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MANAGEMENT OF THE LITTLE PENGUIN (*Eudyptula minor*) IN WESTERN AUSTRALIA

A STRATEGIC PLAN FOR RESEARCH AND MONITORING

PREPARED BY THE

PENGUIN WORKING GROUP

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PART I - STRATEGIC RESEARCH AND MONITORING PLAN

BACKGROUND

Little Penguin Research in Western Australia

Along the west coast of Western Australia the only large breeding colony of Little Penguins (*Eudyptula minor*) is on Penguin Island, situated 42 km south-west of Perth and 600m off-shore from the suburbs of the City of Rockingham. This long-established colony on Penguin Island is at the northern and western limit of the breeding range of the species and numbers about 1000-1200 individuals. There are records of a few pairs of penguins breeding on Seal and Carnac Islands and some have been observed on Bird and Shag Islands. Little Penguins have been reported on many islands on the south coast but numbers are unknown (Map 1).

Western Australia has a unique opportunity to maintain and enhance a significant colony of Little Penguins at Penguin Island within the expanding metropolitan Perth. However, the continued growth of Perth's human population will also result in additional pressures and complexities for the management of the Penguin Island penguin population. Wildlife managers, planners and the tourist industry will require up-to-date and detailed research information to assist management decisions and actions.

Little of this research has been done to date. Researchers from the Murdoch University School of Biological and Environmental Sciences have studied the ecology of the Little Penguins at Penguin Island since 1982 and continuously from 1986. The Murdoch research has principally concentrated upon the breeding biology of the penguins on the island. Very little is known in Western Australia about the behaviour and movement of Little Penguins while they are at sea. In addition, little is known of the populations on the south coast of the State, either their size, location or status.

There is a need for a clear, co-operative framework for future research into Little Penguin ecology in Western Australia. The time is right to develop a comprehensive research plan for the Little Penguin in WA, to provide a basis for sound management into the next century.

The Penguin Workshop

A one day workshop on Little Penguin ecology in W.A. was held on Tuesday 13 December 1994 at Murdoch University. It was organised by CALM's Swan Region and Murdoch University, School of Biological and Environmental Sciences. The Workshop was held for researchers and selected management personnel who are, or have been, involved with Little Penguin management or research in Western Australia. The workshop participants concentrated on determining important research and monitoring projects which will assist in managing W.A.'s existing Little Penguin populations. It is not intended to address the tourism/recreation "people" issues related to penguins.

A total of 21 people participated in the workshop with 7 from CALM, 5 from Murdoch University, 7 people from other organisations and two from Victoria. Peter Dann and Mike Cullen have had many years experience with the Little Penguin population at Phillip Island in Victoria. Their participation provided valuable insight into future directions, issues and problems in Western Australia.

The Workshop was split into four sessions - background, penguin life on shore, penguin life at sea and preparation of a research program. Each session included a key note lecture, a brain-storming session and a workshop discussion. Outcomes were recorded.

Peter Dann gave an outline of the history of research into the Little Penguin associated with Phillip Island Reserve in south east Victoria. Ron Wooller summarised the major research work done by Murdoch University over the past decade on the Penguin Island population. Mike Cullen gave a presentation on the "at sea" work being done off Phillip Island looking at prey species and penguin movement. Rob Tregonning (Fisheries) and Glenn Hyndes (Murdoch University) discussed their research into prey fish species.

During brain-storm sessions, participants nominated issues and potential research or monitoring projects which would be applicable to the W.A. Little Penguin populations. These were recorded without group discussion. Workshop sessions were conducted as open discussion sessions. This session was a free ranging one with a wide range of topics being brought up during discussion.

At the end of the day all remaining participants where asked to write down their top five priorities for research and monitoring. These were to be ranked from 5 (highest priority) to 1 (lowest). All submissions have been reproduced in Attachment I grouped into like-topics, with total votes and number of participants identifying each topic area.

The Penguin Working Group

At the Workshop participants agreed to establish a Penguin Working Group to:

(i) prepare a Strategic Research and Monitoring Plan for the Little Penguin in W.A.;
(ii) recommend ongoing plan implementation arrangements and structures; and
(iii) address communication issues.

In addition, the Workshop participants recommended:

- The key audience for the Strategic Plan should be (i) researchers and management personnel involved in Little Penguin management in W.A., and (ii) for potential funding organisations.
- Mission Statement: "To provide the conceptual, predictive and current information to manage all Western Australian populations of the Little Penguin."
- A draft strategic plan will be available by 31 March for circulation to participants at the workshop. Wider distribution will be considered by the Working Group.
- The Penguin Working Group was based upon representation from the major research, management and volunteer organisations involved with Little Penguins in W.A. The seven members were nominated to prepare the Plan.

The Penguin Working Group met at Murdoch University on 9 and 30 January, 27 February 13 March and 4 July 1995. A draft Plan has been sent to all participants of the Workshop for their comment and input prior to the preparation of the final plan. The final plan will be circulated widely within Western Australia.

PRIORITY RESEARCH AND MONITORING PROGRAMS

Mission Statement

To ensure the information required to manage Little Penguin populations in Western Australia is identified, systematically acquired and available to managers.

Overview

The following brief outlines of programs where prepared by the Penguin Working Group, based upon the Workshop participants brain-storming ideas and their suggested ranking of research or monitoring projects (Attachment I). They are not given in order of priority. All projects listed should be given high priority. There may also be high priority projects not considered below. These should be assessed on a case by case basis as they arise.

The issue of information exchange and communications between managers, researchers, volunteers and the public is very important. It is given under objective 1 and has been discussed in detail in Section II.

Detailed project outlines are given in Section III for the remaining five objectives. They are specific research and monitoring projects which will assist with the long term management of Little Penguin populations in Western Australia. The outlines provide direction to managers and researchers when considering research and monitoring programs. They can be adapted when new findings or techniques are developed.

The range of projects cover the spectrum from expensive, integrated research, through research projects for post-graduate tertiary students, management based monitoring and several projects which can be run by dedicated volunteer groups. The integration and co-operation of all these groups will be a major feature of the success of this Plan over the next 5 years.

The ongoing role of the Penguin Working Group

The Penguin Working Group should be maintained as an independent committee with the same basic representation from major stakeholder groups and players. Individual representatives may be replaced as required by each organisation or group. The working group is not responsible to, and does not report directly to, any organisation or individual.

The primary role of the working group should be to identify research and monitoring objectives and priorities through the preparation of the Plan. The Plan and working group should facilitate attainment of the objectives, where possible, and assist in the resolution of problems. The working group is not responsible for enforcing compliance with the Plan.

The working group should meet on an annual basis (Febuary each year) to review progress and, if necessary, amend or modify sections of the Plan as new information becomes available. Special meetings may be appropriate to address important issues. CALM's Swan Region Marine Operations Manager (currently Peter Dans) will be responsible for arranging the annual meeting of the Working Group.

Penguin Study Group

There is a clear need for a "penguin study group" in Western Australia, as has been the case at Phillip Island for many years. However, the basis may be quite different. The working group suggest it be formed within the Friends of Shoalwater Islands Marine Park group, if they agree. It would be advantageous for the study group to adopt the plan and undertake work towards the completion of the objectives. There may be some issues concerning work by this group on populations other than those on Penguin Island.

Evaluation and Review

The Plan will be reviewed in 5 years - the year 2000. This will involve a Workshop to assess progress to date, discuss issues and set the framework to update the Plan. CALM, in conjunction with Little Penguin research groups, will arrange the Workshop and ensure the re-writing of the Plan takes place.

PRIORITY PROGRAMS

Objective 1: To develop an ongoing network to facilitate the exchange and integration of information relevant to the management of the Little Penguin (eg penguin ecology, plus appropriate fisheries and oceanographic data) within Western Australia.

Strategies

* Maintain the Penguin Working Group to facilitate information exchange. The Group to develop a range of ways to communicate findings (meetings, workshops, pamphlets) as appropriate.

* To develop a conceptual model for the Little Penguin which can be used to provide managers and researchers with a coherent framework to better identify, prioritise and integrate research and monitoring programs, thereby improving its management in the wild.

* Establish and maintain a register of past and current projects which relate to Little Penguins and their environment in Western Australia and the organisations/individuals that are responsible for long-term curation of the data.

Objective 2: Design and implement a rigorous, long-term monitoring program for the Perth population of penguins which indicates population numbers and processes underlying them.

Strategies

* Establish and maintain a known-age population of penguins to predict and model population dynamics, through annually marking a large number of chicks throughout the metro-Perth population.

* Maintain twice monthly counts of penguins at all landfall sites throughout the year.

* Using trained penguin banders, maintain a program to mark and recapture adults at fixed sites and, periodically, island-wide and at landfall sites. Investigate alternatives to bands for marking individuals.

* Increase public notifications and initiate beach surveys for the recovery of dead and injured penguins. Prepare a basic data form for such recoveries to record date, locality and possible causes of mortality.

* Design and develop a penguin database to manage and control common data for the long-term monitoring program.

Objective 3: Design and maintain a long-term monitoring program to determine penguin reproductive success within the metro-Perth population.

Strategies

* Monitoring breeding success and chick development can only practically be done using nest boxes due to instability of natural "burrows". Need to increase spread and number of nest boxes across Penguin Island following appropriate experimental design. Also need to develop an annual maintenance and replacement plan for the nest boxes.

* Determine the utilisation of all parts of Penguin Island and the other metro-Perth islands over time for breeding and moulting by penguins. May use transects or quadrats and vocalisation.

Objective 4: Determine what penguins eat, where they go to feed and the distribution-abundance of the prey fish species.

Strategies

Determine what penguins eat.

Currently the only procedure to determine what penguins eat is to capture them at landfall and flush out the stomach contents. This is an intrusive procedure and there are many problems with identification of stomach contents and differential food digestion.

Determine seasonal foraging ranges and where penguins travel at sea.

* Systematic recording of opportunistic observations of penguins at sea by volunteers and interested members of the public
* Monthly counts of penguins off metro-Perth from boats along predetermined transects as was done in Victoria by Norman (1992).
* Radio-tracking penguins radio-tagged at the breeding colony at Penguin Island.
* Using time-depth recorders or other data loggers placed on penguins for short periods.

Distribution and abundance of penguin prey fish species

* Direct sampling of prey fish species appears to be very difficult as they aggregate into schools, so sampling catches none or large amounts. Difficult until we have good idea of penguin foraging ranges and "hot spots".
* Fisheries Department records.
* Obtain better records (location, how much, size class) from the small number of professional whitebait fishermen, directly or indirectly
* Observe feeding seabirds such as terns

Objective 5: Obtain population estimates of penguins using other islands on the west and south coasts for breeding or moulting.

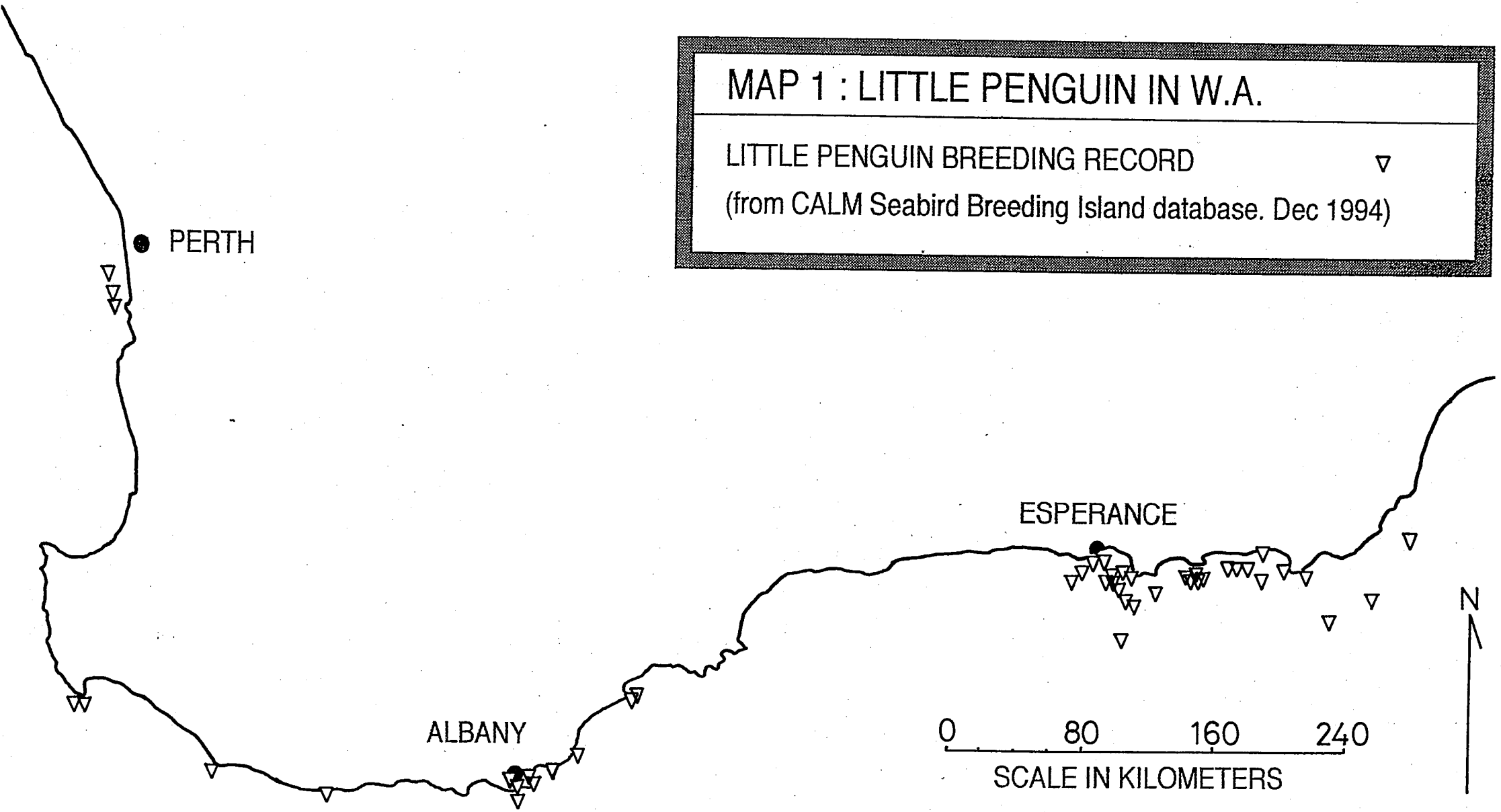
Strategies

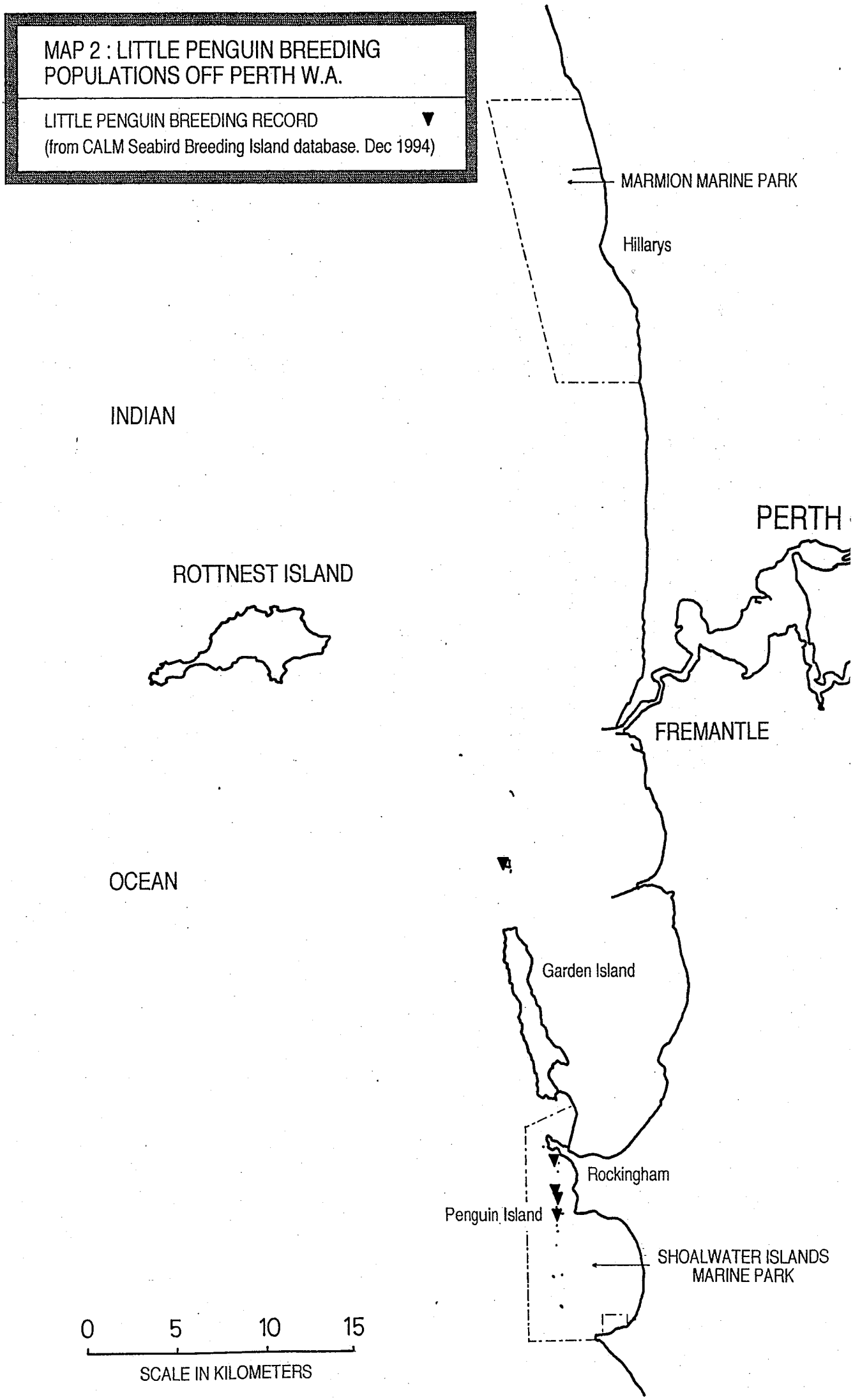
* Whenever conducting studies on the penguin population on Penguin Island, attempt to include penguin populations on the other metro-Perth islands.

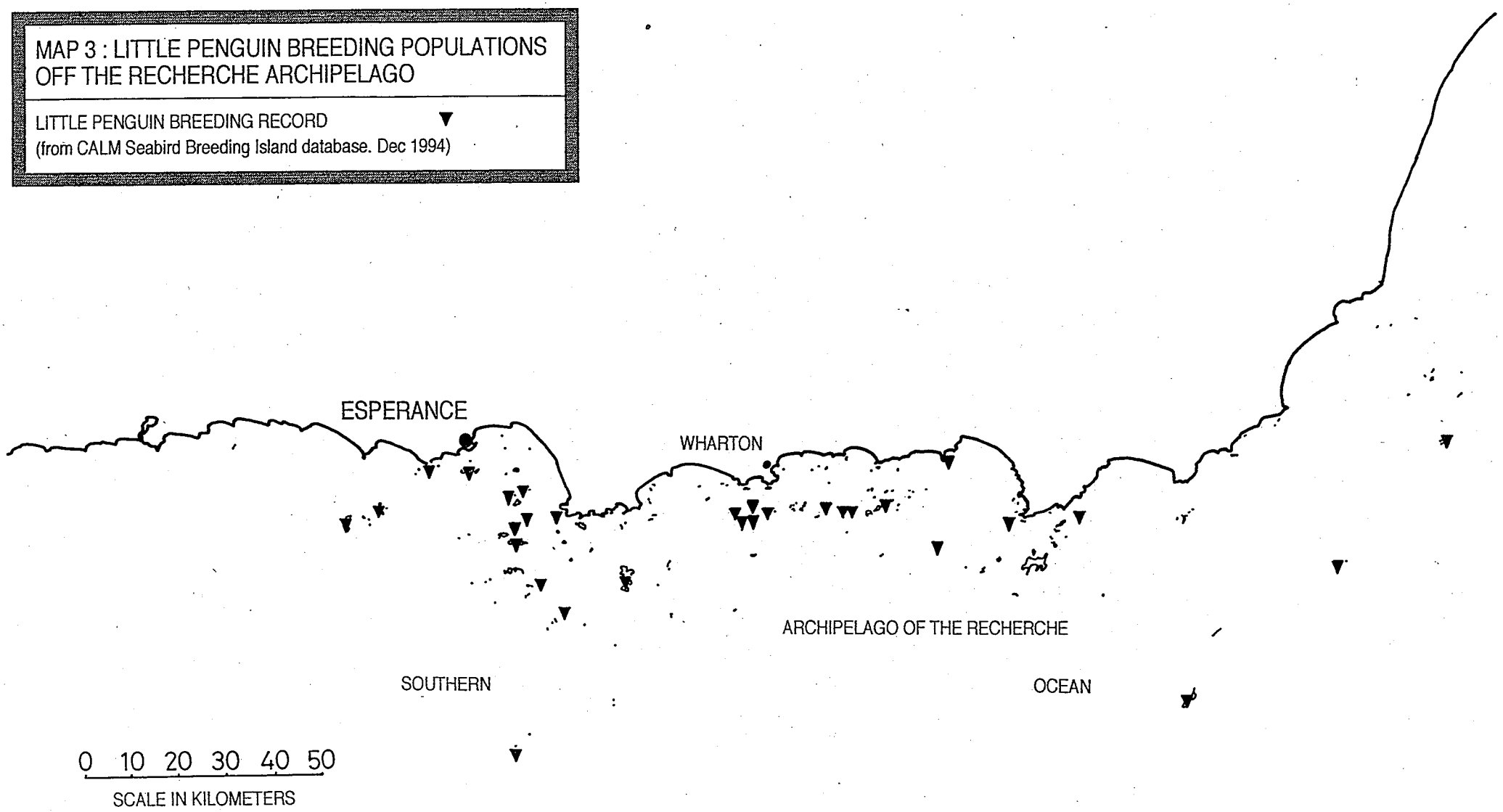
* During visits to islands on the south and west coast, CALM, government and private boat operators should conduct surveys and record the presence of penguins. This can be achieved by increasing awareness of the value of these penguin counts.

* If resources can be obtained, conduct a systematic and detailed survey of the seabirds on the islands east of Albany, including the Recherche group.

Objective 6: Promote Penguin Island as site for the ANCA National Seabird Monitoring Program.


MAP 1 : LITTLE PENGUIN IN W.A.
LITTLE PENGUIN BREEDING RECORD
(from CALM Seabird Breeding Island database. Dec 1994)
PERTH
ESPERANCE
ALBANY
0
80
160
240
SCALE IN KILOMETERS
N


MAP 2 : LITTLE PENGUIN BREEDING POPULATIONS OFF PERTH W.A.
LITTLE PENGUIN BREEDING RECORD
(from CALM Seabird Breeding Island database. Dec 1994)
MARMION MARINE PARK
Hillarys
INDIAN
PERTH
ROTTNEST ISLAND
FREMANTLE
OCEAN
Garden Island
Rockingham
Penguin Island
SHOALWATER ISLANDS MARINE PARK
0 5 10 15
SCALE IN KILOMETERS


MAP 3 : LITTLE PENGUIN BREEDING POPULATIONS OFF THE RECHERCHE ARCHIPELAGO
LITTLE PENGUIN BREEDING RECORD
(from CALM Seabird Breeding Island database. Dec 1994)
ESPERANCE
WHARTON
ARCHIPELAGO OF THE RECHERCHE
SOUTHERN
OCEAN
0 10 20 30 40 50
SCALE IN KILOMETERS

PART II - OUTLINES FOR SPECIFIC PROJECTS

CONCEPTUAL MANAGEMENT MODELS IN SETTING RESEARCH AND MONITORING PRIORITIES.

Objective 1.2

To develop a conceptual model for the Little Penguin which can be used to provide managers and researchers with a coherent framework to better identify, prioritise and integrate research and monitoring programs, thereby improving its management in the wild.

Project outline

The maintenance of natural populations involves a complex array of interrelated physical and biological processes. Management requires an understanding of how populations respond to both natural forces and anthropogenic disturbances if impacts are to be minimised. This understanding is usually provided by undertaking process-orientated research and long-term monitoring. When resources are limited, as they usually are, research and monitoring programs need to target key processes to deliver the most relevant information to managers.

The use of existing or conceptual models will be used to develop research and monitoring priorities for the management of the Little Penguin population at Penguin Island. The model should identify key processes and pathways (both natural and anthropogenic) that are critical to maintaining/achieving management objectives.

In the absence of a suitable existing model, the expertise and research experience of individual researchers will be utilised to develop a conceptual management model. The objective of the modelling will be to use the collective knowledge of the researchers and managers to simplify the model to the key cause-effect pathways rather than to cover the entire range of possible processes. Once this is done the process of prioritising research programs will be undertaken.

Lead organisation / Person
CALM's Marine Branch

KNOWN-AGE POPULATION OF PENGUINS

Objective 2.1

To establish and maintain a known age population of Little Penguins on Penguin Island in order to model their population dynamics.

Project outline

Accurate predictions of the dynamics of a population usually require a model based upon known-age individuals. This is a very long-term aim which requires the recruitment of many annual cohorts of penguins marked as nestlings. There is no reliable way to age most birds after this stage. Little Penguins first breed at 2-4 years old and may live over 20 years thereafter (average 7 years). Thus, at least 10 years regular marking of young will be required before much information becomes available.

After this it may be possible to calculate

- age-related fecundity and survival among breeding adults
- the age of first breeding of returning young
- recruitment rates overall
- any differences between years in the survival of young to breeding age
- any differences in the survival to breeding of young from early and late in the season.
- patterns of mate selection and change.

The protracted breeding season and asynchronous production of young will require many visits to Penguin Island each year by a skilled bander. It is important that a high proportion of young produced each year are marked. Thus all areas of Penguin Island must be searched regularly, as well as known penguin breeding areas on Carnac Island.

Resources and funding

This work is best done in conjunction with the marking and monitoring of adults in the breeding population. Continuity of effort over many years and at least fortnightly visits to Penguin Island over several months each year will require dedicated personnel with animal handling/banding expertise. Committed amateurs could undertake this work as successfully as professionals.

Lead organisation / Person

Murdoch University.

PENGUIN ISLAND POPULATION ESTIMATE

Objective 2.2

To obtain a more reliable estimate of changes in size of the Little Penguin population on Penguin Island.

Project Outline

Studies of the Little Penguin on Penguin Island have concentrated on the Tombolo area and its landfall sites. However it is known that the birds land at points all around the shoreline including the rocky shores. This project will use supervised volunteers to produce island wide counts throughout the main breeding period between March and October.

The number of birds coming ashore each night will be extremely variable due to the breeding cycle and environmental conditions. Beach counts need to be related to breeding events and the activity of a monitored group of birds.

Methodology

Penguins will be counted making landfall around the island twice a month, on the new and full moon, from March to October 1995. Volunteer observers will be positioned at 17 observation points around the island at sunset and will count all Little Penguins making landfall in their area over the subsequent two hours. Each count will be supervised by a seabird biologist and coordinated by CALM officers and the volunteers' convenor.

Beach counts will be interpreted using data from marked and monitored birds on the island (Projects 2.1 and 3.1). Nest boxes from Project 3.1 should be checked in conjunction with each beach count to determine the proportion of birds remaining on the island relative to those feeding out at sea for that day.

Resources and Funding

Island-wide simultaneous counts are labour intensive and will rely on the commitment of CALM volunteers, FSIMP and possibly the Rockingham Naturalist's Club. The possibility of using eco-tourists should be considered as a means of supplying observers and funding this and other Penguin Research Projects.

CALM will have to provide transport to and from the island for up to 20 volunteers and researchers, probably on Saturday evenings, twice a month.

Lead Organisation / Person

WA Seabird Group (including Murdoch personnel) should supervise field activities and compile results. CALM must have logistic responsibilities.

RECOVERY OF DEAD AND INJURED PENGUINS

Objective 2.4

Facilitate increased public notifications of, and initiate beach surveys for, the recovery of information on dead and injured penguins on the W.A. coastline.

Project Outline

The collection of information on dead and injured penguins could build up a useful database on the causes of death, distribution of deaths (seasonal and geographic) and assist population dynamics studies. The recovery of tags and information on tagged penguins should be a priority. A standard recording sheet should be developed and used to record date, locality and possible causes of mortality. The information should be compatible with central database and added to it in a systematic way. Local media releases should be made periodically to increase the public's awareness.

To collate the public's sightings of dead birds on W.A. beaches it may be possible to have a "ring-in" day or week. Through State-wide and local media, members of the public may be asked to phone-in to report their sightings of dead penguins over the past 2-5 years. This could follow procedures used for the "bandicoot phone-in" in 1993 by Tony Friend from CALM. CALM in conjunction with volunteers could manage telephones.

In addition to opportunistic records, information could be collected systematically by individuals doing regular (monthly) beach walks along parts of the WA coastline. Groups of volunteers could target beaches at specific times, such as after significant winter storms and when young are fledging (July-December).

In addition, all penguin carcasses in better condition should be preserved for further study. For example, if we collected 100-200 carcases over several years research could be undertaken on reproductive condition, parasites, stomach contents, body size or structure. Advice on preservation to be obtained from the WA Museum and perhaps they may maintain collection. Public could drop carcasses to selected CALM or other offices where they are preserved and then forwarded to the central collection. The implications of the Wildlife Conservation Act will need to be considered.

There is a need for the major players to know the procedure for managing injured penguins and how to get them to the Native Bird Hospital Inc.

Lead Organisation/Person

CALM, possibly through the Shoalwater Islands Volunteers.

PENGUIN DATABASE MANAGEMENT

Objective 2.5: To design and develop a database to manage and control common data from long-term monitoring programs on Little Penguins in Western Australia.

Project Outline

To get the best usage of data from long-term monitoring projects it needs to be collected, recorded and maintained in a systematic and uniform manner. In addition, as the data set gets larger, the actual management of the information itself becomes a major problem unless it is systematically maintained on a computer. This project aims to develop a single computer database for maintaining all the long term data on Little Penguins in WA. Each record will include important parameters from a single capture of an individual bird. Need to determine what questions will be asked of the data set prior to developing the database.

This project is of high priority. It requires a detailed project design and budget prepared. May require a technical officer for a year to design the database and enter the data.

Principal characteristics of the database package:

Simple as possible
Each record for a single capture of an individual bird
Each record to include all regularly taken and useful parameters
Compatible with Murdoch University's current database system
If possible, compatible with Phillip Island database.
If possible, compatible with the RAOU or similar databases
To control data from mark-recapture projects
To control data from reproductive success projects
Database to be IBM compatible
Use single, common database program
Database program easily read by statistics packages

Issues

Address intellectual property and access issues
Data entry easy and not confusing
How and who will validate new entries to the data set?
Who to maintain data set?
Keeping multiple copies of the database in case of a disaster

Resources and funding

The design of the database system and writing of a complementary manual could be achieved by a small working group, which should include a person experienced with large databases, a statistician/database/computer expert, a penguin researcher and a CALM officer. The data entry and/or manipulation of existing data sets will need to be done separately to the design work.

Lead Organisation/Person

Once the database is established and the backlog of data entered, Murdoch University should manage and maintain it until staffing and resources become a problem. At that time CALM should assume responsibility of the database for the long term.

METROPOLITAN LITTLE PENGUIN BREEDING SUCCESS

Objective 3.1

Design and maintain a long-term monitoring program to determine penguin reproductive success within the metro-Perth population.

Project Outline

Monitoring Little Penguin breeding success and chick development can only practically be done using nest boxes due to instability of natural "burrows". There is a need to increase the spread and number of nest boxes across Penguin Island following appropriate experimental design. Also need to develop an annual maintenance and replacement plan for the nest boxes.

Methodology

Require detailed design for the breeding success and chick development monitoring program on Penguin Island. Once the design has been completed, the establishment of nest boxes should be done as soon as possible. Need to ensure that all the boxes can be monitored by one scientist in a morning (2-4 hour period). Handling of birds can only be done by a trained person.

Need design drawings and materials list for a standard nest box from Murdoch University. Develop a five year program for new and replacement nest boxes, which will be reviewed by the Penguin Working Group annually.

Resources and funding

CALM to provide resources to pay for new nest boxes. Boxes are placed in the field by Shoalwater Islands Volunteers under supervision from Murdoch University personnel.

Lead Organisation/Person

Murdoch University

DIET OF LITTLE PENGUINS

Objective 4.1

To determine what Little Penguins from Penguin Island eat.

Project outline

Some data on diet was collected in 1986 and 1989. This showed that during the breeding season, the penguins ate mainly Sandy Sprat (*Hyperlophus vittatus*), Blue Sprat (*Spratelloides robustus*), Pilchard (*Sardinops neophilchardus*) and Southern Sea Garfish (*Hyporhamphus melanochir*), as well as some squid and other fish species. The penguins appear opportunistic predators of small schooling fish and their diet varied little within or between the two years studied. Given the difficulties of obtaining meaningful dietary samples, further work on diet may only be justified when

(a) a substantial time (more than three years?) has elapsed since the last sample was taken, in order to monitor changes in diet.

(b) there is reason to believe that the penguins are being forced to change their diet as a result of adverse climatic or human activity.

Dietary work would be most useful as part of an integrated project including foraging patterns and the distribution / abundance of major prey.

Methodology

- Penguins cannot readily be caught at sea.
- Birds coming ashore may have digested most of the food caught earlier.
- Best to sample birds as soon as they come ashore.
- Emetic methods and stomach pumping are largely abandoned as too stressful.
- Water offloading is the preferred procedure but can still prove stressful.
- Do not offload each individual successively until empty.
- Sample each individual only once in a given time period (eg. once a year).
- Identification requires calibration of fish otoliths and squid beaks with consequent uncertainty.
- A full picture of diet would require that penguins be caught outside the breeding season and that penguins of all ages be sampled.

Resources and funding

Principal requirement is personnel experienced with the technique (additional less-experienced "catchers" useful) and the laboratory facilities/expertise to identify remains in food samples. Most suited to university Honours activities.

Lead organisation / person

Murdoch University with assistance from volunteers to capture penguins and Fisheries Department staff in identification of prey fish species.

BOAT BASED SURVEY OF LITTLE PENGUINS IN WARNBRO SOUND

Objective 4.2.2

To gather information on the diurnal, marine distribution of Little Penguins in the Warnbro Sound - Murray Reefs area..

Project Outline

Little other than anecdotal evidence is available on the distribution of Penguin/Carnac Island Little Penguins in local waters. This project is a boat-based survey in the area which we believe constitutes the main part of the foraging range of this population of Little Penguins ie. Warnbro Sound and Murray Reefs.

Pilot Survey

CALM vessel the "Gandara" based at Hillarys will be used for the pilot survey. Suggest 2 crew, 2 observers and 1 recorder. Vessel has 2 observation seats on cabin roof about 2.5 metres above sea level. The vessel has GPS capable of entering positions of sightings instantaneously for later transfer and recording. However, the echo sounder may not have sufficient resolution to detect and identify penguins or bait-fish below the surface.

Eight north-south transects will be conducted in an area defined by the Passage Rock in the west, Becher Point in the south and the shores of Warnbro Sound (east and north). Total transect length is approximately 28 nautical miles. Survey speed of 12 knots will mean a survey duration of about 3 hours including setting up between transects.

The first transect is proposed to take place between Monday April 3 and Thursday April 9. Surveys to take place early morning to minimise wind effects and maximise potential for sightings. This project will be funded from CALM's Swan Region resources.

Systematic Monthly Surveys

Following methodology worked out during the pilot survey, boat transects will be planned one day a month over a 12 month period over the Warnbro Sound - Murray Reefs area. Surveys will generally be conducted in the mornings to avoid wind speeds in excess of 15 knots. This larger project requires the use of a small powered vessel, equipped with GPS or an echo-sounder unit.

Observers will be experienced seabird biologists from Murdoch University, CALM or the WA Seabird Group. The Rockingham Boating Association would be approached for an appropriate vessel and volunteer skippers. Funding for expenses (mainly fuel) will be sought through the WA Conservation Grants or raised from Penguin eco-tourism projects. A Penguin Log Book may also be developed for private boat owners to record penguin sightings.

Lead Organisation

CALM for the pilot survey. The WA Seabird Group with networking assistance from FSIMP and the Marine and Coastal Network for the follow up 12 month survey.

RADIO-TRACKING LITTLE PENGUINS AT SEA

Objective 4.2.3

To determine where Little Penguins feed and how this changes within and between seasons.

Project Outline

The only feasible way of monitoring Little Penguins at sea is using radio-tracking. Although other electronic monitoring devices for tracking wild animals exist, they are too bulky to be carried by Little Penguins at present. This project would be fairly expensive over 2-3 years and the approach adopted will depend upon the patterns of movement revealed by the initial results. Ideally, the project would be integrated with water offloading studies of diet and some assessment of the distribution and abundance of fish in the areas visited by penguins.

Methodology

Two stage VHF radio-transmitters operating around the 151 MHZ frequency would be used in conjunction with 15 cm long flexible aerials. This package weights about 9g and represents about 2% of the cross-sectional area of a penguin. It would be secured to the feathers of the lower back. Signals would be picked up by multi-channel scanning receivers and rotating directional antennae mounted on towers up to 7-8 m high. Cross bearings on each transmitter would be recorded at 30 minute intervals throughout the daylight hours, using two or three receivers. These receivers would be located on the south end of Penguin Island or on Becher Point and on an intermediate site such as Tamworth Hill, to provide coverage of Warnbro Sound. If coverage of Cockburn Sound was required, receivers might be sited on Garden and Rottnest Islands, as well as Mt Brown. Rottnest Island could also be useful to track birds offshore. Communication between tracking stations would be done through CALM radio channels or using mobile phones.

Up to ten transmitters would be deployed during each ten day tracking session. About 5-6 sessions per year for two years would be required to provide adequate data on seasonal and annual variability. Initially, only penguins regularly using nest boxes on Penguin Island would be fitted with transmitters, so transmitters could be recovered and reused. Later in the project, non-breeding birds, young leaving the colonies or adults about to depart after moulting might be used, accepting the higher rate of loss of transmitters that might ensue. Light aircraft may be used to help track these birds.

Resources and Funding

Equipment - At least 20 transmitters would be required ($150-200 each) over two years to allow for 20% failure rate. Some radio-tracking receivers and antennae are available from CALM and Murdoch University, but may need to be supplemented. Each receiver is worth about $2500. Vehicle costs (plus boat and plane costs) would be required.

This intensive project would require at least one person experienced with penguins and radio-tracking dedicated full time to the project. In addition, a large number of volunteers would be needed to operate tracking stations over long periods (the Phillip Island tracking study used more than 80 people in two years). CALM and Murdoch University would be required to co-ordinate volunteers and provide specialist services (eg electronics workshop).

THE DISTRIBUTION AND ABUNDANCE OF PREY FISH SPECIES PART I - COLLATION OF EXISTING RESEARCH AND KNOWLEDGE

Objective 4.3: To gain an understanding of the distribution and abundance of prey species of fishes at the time of year and in the locations in which they are utilised as a food source by Little Penguins.

Fisheries Department Records

Much information on the distribution and abundance of prey fish species could be obtained by analysing previous research and by studying the relevant commercial fisheries. These studies could be carried out relatively cheaply. The species studied would be selected on the basis of previous studies of penguin diet, with most attention being directed towards those prey items which are of significant calorific value to the penguins.

The Research Section of the Fisheries Department has completed research on whitebait (*Hyperlophus vittatus)* and pilchard (*Sardinops neopilchardus)*, two prey species of importance to the Little Penguin at Penguin Island. The studies assessed the abundance and distribution of these species over the range of the commercial fisheries. The principal aim of the studies has been to develop an estimate of total stock size. However, they can provide information on the biology and natural history of both species. The Fisheries Department continues to monitor the commercial catch of these two species.

However, these studies, while they are relevant, do not specifically deal with the small scale fluctuations in baitfish availability in the limited foraging range of the breeding Little Penguins. An understanding of the distribution and abundance of prey fish that are available to the penguin colony would require more localised research.

Available commercial fisheries data, relevant research and stock assessments would be obtained through the Research Division of the Fisheries Department. The Fisheries Department receives from commercial fishermen, as a condition of licence, monthly statements which set out the weight, location (within a designated block), fishing method used, and the effort (for example the number of days fished) for all species caught. The catch records of individual fishermen cannot be made available, nor can the information be legally used for any purpose other than the purpose for which it was collected (research). However, summarised catch data can be made available by the Department.

Approach to Commercial Fishermen

An approach could be made to individual fishermen to provide more detailed data of catch and observations of the target species. Interviews could be arranged with those local fishermen willing to assist with the study. The fishermen's recollections and their understanding of the natural history of the target species would be recorded. Fishermen may be willing to provide more precises catch locations than are available in Fisheries Department data. Regular contact would be made with the fishermen and their observations throughout the season would be recorded.

If the biology and life history of other fish species have not been previously studied, then biological specimens would be regularly purchased from the fishermen for analysis.

Lead Organisation / Person

The Research Section of the Fisheries Department should be approached for catch data and to arrange introductions to fishermen.

THE DISTRIBUTION AND ABUNDANCE OF PREY FISH SPECIES PART II - SYSTEMATIC SURVEY AND SAMPLING OF BAITFISH

Objective 4.3: To gain an understanding of the distribution and abundance of prey species of fishes at the time of year and in the locations in which they are utilised as a food source by Little Penguins.

Project Outline

Commercial fisheries in the foraging range of the Little Penguin, are sporadic and small scale, especially for species such as garfish and squid. Therefore, in order to gain a complete understanding of the distribution and abundance of prey fishes in the area, a sampling regime, independent of commercial fisheries should be employed. Such methods however, could not be employed by a researcher who does not have access to a large budget and a substantial infrastructure.

On the basis of information gained, a sampling regime, independent of commercial fisheries would be designed. A sampling technique would be applied at regular intervals, at a series of sampling sites, which would include but not be restricted to the times and location of known or suspected penguin feeding activity. If appropriate, plankton surveys could be used to help locate and quantify prey species in the survey area.

Results of this project could be integrated with other research data in order to examine the ecological relationship between Little Penguins and their prey species and in particular to determine the impact upon the penguin population of fluctuations in the abundance and distribution of prey species.

Methodology

A commercial fisheries independent method of sampling the target species would be selected. Possible methods are the use of small boat mid-water trawls, purse seines, or the use of fine mesh nets either set linearly or used as a ring net. Trawls and seines require the use of specially equipped vessels and experienced crew. Each method has its own sampling bias.

Probably the cheapest approach would be to carry out acoustic surveys where the soundings are sampled with fine mesh gillnets. Echo-sounding surveys could be conducted if the soundings were verified by sampling so that the characteristic form of the target species sounding was known. Local bait purse seine fishermen, familiar with the characteristics of baitfish soundings could be approached for advice.

If the prey species carries out spawning at the time and in the location in which they are consumed by the penguins, and if the breeding biology of the species is well known and samples of the adult population are available, then plankton surveys could be utilised to give an indication of the distribution and abundance of newly spawned eggs, and consequently of the distribution and abundance of the adult stock (Egg Production Method of Stock Assessment).

Resources and Funding

This project would require a number of personnel to collect and analyse the data, a boat or boats, and some expensive equipment.

POPULATION ESTIMATES ON OTHER METROPOLITAN ISLANDS

Objective 5.1

Provide an indication of extent to which Little Penguins utilise nature reserve islands, other than Penguin Island, in the Swan Region for breeding and moulting purposes.

Project Outline

Conduct daytime surveys of islands off Perth to locate breeding Little Penguins. The breeding season is between July and November. The survey will involve looking for tell-tale signs of penguins, such as 'runs' or nesting sites, around the entire perimeter of each island. It may be possible to use recordings of penguin vocalisations to locate birds which are breeding in thick vegetation. The islands off the coast of Perth with appropriate habitat and the agency who may survey each are: .

Dyer Island (and others)	Rottnest Island Environmental Section
Carnac Island	CALM Marine Operations
Bird Island	CALM Marine Operations
Seal Island	CALM Marine Operations
Shag Rock	CALM Marine Operations
Garden Island	Ranger in Charge, Jim Maher

The initial surveys should be conducted early in the breeding season, so follow up detailed surveys of breeding colonies could be conducted. Further surveys may include a range of methods of estimating population size (counting birds at landfall; mapping breeding areas and possibly banding individual birds). However, there are major logistical constraints in visiting these small penguin populations at night on very isolated islands.

Resources and Funding

Initial surveys may be done by the agencies nominated above, while conducting general patrol work or on specific visits to islands. However, follow-up surveys in the evenings or at night may be beyond the agencies resources. It may be possible that volunteers and researchers may be able to arrange several night visits to penguin colonies on these islands.

POPULATION ESTIMATES FOR PENGUINS ON THE SOUTH COAST

Objective 5.2: Obtain population estimates of Little Penguins using islands on the south coast for breeding or moulting.

Project Outline

In December 1994, the CALM "Seabird Breeding Islands Database" had recorded Little Penguins breeding on over 40 islands in Western Australia, most of them on the south coast. For many of the south coast islands no counts have been attempted. Andrew Burbidge (WATSCU) believes that some of the south coast islands could harbour large colonies (e.g. Breaksea Island). The data for the Recherche Archipelago is particularly inadequate.

Many of the islands on the south coast are visited irregularly and can be difficult to get to. Occasional visits to the islands do occur by CALM staff and other field ecologists to study some part of the islands management or to survey other species such as fur-seals.

However, there are records from CALM Wildlife Officers visiting the range of islands off the coast, many of which are nature reserves. These records are held by CALM in District, Regional and head office island nature reserve files. They include records from the Department of Fisheries and Wildlife going back to the 1960s. Good records are available from District Wildlife Officers for the Augusta area including Seal and St Alouarn Islands (Peter Lambert, CALM Como), Albany (Peter Collins, CALM Albany) and Esperance (Bernie Haberley, CALM Esperance).

Methodology

Collation and analysis of existing CALM/Department of Fisheries and Wildlife records taken by Wildlife Officers from island nature reserves may provide useful data on Little Penguins on the south coast. Discussions with relevant officers may fill in details. In addition, analysis of data collected may indicate some improvements in data collecting and recording.

It is important that details of penguin (and other seabird) breeding occurs during visits to south coast islands by CALM staff and other interested groups or individuals. Details must be forwarded to the "Seabird Breeding Islands Database" for permanent record. Visits to islands for management purposes should be co-ordinated with the breeding season of the Little Penguin where possible. Appropriate CALM (District, Wildlife Officers and Science and Information Division) staff, the RAOU and individuals should be made aware of this Plan and the need to survey Little Penguins.

It would be appropriate to gain specific funding for a survey of seabird breeding on islands on the south coast. Priorities are the islands (1) of the Recherche Archipelago, (2) off Albany (Denmark to Bald Island) and (3) from Dunsborough to Augusta. Local CALM staff and people with specific seabird knowledge should be involved in proposed surveys. The surveys could be done from boats or teams being dropped by helicopter.

Resources and funding

External funding be sought for the costs of running boats, travel expenses and staff salaries. It may be possible to use volunteers and some CALM staff time for these surveys.

ENVIRONMENTAL CONTAMINANTS IN LITTLE PENGUINS

Objective 6.2

To monitor the exposure of Little Penguins to significant contaminants identified in the southern metropolitan coastal waters.

Project Outline

Techniques have now been developed to determine the levels of various environmental contaminants in bird feathers. Feather samples may contain a chemical record of the exposure to environmental contaminants during the period preceding annual feather growth. In Little Penguins this may represent exposure during the pre-moult fattening period.

Since Little Penguins use nest boxes as moulting sites it should be possible to date the moulted feathers and in many cases identify the marked individuals providing the samples. Thus one year's exposure to contaminants can be compared to the previous ones within the colony or within individuals.

Penguins are top order consumers and ideally suited for the study of the biological effects of coastal pollutants, especially substances which bio-accumulate such as metals (cadmium, lead and mercury), organochlorines, PCBs and organotin (TBTs). It may also be possible to monitor exposure to poly-aromatic hydrocarbons. Penguins can be used in this way to monitor pollutant levels impinging on the Shoalwater Islands Marine Park.

Methodology

Feather samples can be easily collected from previously cleaned nest boxes during the moulting period. Murdoch University could start collecting and storing samples over the next moulting season. These samples can be dry stored prior to obtaining finance for the chemical analysis. Most of the chemical analysis can be carried out by the environmental chemistry unit of the WA Chemistry Centre. TBT assays may have to be sent to ANSTO.

Resources and Funding

The major cost of this project will be the cost of chemical analysis of the samples, which may be $50-$100 per sample. External funding for the chemical assays could be sought from AIMS or the DEP. Fundraising could be undertaken by FSIMP.

Lead Organisation / Person

Murdoch University.

ATTACHMENT I - Little penguin workshop priorities, recorded into alike topics.

PENGUINS ON LAND

Priority 1. Long term monitoring of population numbers

(5) Design of rigorous robust controlled long term monitoring program which indicates changes in penguin numbers from year to year.
(5) Count as come ashore
(5) Mark-recapture monitoring and birds coming ashore
(5) Population studies of penguins
(5) Population monitoring (index)
(5) Maintain population size data (establish an index and then monitor)
(5) Change in population size
(5) Maintain long term monitoring of breeding population numbers
(5) Long term monitoring of breeding population numbers
(5) Population size on land (census of all colonies). Try high tech methods (infra red?)
(5) Determine population size and trend
(4) Population size or indicator of size of Penguin Island population for examining population trends
(4) Model population dynamics and critical process to population maintenance
(3) Monitor adult survival (via 5 above)
(1) Design and development of penguin database to manage and control common data.
(1) Population densities on land

(11x5; 2x4; 1x3; 0x2; 2x1; = 68/16)

Priority 5: Maintain long term monitoring program on Little Penguin reproductive success

(3) **Determine index of reproductive success - what factors varying from year to year inhibit laying and chick rearing**
(5) Philopatry, recruitment rates and adult survival
(4) Monitoring breeding success
(4) Long term monitoring of breeding success
(2) How is the breeding population size changing?
(2) 5-10 year breeding study to establish variability and evaluate human impacts

(1x5; 2x4; 1x3; 2x2; 0x1; = 20/6)

Priority 7: Obtain population penguin estimates for south coast and other sites

(4) Compare west and south coast populations
(2) Determine breeding populations numbers and distribution on other islands outside of Penguin Island
(1) Try to obtain estimates of populations elsewhere in W.A.
(3) Population of penguins on penguin Island and other islands in the south coast

(0x5; 1x4; 1x3; 1x2; 1x1; = 10/4)

Priority 8: Examine impacts of visitors on Penguin Island penguin population

(1) Impact of people on penguins at Penguin Island
(4) Behaviour in relation to human disturbance
(3) Visitor access/impacts both spatial and temporal
(1) Monitor effects of recreation on penguins

(0x5; 1x4; 1x3; 0x2; 2x1; = 9/4)

Priority 9: Assess characteristics and preferred use of habitat by penguins

(3) Habitat analysis
(2) Optimal habitat for breeding sites
(2) Habitat competition between species
(1) Preferred habitat

(0x5; 0x4; 1x3; 2x2; 1x1; = 8/4)

Priority 11: Recruitment of fledglings back into the breeding population

(2) Recruitment At what rates do fledglings join the breeding population. Annual variation.
(2) Monitor recruitment of banded young to breeding population
(1) Estimate of recruitment rate to Penguin Island breeding population

(0x5; 0x4; 0x3; 2x2; 1x1; = 5/3)

Priority 2: Where penguins feed and how this changes within and between seasons

(4) Radio-tracking program to find out where penguins feed and how this changes with season and how consistent this is from year to year
(5) Foraging areas of Penguin Island penguins throughout the year
(5) Where do the Little Penguins forage and how do they locate prey?
(5) Radio tracking
(5) Radio tracking
(5) Radio tracking
+ (5) Distribution of prey species and foraging penguins
(4) Where penguins are at sea
(4) Feeding RANGE of breeding pairs and fledglings
(4) Foraging ranges
(4) Determine penguin movements at sea in space and time
(4) Behaviour at sea. Where they go.
(4) Time depth recorders
(3) Foraging distribution of penguins
(3) Radio-tracking. Where do they go (year to year variation)
(3) Determine feeding areas and prey species
(2) Penguins offshore
(2) Where fledglings go when first leave Penguin Island

(5x5; 7x4; 3x3; 2x2; 0x1; = 66/17)

Priority 3: Distribution and abundance of prey fish stocks

(4) What is the distribution, age and size structure of prey species?
* (5) Distribution of prey species and foraging penguins
(3) Understand prey abundance and management over time
(3) Relationships to prey fish stocks and distribution
(3) Distribution and abundance of prey species within foraging areas (range) of Penguin Island birds
(3) Habitat preference of prey species
(2) Distribution of prey species
(2) Distribution of prey species
(2) Studies of prey fish stocks and influence of environmental variables on them
(2) Determine factors affecting prey availability
(1) Factors affecting prey abundance and distribution
(1) Baitfish stock sizes
(1) Prey abundance and distribution

(1x5; 1x4; 4x3; 4x2; 3x1; = 31/13)

Priority 4: Study of diet of Penguins

(4) Monitor diets of penguins throughout year and from year to year
(4) What do penguins feed on, in different areas (WA coastline)
(3) What penguins eat (fish species, size)
(3) What they feed on and where/when
(3) Prey species and quantities
* (2) What food types are available and the effect of environmental variables, competition with fishermen
(1) Chose of prey species

(0x5; 2x4; 3x3; 1x2; 1x1; = 20/7)

Priority 6: Interaction between prey availability and penguin breeding.

(3) Feed availability verses penguin breeding
(4) Influence of recruitment success of the prey species on the breeding success of little penguins
(3) How penguins locate prey
(3) Effect of weather on foraging success and breeding success

(0x5; 1x4; 3x3; 0x2; 0x1; = 13/4)

Priority 10: Causes of mortality of penguins at sea

(2) **Mortality at sea (recreational, commercial, natural)**
(1) Mortality at sea
(1) Effects of pollution, disturbance, environmental variables on penguin mortality
(1) Impact of plastic pollutants
(1) Mortality at sea

(0x5; 0x4; 0x3; 1x2; 4x1; = 6/5)

Priority 11: Competition with commercial fisheries

(2) **Competition with commercial fisheries**
+ (2) What food types are available and the effect of environmental variables, competition with fishermen
(2) Competition with commercial fisheries
(1) Interaction/competition with fishery operations

(0x5; 0x4; 0x3; 2x2; 1x1; = 5/3)

(5) Predation on little penguins
(4) Bio-accumulation in penguins
(2) Exposure to bio-accumulators, heavy metals, pesticides and PCB's from feather analysis
(1) Population genetics for comparison between species
(1) Indicators of population health e.g. disease, parasites, breeding success.