1994-5 habitat study would yield little useful data. Trapping to monitor a small population could continue. Apparent extinction would suggest intensive work on the island is of little practical value, save for trapping during a second season to ensure the conclusion was not incorrect.

Methods and data collection

Summer 1993-4: Use pit-fence style trapping and capture-mark-release-recapture techniques to sample reptile populations in all areas and habitat-types, with special reference to the following subunits: on/near the gull colony, and in areas with differing levels of disturbance associated with weed abundance and with recreational use. Habitat types which can not be effectively trapped with lines or grids subject to search and capture. Initially use 100 pits and *ca* 5 m fence per pit (may need to add a second lot of 50-100 traps depending on initial results). All animals captured to be permanently marked with a single marker (toe-clip). *C. lancelini* to be marked with individual toe-clips. Weights and SVL to be recorded for all captures. Additional measurements for *C. lancelini* (head width and length, tail length and basal diameter). Tails lost in handling to liquid nitrogen. Traps cleared 3-4 times daily (but may vary in response to observations of activity and temperature) and temperature recorded for each clearance. Trapping schedule to approximate 4-5 days trapping twice each month (November-January), and subsequently 1-2 trap periods/month until winter (with some flexibility to avoid or intersect with particular weather patterns). Faecal pellets collected if available. Gut-flushing trialled on *C. fallens*, and if judged acceptable judiciously used on

selected *C. lancelini*. Map and describe island habitat types (subjectively determined) and trap positions and details. Make opportunistic observations of behaviour and daily activity patterns. Undertake limited excavation to collect information about rest sites. Make regular records of observations of levels of activity of potential predatory species and signs of visitor activity. Record abundances of invertebrates in pits.
Winter 1994: Analyse biological data to derive an indicator of *C. lancelini* habitat quality based on measures of body condition, relative abundance and rates of growth for different trap areas and, if available, survivorship. Undertake at least one late winter/early spring trip to attempt to locate winter rest-sites. Microscopic inspection of poop samples. If indicated, design census techniques for abundance of invertebrate prey species (to start before summer activity and to continue throughout the season) in order to include this variation in subsequent habitat analysis.
Summer 1994-5: Undertake trapping specifically to capture *C. lancelini* in order to collect further information about biological parameters and to calculate a numerically robust indicator of *C. lancelini* habitat quality in different habitat types. Trapping schedule to be determined with reference 1993-4 results. Quantify the major aspects of habitat variation [including vegetation and substrate type, the degree of disturbance (visitors, weeds, seabirds), relative abundance of potential competitive and predatory species, and the relative abundance of food and shelter in major habitat units] in a form suitable for multivariate analysis. Analyse to investigate patterns of covariation between such parameters and the indicator of *C. lancelini* habitat quality.
Autumn-Winter 1995: Analysis of data and final write-up.

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Appendix 4

FIRST REPORT: Field study of *Ctenotus lancelini*

Barbara Jones December 1993

Contents:

Introduction

An apparent decline in abundance of *Ctenotus lancelini* was reported by Browne-Cooper and Maryan (1992) and work by CALM (Rolfe 1993) seemed to confirm Browne-Cooper and Maryan's observations. As a consequence CALM established Interim Management Guidelines for the species and its habitat, and secured funding for research of the species biology. The initial CALM brief for the research specifies the following objectives for a 20 month project:

1. Develop suitable trapping techniques and conduct population estimates;
2. document the species habitat requirements, breeding biology and natural history;
3. investigate the effects of weed invasion, increased gull numbers and recreational use of the island on the skink's habitat and conservation status;
4. establish the reasons for the species decline in abundance;
5. assist with captive breeding and/or translocation;
6. recommend appropriate management of the skink population and the island.

An earlier proposal suggested the 1993-4 season should be devoted to intensive capture-mark-release (CMR) studies of all reptile species in all habitat types, and indicated that the second season (1994-5) should be devoted to CMR and habitat studies aimed at identifying habitat parameters associated with the gradient of habitat quality for *C.lancelini*. A copy of notes presented at the first Recovery Team meeting held at Woodvale on December 11 is also included (Appendix 2).

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On the basis of these two proposals, the major systematic component of research for the period November 1993-June 1994 is the design and implementation of an adequate trapping programme.

This report outlines the proposed trapping programme which will support both the population studies and later, the analysis of habitat parameters. Also included in this report are outlines relating to the handling and storage of raw data, and the content of the two subsequent reports.

Several aspects of the field study are essentially adjuncts to the trapping programme, including the collection of information about seasonal variation in the two aspects of habitat parameters implicated in decline (weeds and Silver Gulls), dietary studies using faecal pellet and/or gut-content analysis, systematic rock-turning to collect data on shelter sites, and the application of habitat treatments aimed at improving habitat quality. Of these, only the scoring of Silver Gull and weed characteristics can be initiated without any consideration of their impact on the *C.lancelini* population. Data reflecting these two habitat variables is to be associated with grids or lines of traps, and to be collected each month during 1994. The early results of trapping are essential to more critically evaluate the feasibility, productivity and potential disturbance associated with diet analysis, rock-turning and habitat treatments.

The information available about the species biology is scant, being based on the field observations of about 8-10 herpetologists who visited the Island since 1961, when Julian Ford collected the first five specimens. The main body characteristic which helped Ford (1969) to distinguish the taxa from its closest relative (*C.labillardieri*) was *C.lancelini*'s relatively short hindlimb. The ecological implications of variation in relative limb length amongst 7 desert *Ctenotus* species were discussed by Pianka (1969) who identified the trend for long-limbed species to forage primarily in the open, and for short-limbed species to forage under cover. *Ctenotus lancelini* has hindlimbs shorter than any of the species from Pianka's study area. This, when coupled with the usual collection site of 'under limestone', and the paucity of sightings of active animals on the surface suggests the species may be specialised for foraging under things.

Fieldwork

The immediate aims of the fieldwork over the next six months are:

1.the generation of adequate capture-mark-recapture (CMR) results to permit useful population estimates for *C.lancelini*;

2.the determination of the distribution (occurrence or relative abundance) of *C.lancelini* with respect to the Island habitat-types;

These aims can be satisfied within the process of generating data for seasonally variable factors for all months in 1994. This will permit the evaluation of seasonal trends associated with lizards, and with the seasonally variable habitat parameters which are of major interest (weeds and Silver Gulls).

The design of the trapping programme was considered with respect to the species biology, the above aims, and with consideration of the numeric requirements of the subsequent habitat analysis. Constraints imposed by the Island habitat types were also considered (see Appendix 2 for more details). A major concern was the extent of damage or disturbance to the habitat which is associated with different designs.

Traps

The pits selected are small by current standards: 'one-gallon Liver Pails' which are square, 190 mm deep and 180 mm wide. These were selected because soil depth in the known *C.lancelini* habitat is rarely over 20 cm, and often much less. Two grids in deeper sand have mixtures of these small pits and larger 10 l buckets. Comparison of SVL's of reptiles captured on these grids should indicate if large lizards might escape from the small pits. The use of larger pits in all sandy areas was avoided because the process of digging them in would have caused more extensive damage to the habitat in the immediate vicinity of the pits.

Pits are all covered using squares of plywood 30 x 30 cm, with wire pegs. Covers are needed to keep seabirds out of the pits, and also to protect captured lizards from high temperatures (particularly important for such small pits). Larger covers than those used by Rolfe (1993) were chosen using the assumption that pits are more likely to be encountered by *C.lancelini* if they were placed 'under things'. Covers generally to be placed closer to the pits than those used by Rolfe (1993) (this study 2-4 cm cf 5 cm), and are to be placed off-centre to avoid consistent bias. Provided covers are not subject to vandalism, they are to left in situ over closed pits and hopefully lizards will learn to use them, then be surprised by the absence of ground when the pit is opened.

Fence maintenance was considered to be a particular problem, primarily due to the density of seabird burrows, and the high traffic associated with birds accessing these and surface nests. Secondarily, the captured animals may have been forced along fences from different microhabitats to that in which the trap was placed. Other workers results (Friend *et al.* 1989, J.Dell, unpublished data) suggested unfenced pits tended to catch about half of the animals caught using a single pit with a short (ca. 7 m) fence. Hence, the use of fences was considered to be difficult, time consuming and possibly responsible for the distortion of data. If capture rates seem too low, trials of fences and baiting of pits to be conducted.

Trap array

No single trap array could answer all requirements for survey of different habitat-types, and the generation of adequate data for population studies and habitat analysis. The trapping programme selected has three components which differ in terms of spatial array:

1. grids of 9 traps at 10m intervals;
2. lines of 3 traps at 10m intervals
3. single traps

Eleven grids to be used in the 3 most extensive habitat types (after Keighery and Alford, in prep) (which account for a total of ca 95% of the Island's area): these form the basic units for population studies. Six lines of three traps are to be used to determine relative abundance/occurrence in smaller habitat units, and to assess the range of variation in reptile abundances within the major habitat types. Should preliminary results for these indicate high density of *C.lancelini*, lines can be extended to grids. Single traps will be used to determine which species occur on the rocky slopes. Single traps may also be used 'at whim' to increase the number of marked individuals in the rocky habitats, where many of the grid traps are distant from surface rocks and shrubby cover.

Figure 1 shows the approximate position of traps in the 10 grids established to date. One more grid is to be established on the northern rocky peninsula when the chicks of the Crested terns which are currently nesting there can fly (hopefully by mid-January).

Each trap, regardless of the spatial array of its neighbours, will have a set of habitat scores (to be collected after June 1994) associated with its capture data (for reptiles and for invertebrates). Habitat parameters will be scored for 5 small quadrats (at the four corners of square of 5m sides, and a central one around the pit). For a total of about 130 pits this should provide a robust matrix. Alternatively pits can be grouped on the larger subunit of three adjacent pits (to yield about 40 data units), or associated with whole grids. After assessment of the extent of seasonal variation in weed and Silver Gull data, a seasonally appropriate value can be associated with grids.

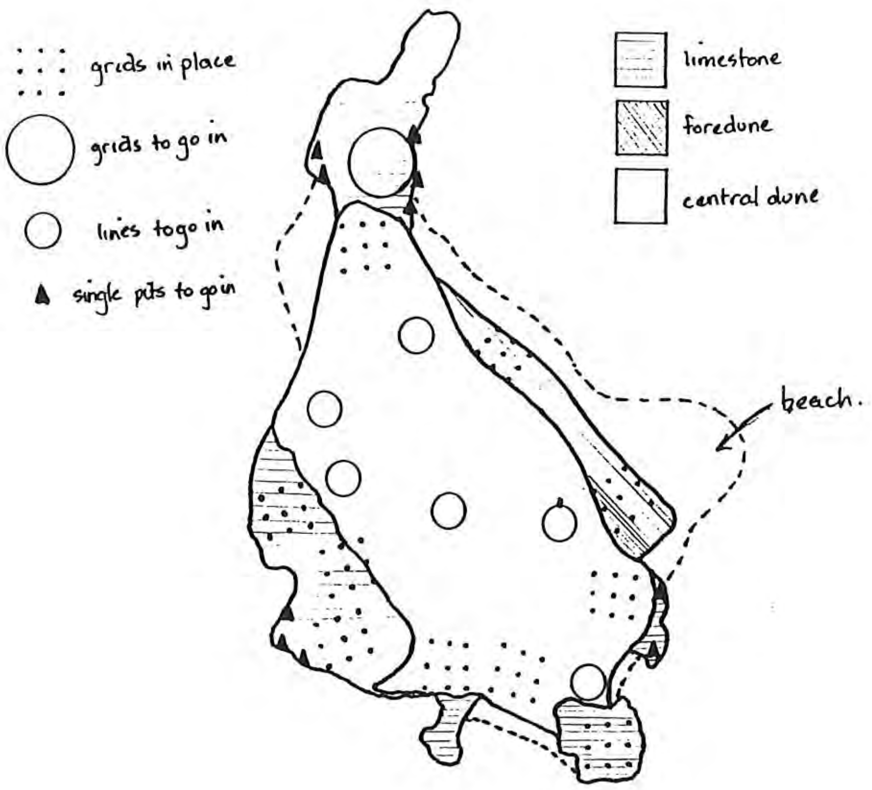

Figure 1. Map of Lancelin Island showing the main habitat types, and the approximate position of the 10 major grids in use and the proposed position of the additional grid, and the lines of 3 traps and single pits.

Field schedule

Fieldwork in late November and December has been associated with preliminary evaluation of the Island's habitat-types and design and establishment of the trapping programme for the main grids. Highlights of results for this period are given in Preliminary Results, and these suggest that it will be possible to generate numerically robust data sets for the *C.lancelini* population. The preliminary capture rates are, for the purposes of planning work, assumed to be representative of the seasonal peak of activity.

A field schedule for trapping is shown in Table 1. Timing of individual trips will be variable, and primarily be determined by weather patterns. Trapping results to be maximised by aiming mostly for 'good' lizard weather, and safe travel between the Island and mainland. The minimum requirement for trapping days is associated with the generation of data for the major grids. The maximum indicates the limit of extra days available for other trapping or field activities, or for extra trapping on all main grids to compensate for poor weather earlier in the month or trip.

The time taken to clear all traps (ca 130) means each trap will only be able to be cleared 2-3 times per day. The diverse requirements of the field research are best accommodated by a two-tiered trapping schedule. The major set of trapping data will result from a minimum of 7 trapping-days per calender month (≥1000 trap-days (TD) / month) for summer, autumn and spring . During winter, weather conditions will be more restrictive (in terms of reptile activity, and of getting to and fro), so for this period (mid May-August) the minimum requirement is for 2-4 trapping-days (ca 500 TD/month) per month, depending on whether there is any reptile activity. The resultant data will form the basis of the *C.lancelini* population studies (including population size estimates) and the habitat quality matrix.

A secondary trapping schedule is to be conducted using fewer open grids (those with higher *C.lancelini* capture rates) to facilitate more frequent clearing to determine daily activity patterns. Should the gut-flushing procedures be judged safe and productive (in terms of data), this activity will also need to be undertaken using a smaller subset of open grids to allow time for additional handling.

Table 1.

Month	Dates	Trapping Days		Field or Field-backup Days	
		max	min	max	min
Jan	.14-21	6	4	10	7
	.26-31	6	4	10	7
Feb	.3-10	6	4	10	7
	.16-23	6	4	10	7
Mar	.1-8	6	4	10	7
	.23-30	6	4	10	7
Apr	.4-11	6	4	10	7
	.18-25	6	4	10	7
May	.6-13	6	4	10	7
	.23-27	4	4	6	6
June	.6-10	3	3	5	5
	.20-24	3	3	5	5
	Sums	64	46	106	79

Table 1. The proposed dates and duration of field-trips aimed at collecting trap results. Due to the unpredictability of the weather these dates must be considered tentative. For each month, the minimum and maximum number of days associated with trapping are given. The field or field-backup days includes the trapping days, and days associated with travel, opening and closing pits, data entry and ancilliary field data. Generally the minimum requirement is 7 trapping-days per month for January-May. Extra days are available each month to compensate for poor weather on early trips, and to conduct more intensive trapping associated with determining daily activity patterns.

Documentation

Raw data

The following procedure to be followed for field data. Initial recording into field notebooks. Within a few days, to be transcribed to one of two databooks: Lancelin Island trapping, and LI habitat. Subsequently to be entered on Barb's Mac. The two main data books will be the primary repository for all data which is suitable for analysis. At monthly intervals photocopies of recent additions to the main data books to be lodged with David Pearson for safe keeping. Corrected printouts will be provided with reports, but the original photocopies should remain with David.

Preliminary Results

Ten grids have been established and trap results are available for these grids for 21-22 December 1993 (two days). Daytime temperatures for these days were measured at a single, shaded location on the island and ranged between 20-24° C. For the 88 traps open (2 short on one rocky grid) on two days there were 32 reptile captures, of which 9 were *C.lancelini* (all 9 were first captures). Additional pit captures referred to below resulted from captures on two grids on a single day (16-12-93). The results for 21-22 December were considered in estimating an appropriate sampling effort, and hence the amount of field-time required.

To date a total of 12 *C.lancelini* have been captured and measured. Animals have been trapped on grids in the known *C.lancelini* habitat (2 individuals), the central dune habitat type (4) and the foredune area (4). Three *C.lancelini* have been hand caught: 2 from under rocks, and one active on the surface in the central dune habitat-type. Preliminary trap results suggest high variability in lizard abundance with six grids with low abundance (0-1.5 captures/day) and three grids with 3-6 captures/day). Most *C.lancelini* were trapped on the two grids with the highest capture rates (4 *C.lancelini* from a grid with a lizard capture rate of 6/day, and 4 from a grid with 5/day). The two grids with high capture rates are dissimilar, with *C.fallens* abundant on one and rare on the other. The most frequently caught species is *C.fallens* (16 trapped cf 10 *C.lancelini*).

Generally, *C.lancelini* handled have looked to be in good condition (fat and shiny), but almost all animals (85%) have shown sign of past encounters with 'attack' with many having scars and tails, feet or toes missing (large scars implicate birds). SVL measurements have commonly been over 80mm, which contrasts with Julian Ford's measured sample from 1961 (five adults, all ≤ 78 mm).

All *C.lancelini* captured (up to December 30,1993) have been judged to be adult and, during early December, 2 animals (hand-caught) were judged to be gravid. Both appeared to have two eggs. Trapping on Dec 21-22 yielded no gravid animals.

Some successful rock-turning has been undertaken in the two southern patches of limestone during late November-December: on 16-11-93 Jim Rolfe turned 6-8 rocks, and no *C.lancelini* were seen; on 26-11-93, I turned 6 rocks and caught 1 *C.lancelini*, on 3-12-93 I turned 5 rocks for 1 *C.lancelini* sighting, and on 16-12-93 Magnus Petersen (with me as a voluntary) turned 6 rocks and caught 1 *C.lancelini*. This subset of ca 25 rock-turns yielded 3 *C.lancelini*, and the only other reptile found was one *Cyclodomorphus branchialis*.

Discussion

The preliminary results indicate that the habitat available for *C.lancelini* is not restricted to rocky areas (80% of *C.lancelini* caught came from grids on sandy soils without surface limestone), and that the rate of captures is sufficient to support viable population studies. The variation in capture rates of *C.lancelini*, and of reptiles overall, indicates substantial variation in reptile habitat quality both within and between the major habitat types. This situation is suited well to the proposed analysis of habitat parameters which will permit identification of those associated with high habitat quality for *C.lancelini*.

The preliminary rate of captures also indicates the viability of the chosen trap design and spatial array for capturing Island reptiles. Reptile capture rates for the two CALM trips (Rolfe 1993) were 3 captures (November) for 160 TD, 2 captures (March) for 160 TD, and overall each reptile capture required 64 TD. This study's preliminary results yielded one reptile capture for 5.5 TD. The selected trap design and array also appears to be suited to capture of *C.lancelini*. CALM trapping results (Rolfe 1993) yielded a ratio of *C.lancelini*: *C.fallens* captures of 1: 4, compared with 1: 1.6 for the above preliminary results.

Unfortunately the preliminary results offer no insight regarding the importance of rocky habitats to *C.lancelini*. Capture rates for grids in rocky areas are likely to differ from those in sandy areas, since the rocky habitats are much more obviously patchy in terms of two visible habitat features (shrubby cover and rocks). Comparison of relative abundance for rocky and sandy areas will need to be on the basis of CMR results, rather than on relative capture rates.

The small sample of rocks turned yeilded one *C.lancelini* sighting per 8.3 rocks turned. These results appear to contrast with Browne-Cooper and Maryan's (1992) results for October 1991, and Rolfe's (1993) November 1992 results when rock-turning yielded no *C.lancelini*. It is notable that these two rock-turning exercises, which prompted concern for the taxa's status, were conducted early in the season (6-10-91: Browne-Cooper and Maryan (1992) and 16-11-92 to 20-11-92 Rolfe (1993)). As the season has progressed, rocks which were not visible on my first trip to the Island on 16-11-93 (due to weed cover) have become visible as the dead weeds have been progressively blown flatter. Hence, the value of rock-turning in October-November may have been limited by low rock visiblity. Visible rocks might tend to be a biased group, with small to medium sized rocks more obscured than larger ones. This seasonal variation in rock visibility may also explain observations by other workers (e.g. Greg Harold, pers comm) who have felt that there were more rocks during the late 70's-early 80's than on their more recent trips.

The difference between the October-November and the December rock-turning results is also consistent with the hypothesis that there is some seasonal variation in habitat usage by *C.lancelini.* While data is scant, most visits to the Island which have found the species to be relatively abundant have been between December and late April. During the March CALM trip no rocks were turned. It seems prudent to conduct a sytematic rockturning exercise during February or early March, and again during September or October in an attempt to evaluate whether seasonal variation may have been associated with the low abundances recorded for October 1991 and November 1992. The design of such an exercise is under consideration: the two major constraints are the degree of habitat disturbance and the sample sizes required for statistical significance. I will be seeking advice regarding the numeric requirements from a statistican.

Acknowledgements

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Figure and Table Captions

Figure 1. Lancelin Island, showing the position of trapping grids and major habitat types (rocky areas, central dune and white sand foredune).

Table 1. The number of captures of the four commonly caught reptiles on different grids and trips. Captures of adults (A) and recent hatchlings (RH) are listed separately.

Figure 2. Reptile capture rates averaged for each grid (over Trips 1-7, and expressed as captures per open trap per day) for each of the four commonly caught reptiles.

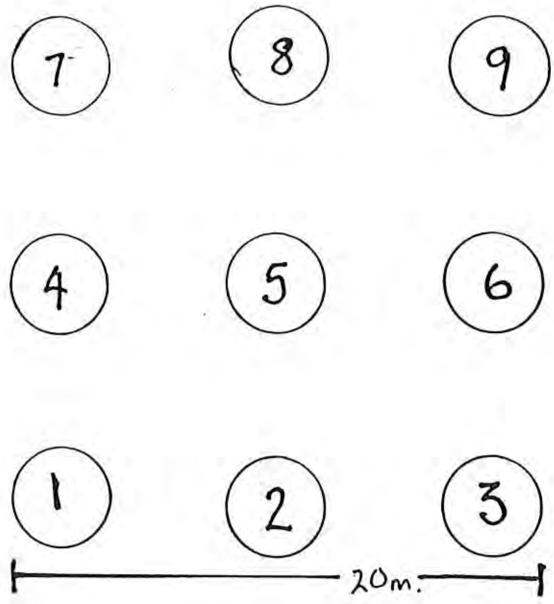
Figure 3. The number of *C.lancelini* caught in different traps on the four grids with higher *C.lancelini* capture rates (for Grids 0, 10, 20, 70 on Trips 1-7).

Figure 4. Reptile capture rates for Trips 1-7 (based on captures on Grids 0-100 for Trip 1, Grids 0-110 for Trips 2-6, and Grids 0-130 for Trip 7). (a) for all individuals, (b) for animals considered adult, and (c) for recent hatchlings. (Adults refers to animals hatched prior to the summer of 1993-4).

Figure 5. Invertebrate activity levels. (a) the percentage of traps with at least one invertebrate on subsequent trips, (b) the percentage of traps with invertebrates averaged over Trips 2-7 for each grid (based on Grids 0-110 for Trips 2-6, and Grids 0-130 for Trip 7). (c) The number of captures of invertebrates and of *C.lancelini* on the four grids with higher *C.lancelini* capture rates. (The number of invertebrates captured was divided by 10 to facilitate visual comparison of lizard and invertebrate captures per trap).

Figure 6. Weight vs snout-vent length (SVL) for female and male *C.lancelini* (excluding recent hatchlings, and animals with obviously small tails). Circled points indicate animals which had tails likely to be light due to regeneration or tail loss.

FIGURE 1.



Trap array

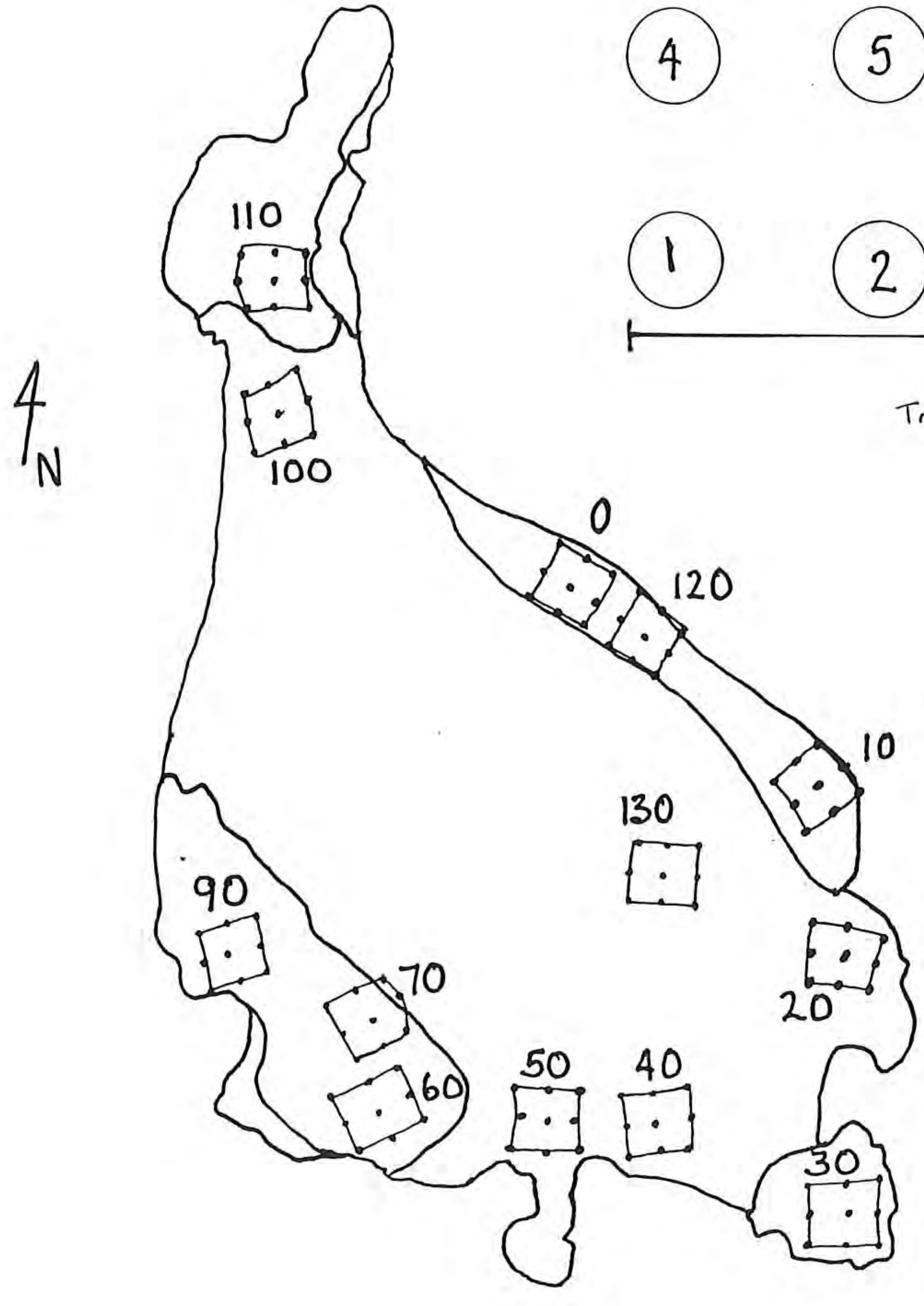


Table 1

Ctenotus lancelini

Trip #	1		2		3		4		5		6		7	
Grid	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH
0	3		8	1		4	4			1				
10	1		2		1		1	1						
20	3						1					1		
30	1													
40			1		1		1							
50									1	1				
60														
70			5		1		1			3		2		
90			1											
100			1											
110	-	-												
120	-	-	-	-	-	-	-	-	-	-	-	-		1
130	-	-	-	-	-	-	-	-	-	-	-	-		

Morethia

Trip #	1		2		3		4		5		6		7	
Grid	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH
0			2	2					1	1				
10			1					1					1	
20			1								1			
30			1									1		
40							1							
50						1		1				1		2
60						1				1		1		1
70	1		1		1					3		1		2
90			2											
100														1
110	-	-	1						1			1		1
120	-	-	-	-	-	-	-	-	-	-	-	-		1
130	-	-	-	-	-	-	-	-	-	-	-	-		

Ctenotus fallens

Trip #	1		2		3		4		5		6		7	
Grid	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH
0	5		11		7		8	1	5	2	1	2	4	9
10	7		11		7		7		2	1		2	1	3
20	2		3		1		1							2
30	1		5				4				1	1	1	1
40			1				1					2		
50	1		1		1					3	1	3		
60	1									1		3		
70	2		3		2		2			1	3	2		2
90			1				1	1	1	1		4		5
100			2				2						1	1
110	-	-	12		1		5			1	1	2	1	2
120	-	-	-	-	-	-	-	-	-	-	-	-		1
130	-	-	-	-	-	-	-	-	-	-	-	-		

Egernia bos

Trip #	1		2		3		4		5		6		7	
Grid	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH	A	RH
0														
10												1		
20	3		1											
30														
40			1											
50			3									1		
60														
70														
90														
100			1		1									
110	-	-					1							
120	-	-	-	-	-	-	-	-	-	-	-	-		
130	-	-	-	-	-	-	-	-	-	-	-	-		

16
60
92

FIGURE 2.

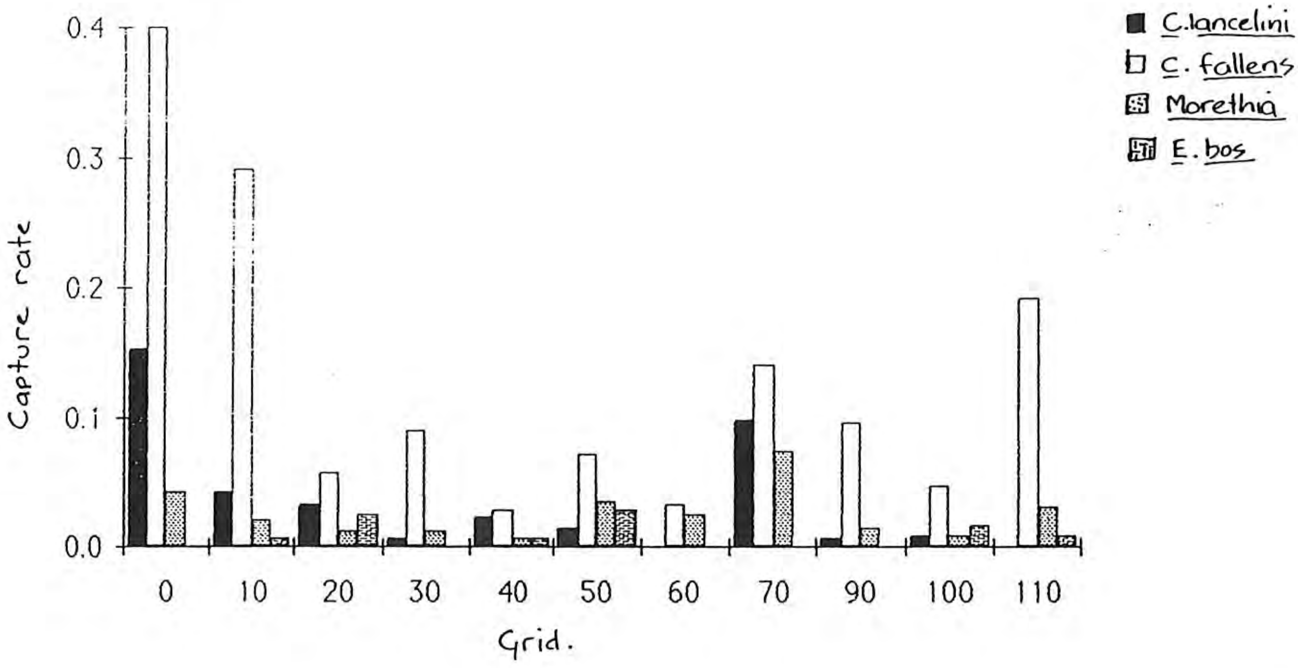


FIGURE 3.

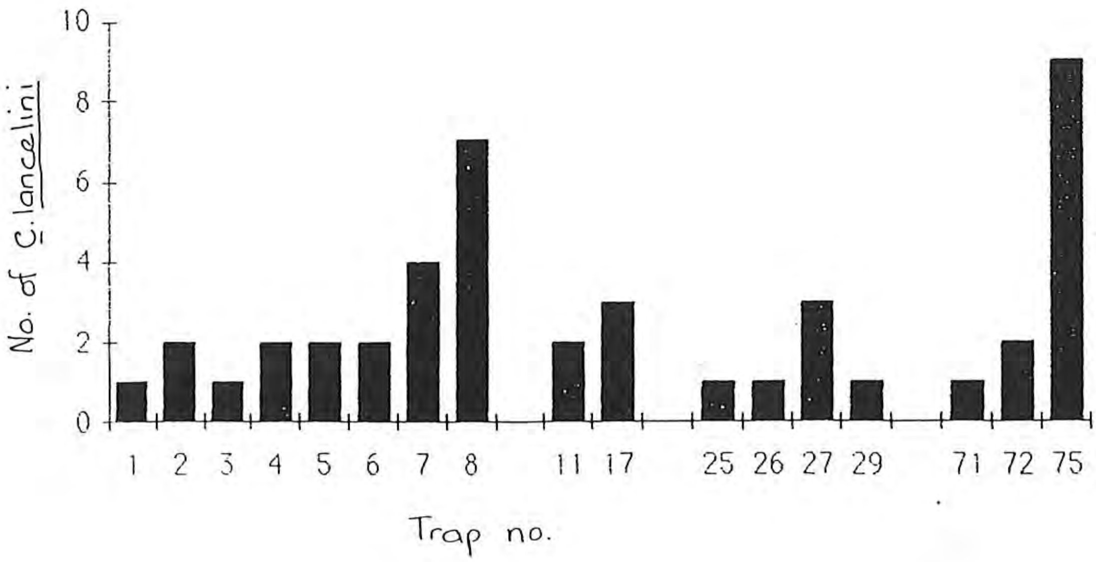


FIGURE 4.

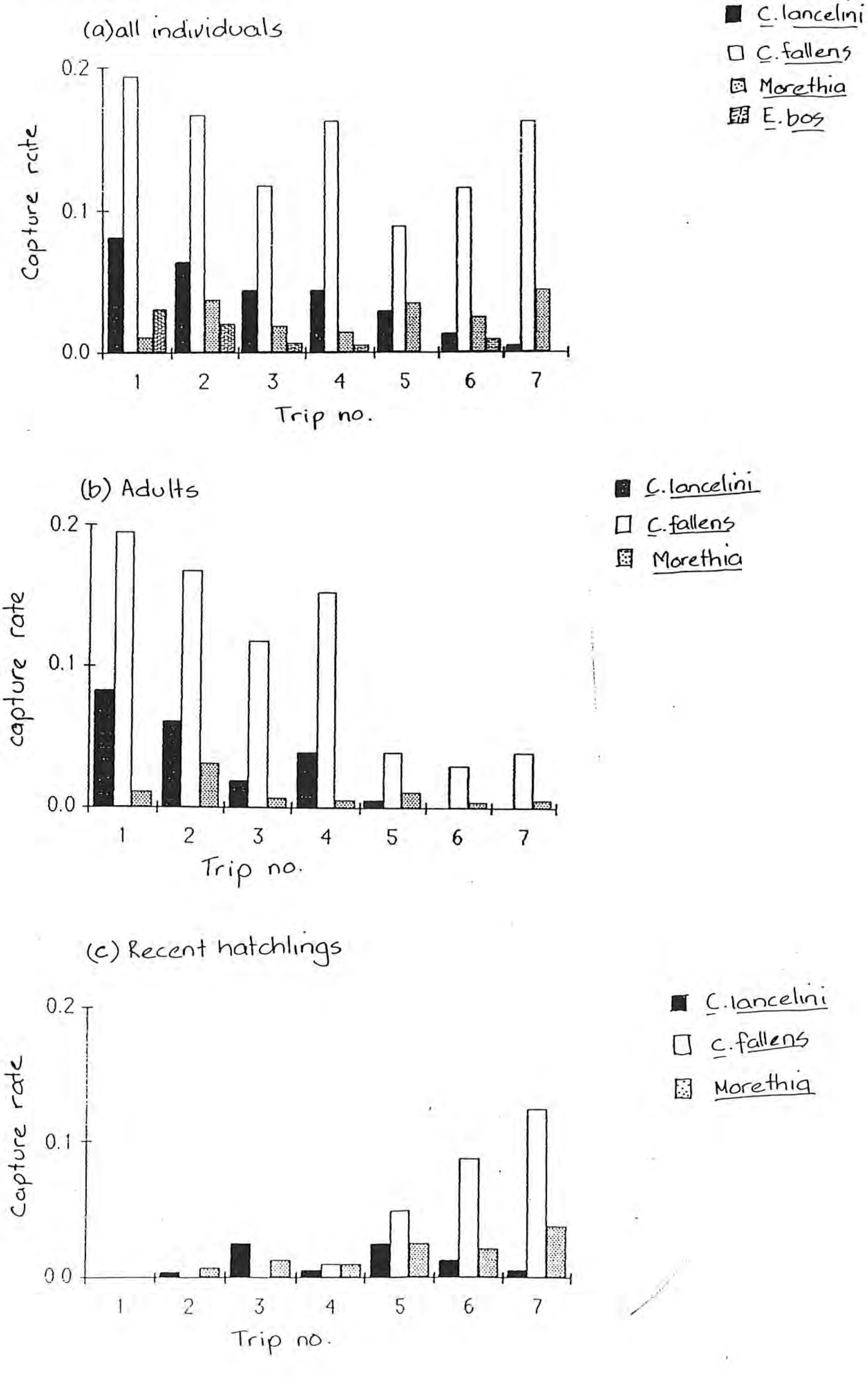
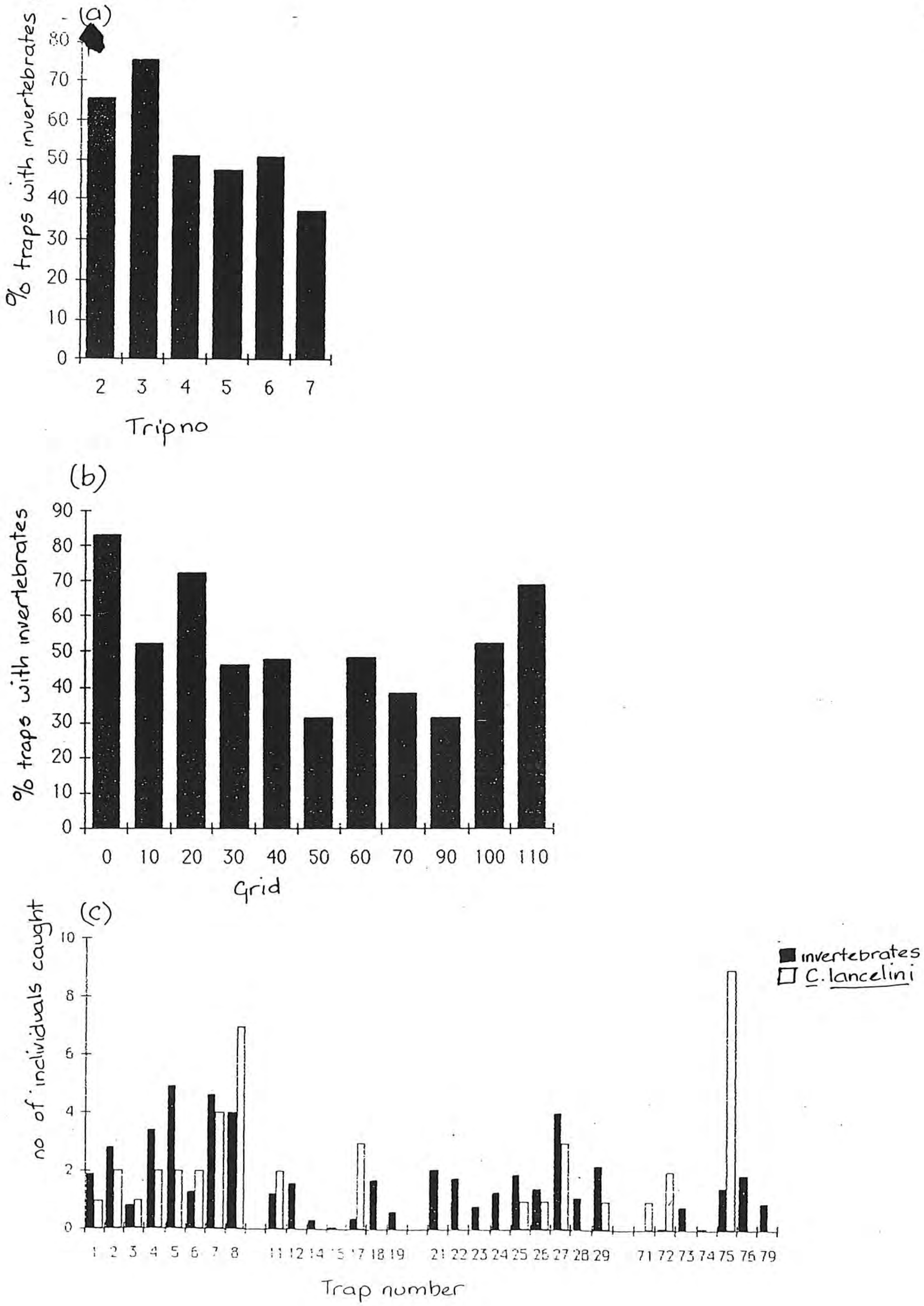

(a) all individuals
capture rate
0.2
0.1
0.0
1
2
3
4
5
6
7
Trip no.
C. lancelini
C. fallens
Morethia
E. bos
(b) Adults
capture rate
0.2
0.1
0.0
1
2
3
4
5
6
7
Trip no.
C. lancelini
C. fallens
Morethia
(c) Recent hatchlings
capture rate
0.2
0.1
0.0
1
2
3
4
5
6
7
Trip no.
C. lancelini
C. fallens
Morethia

FIGURE 5



(a)
% traps with invertebrates
0
10
20
30
40
50
60
70
80
2
3
4
5
6
7
Trip no
(b)
% traps with invertebrates
0
10
20
30
40
50
60
70
80
90
0
10
20
30
40
50
60
70
90
100
110
Grid
(c)
no of individuals caught
0
2
4
6
8
10
invertebrates
C. lancelini
1 2 3 4 5 6 7 8
11 12 14 15 17 18 19
21 22 23 24 25 26 27 28 29
71 72 73 74 75 76 79
Trap number

FIGURE 6.