MONITORING BIODIVERSITY IN SOUTH-WEST FORESTS

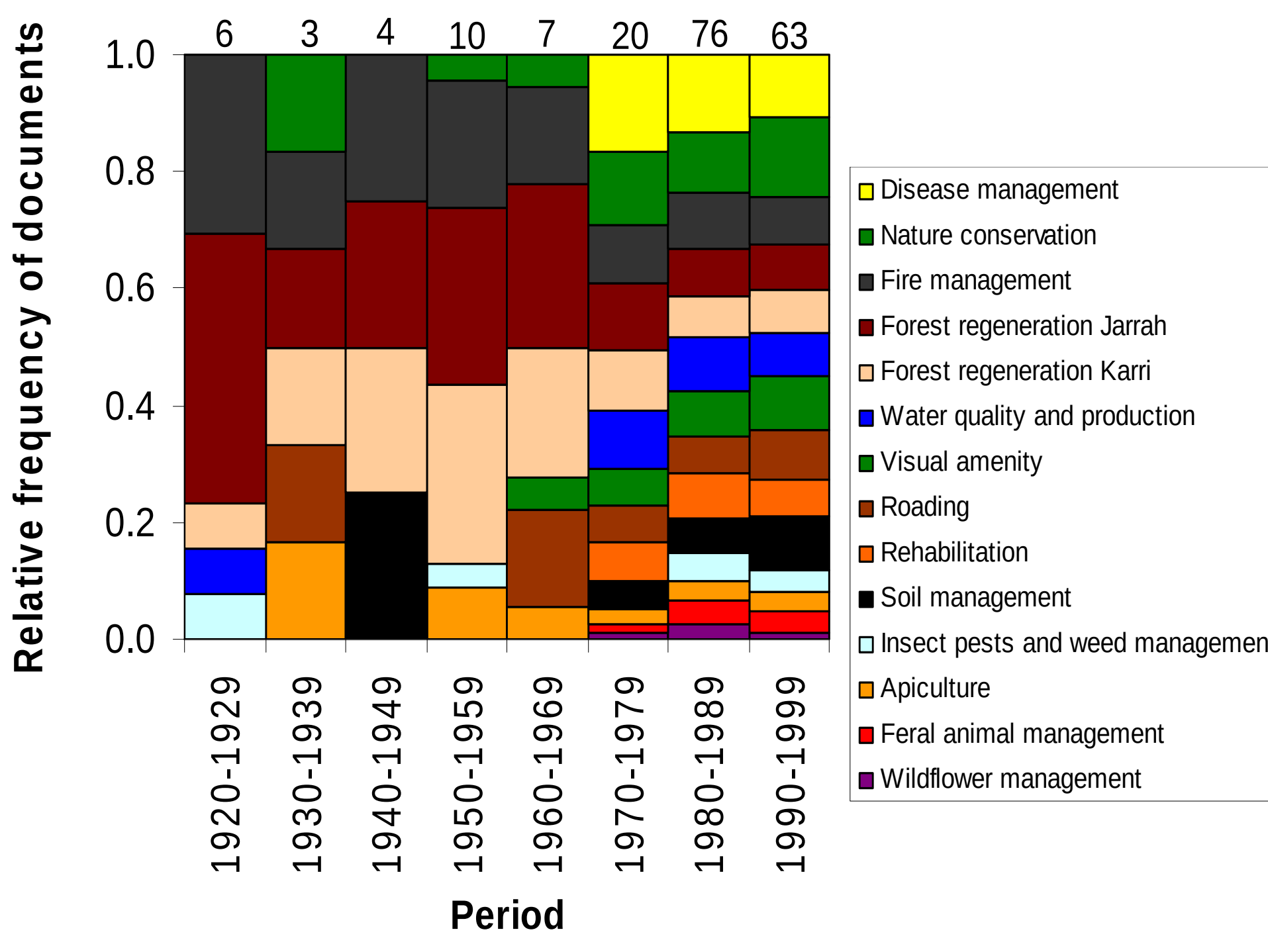
What is FORESTCHECK?

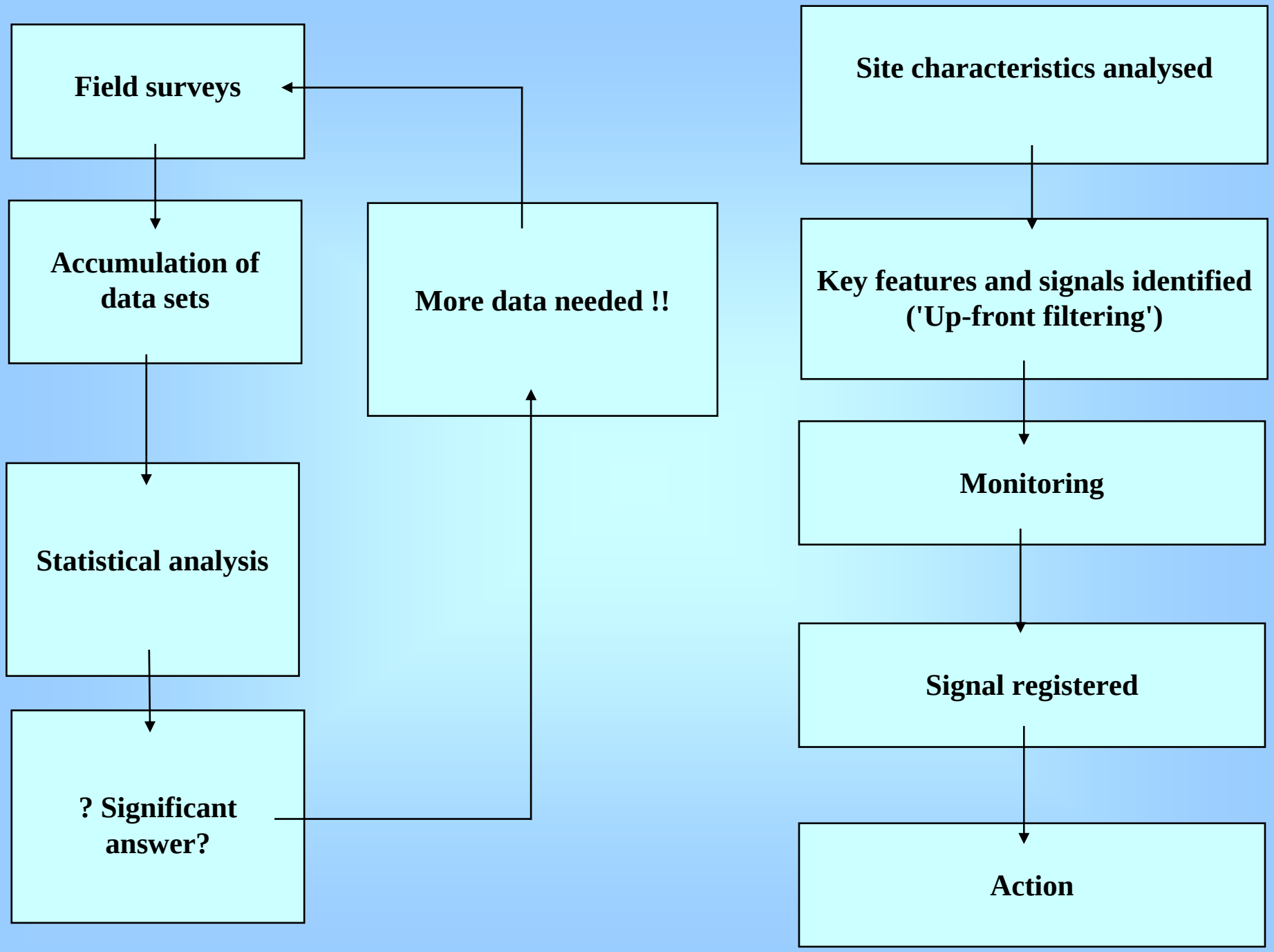
A framework to quantify, record, interpret & report on the status of key forest organisms, ecological communities & processes in response to forest management & natural variation.

AUDIT	checks the extent and quality of strategic & business planning processes
COMPLIANCE	checks the adherence to prescriptions, policies & codes of practice
RESEARCH	hypothesizes, discovers new facts, formulates new concepts, re-organizes knowledge
MONITORING	checks the quality of the outputs & outcomes against set goals

Forest management in WA has comprised a mix of adaptive and directed management:

- strong in strategic planning, audit and compliance
- based strongly on scientific research
- weak on monitoring of outcomes


6
3
4
10
7
20
76
63
1.0
0.8
0.6
0.4
0.2
0.0
Relative frequency of documents
1920-1929
1930-1939
1940-1949
1950-1959
1960-1969
1970-1979
1980-1989
1990-1999
Period
Disease management
Nature conservation
Fire management
Forest regeneration Jarrah
Forest regeneration Karri
Water quality and production
Visual amenity
Roading
Rehabilitation
Soil management
Insect pests and weed managemen
Apiculture
Feral animal management
Wildflower management


Field surveys
Accumulation of data sets
Statistical analysis
? Significant answer?
More data needed !!
Site characteristics analysed
Key features and signals identified ('Up-front filtering')
Monitoring
Signal registered
Action

Initiation of forest monitoring in WA (mostly by scientists)

1916 - growth plots for trees established

1972 - forest mammals at Perup

1972 - fire impacts on plants

1982 - birds in karri forest

1995 - Forest red-tailed black cockatoo

1999 - FORESTCHECK concept planning begun

Why FORESTCHECK?

- Monitoring is an important element of ESFM
  - adaptive management
- Ministerial Conditions 1992
- Forest Management Plan 1994
- Montreal Process - C & I of ESFM
- RFA
- Community expectations

Broad goals of ESFM (Biodiversity)

- In each forest landscape conservation unit, no species becomes extinct, or falls to irretrievably low levels, as a result of management activities
- Species assemblages at the coupe level recover in time (before the next logging event)
- Water quality is maintained within acceptable (potable) limits
- The physical condition of the soil is protected

Ministerial conditions attached to 1994 Forest Management Plan

Conditions 3-1, 3-2, 5-3, 11-1 and 12-3 (set by Minister McGinty) address the requirement for commitment to monitoring

Obstacles to more effective forest monitoring

- Forest monitoring & research committee established 1993 but ineffective
- Senior forest managers saw monitoring as unnecessary (in the context of audit, compliance & research) & a financial burden

New opportunities supportive of forest monitoring - 1

1994 - Forest Management Plan

(a) Monitoring the effectiveness of measures to protect the environment

(b) Monitoring the impact of disturbance-causing activities

(c) Monitoring ecosystem change through periodic measurement of an extensive system of permanent plots and selected vertebrate and invertebrate species

New opportunities supportive of forest monitoring - 2

1998 - Montreal process of criteria & indicators agreed to by CoA and the States

Table 1: Agreed phased implementation of indicators

Category A—Largely implementable now	Category B—Require some development	Category C—Require longer-term R&D
1.1.a Extent of area by forest type and tenure. (Amended to include 1.1.c)	**1.1.e** Fragmentation of forest types.	**1.2.c** Population levels of representative species from diverse habitats monitored across their range.
1.1.b Area of forest type by growth stage distribution by tenure. (Amended to include 1.1.d)	**5.1.a** Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages.	**1.3.a** Amount of genetic variation within and between populations of representative forest dwelling species.
1.2.a A list of forest dwelling species.	**6.1.a** Value and volume of wood and wood products production, including value added through downstream processing.	**3.1.a** Area and per cent of forest affected by processes or agents that may change ecosystem health and vitality.
1.2.b The status (threatened, rare, vulnerable, endangered, or extinct) of forest dwelling species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment.	**6.3.a** Value of investment, including investment in forest growing, forest health and management, planted forests, wood processing, recreation and tourism.	**3.1.c** Area and percentage of forest land with diminished or improved biological, physical and chemical components indicative of changes in fundamental ecological processes.
2.1.a Area of forest land and net area of forest land available for timber production.	**6.4.a(i)** (priority areas) Area and per cent of forest land in defined tenures, management regimes and zonings which are formally managed in a manner which protect Indigenous peoples' cultural, social, religious and spiritual values, including non-consumptive appreciation of country.	**4.1.c** Per cent of stream kilometres in forested catchments in which stream flow and timing has significantly deviated from the historic range of variation.
2.1.d Annual removal of wood products compared to the sustainable volume.	**6.4.a(ii)** Proportion of places of non-Indigenous cultural values in forests formally managed to protect these values.	**4.1.d** Area and per cent of forest land with significantly diminished soil organic matter and/or changes in other soil chemical properties.
2.1.f Area and per cent of plantation established meeting effective stocking one year after planting.	**6.5.a** Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment. (Indirect)	**4.1.d** (Interim) The total quantity of organic carbon in the forest floor (< 25 mm diameter components) and the surface 30 cm of soil.
2.1.g Area and per cent of harvested area of native forest effectively regenerated.	**6.6.a** Extent to which the management framework maintains and enhances Indigenous values including customary, traditional and native title use by Indigenous peoples and for Indigenous participation in forest management.	**4.1.e** Area and per cent of forest land with significant compaction or change in soil physical properties resulting from human activities.
3.1.a Area and per cent of forest affected by processes or agents that may change ecosystem health and vitality. (A narrative as interim)		**4.1.f** Per cent of water bodies in forest areas (e.g. stream kilometres, lake hectares) with significant variance of biological diversity from the historic range of variability.
4.1.a (Interim) Area and per cent of forest land systematically assessed for soil erosion hazard, and for which site-varying scientifically-based measures to protect soil and water values are implemented.		**6.1.b** Value and quantities of production of non-wood forest products.
6.2.c Number of visits per annum.		**6.2.b** Number, range and use of recreation/tourism activities available in a given region.
6.5.a Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment. (Direct)		**6.5.c(i)** Viability and adaptability to changing social and economic conditions of forest dependent communities.
7.1 (Narrative) *Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests.*		**6.5.c(ii)** Viability and adaptability of forest dependent Indigenous communities.
7.2 (Narrative) *Extent to which the institutional framework supports the conservation and sustainable management of forests.*		
7.4 (Narrative) *Capacity to measure and monitor changes in the conservation and sustainable management of forests.*		
7.5 (Narrative) *Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services.*		
Total: 12 indicators & 4 sub-criteria	**Total: 8 indicators**	**Total: 13 indicators**

New opportunities supportive of forest monitoring - 3

- 1999 - FMRC Working Group of Scientists (B Dell *et al*.): external review of CALMScience
- 1999 - Regional Forest Agreement
- 1999 - Ferguson committee
- 1999 - EPA Bulletin 928

Development of FORESTCHECK concept plan: internal stakeholder involvement

- March 1999 - Science Management Council endorsement of draft Integrated Forest Monitoring System concept plan
- April 1999 - CALM workshop (9 CALMScience, 9 other CALM)

Development of FORESTCHECK concept plan: external expert stakeholder involvement

- October 1999 - workshop (22 external experts, 9 CALM scientists)
- November 1999 - document revised for further peer review
- March 2000 - workshop (10 external experts, 16 CALM scientists) to finalize protocols

Corporate buy-in

- May 2000 - Concept plan approved by CALM's Corporate Executive
- Implementation stalled by insufficient resources & major legislative changes (2 new appointments required: Co-ordinator and Technical Support Officer)

Implementation

- June 2001 - CALMScience workshop at Manjimup
  - compiled an operations manual of standardized sampling methods & set up workable databases based on the Kingston experience
  - decided on 3 sites to be monitored in November 2001
  - confirmed membership of FORESTCHECK teams

WE CANNOT:

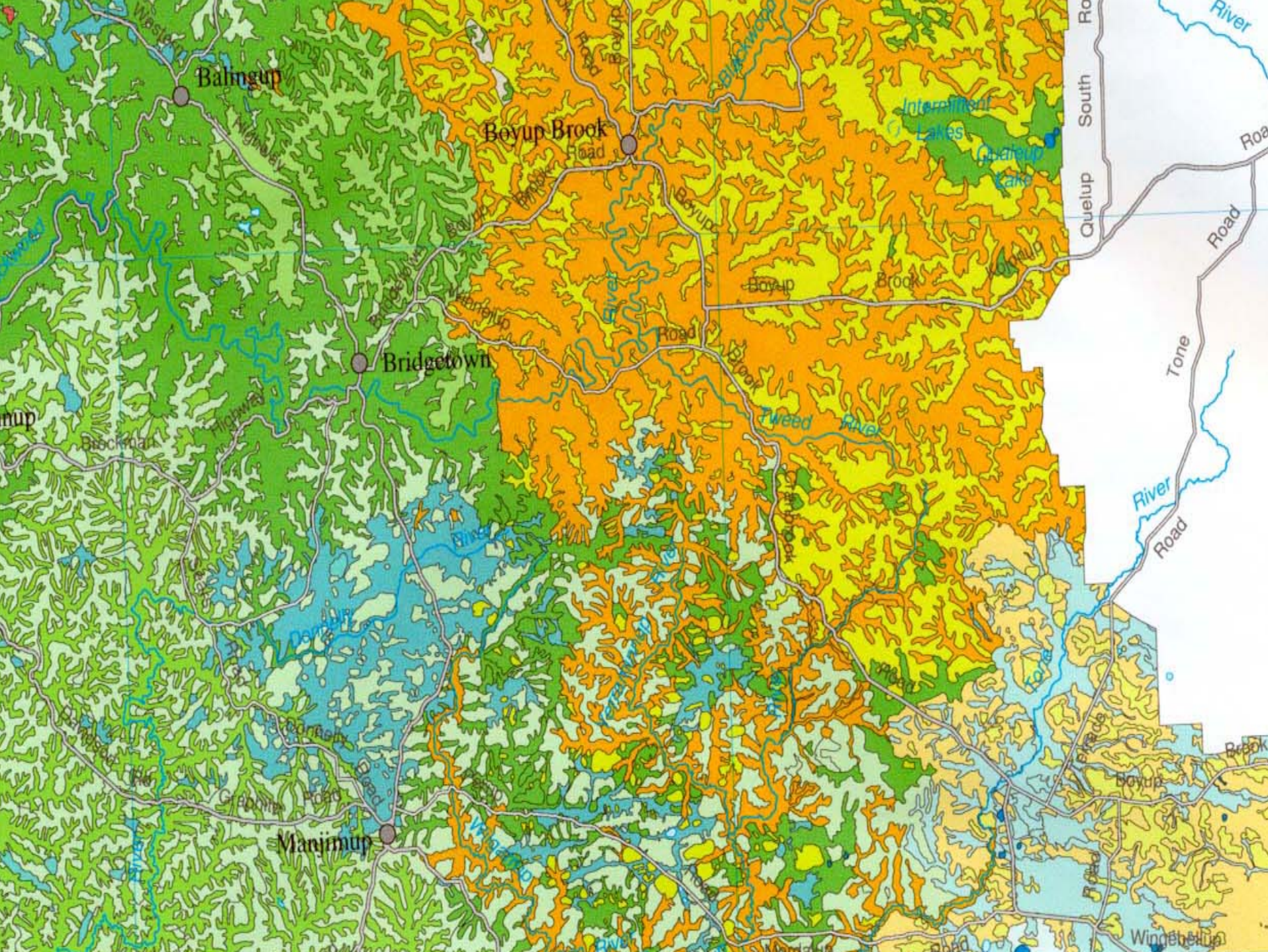
- Measure everything, everywhere, all of the time

WE CAN:

- Measure some things, somewhere, some of the time

Sampling design

- Forest landscape conservation unit (initially), vegetation complexes (ultimately)
- Logging disturbance: gap release, shelterwood (initially); fire history (ultimately)
- Time since logging (1990 onwards)
- Each site sampled in spring and autumn


Balingup
Boyup Brook
Bridgetown
Manjimup
Quelup Lake
Intermittent Lakes
Tweed River
Boyup Brook Road
Bridgetown Road
Manjimup Road
Quelup South Road
Tone River Road

Each FORESTCHECK site will consist of several disturbance types in close proximity:

- One gap release coupe
- One shelterwood coupe
- One internal reference area (coupe buffer)
- One external reference area

Components sampled

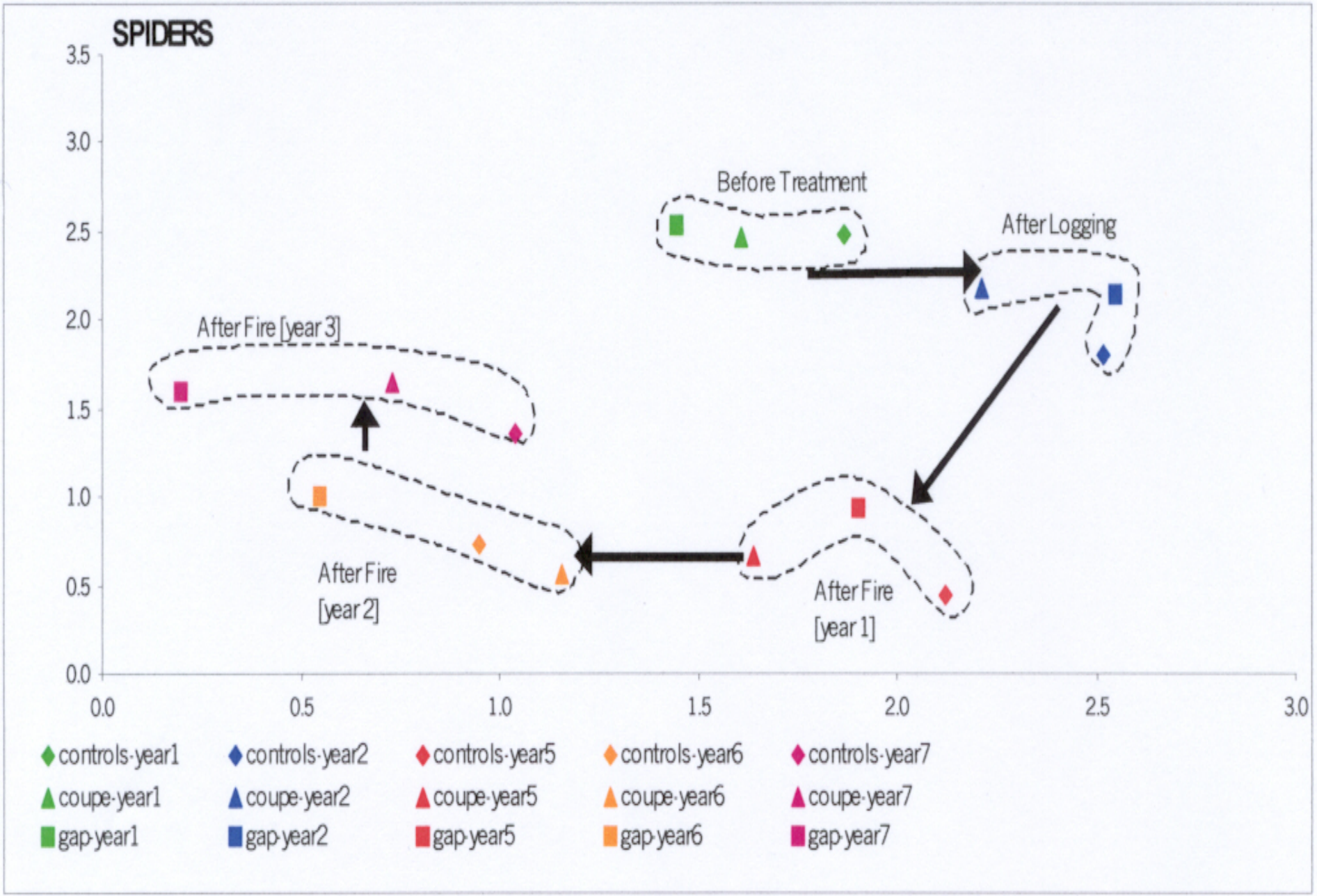
- Plants & cryptogams
- Invertebrates
- Macrofungi
- Birds
- Mammals (incl. fox & cat), reptiles & frogs
- Ecosystem processes

Interpreting Data

- Traditional hypothesis-testing techniques reliant on adequate statistical power
- Trend analysis (Bayesian statistics)
- Simpler descriptive (graphical) techniques

Some examples of possible analyses

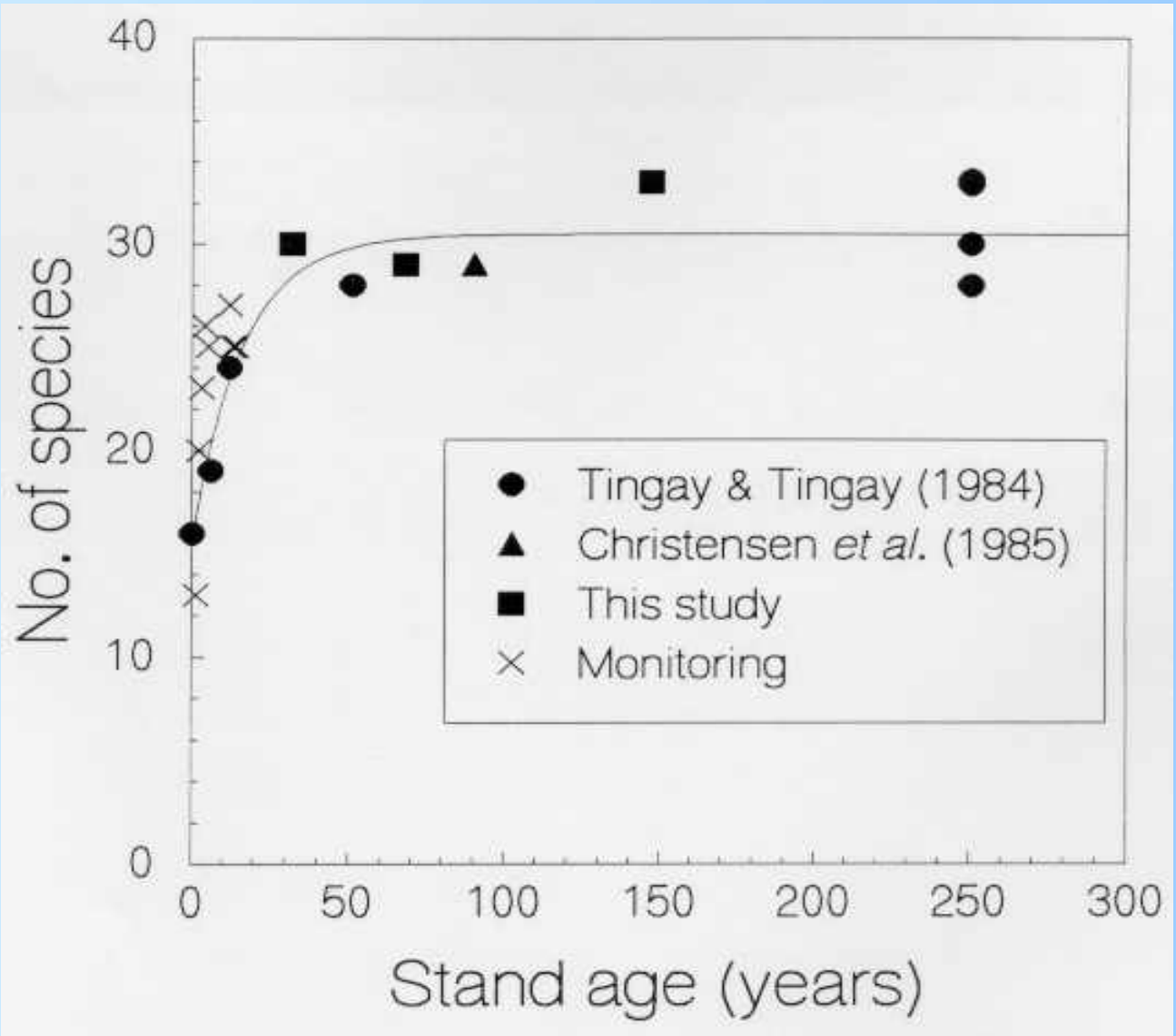
Ordination of assemblage (species composition) data using non-metric multiple dimensional scaling (based on abundance data)


SPIDERS
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Before Treatment
After Logging
After Fire [year 3]
After Fire [year 2]
After Fire [year 1]
controls-year1
controls-year2
controls-year5
controls-year6
controls-year7
coupe-year1
coupe-year2
coupe-year5
coupe-year6
coupe-year7
gap-year1
gap-year2
gap-year5
gap-year6
gap-year7

Trajectory graphs

These show the extent and rate that species and attributes return to levels comparable to reference sites

It should be possible to add standard errors of the means as data accrue


40
30
20
10
0
No. of species
0
50
100
150
200
250
300
Stand age (years)
Tingay & Tingay (1984)
Christensen *et al.* (1985)
This study
Monitoring

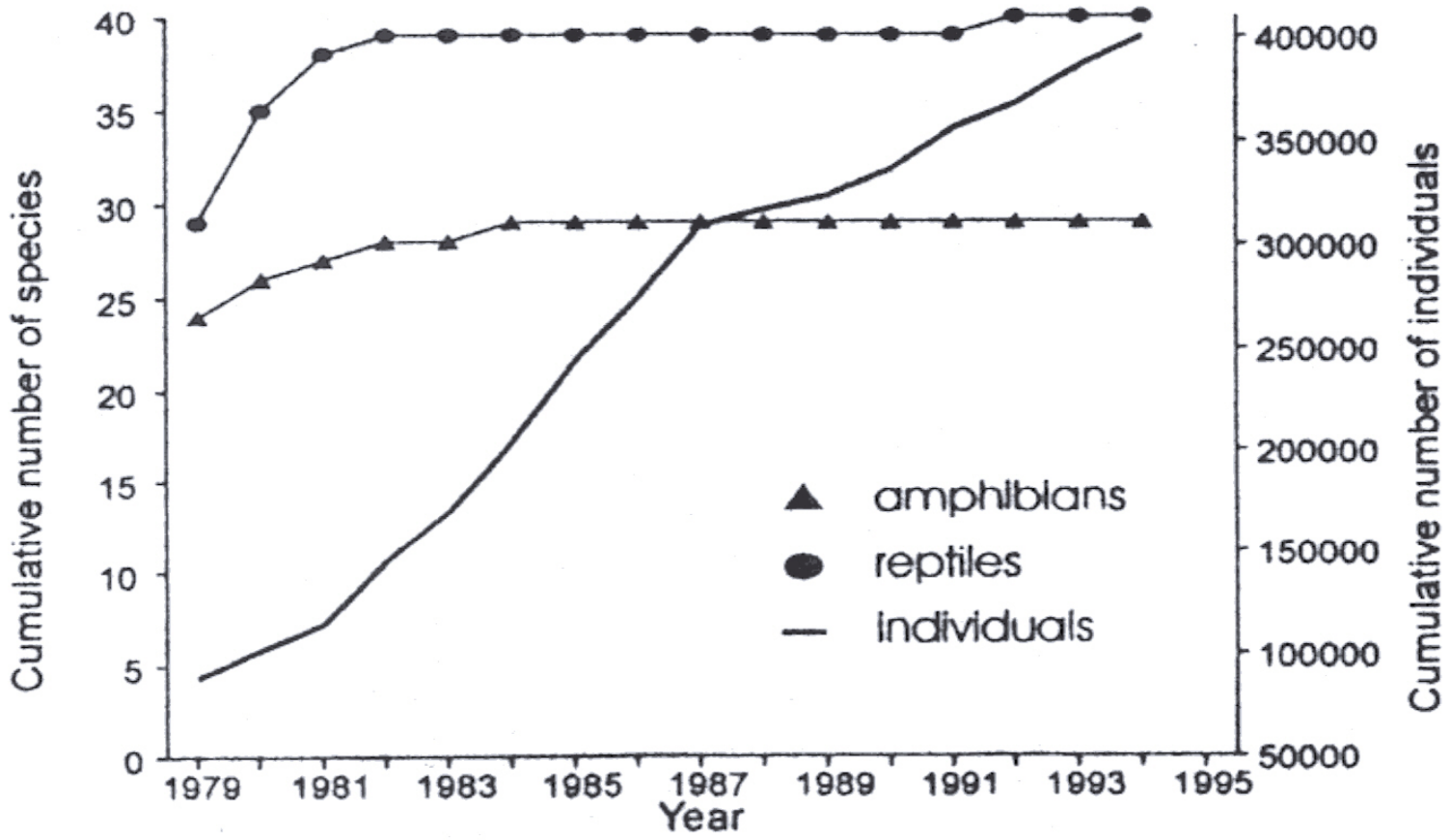
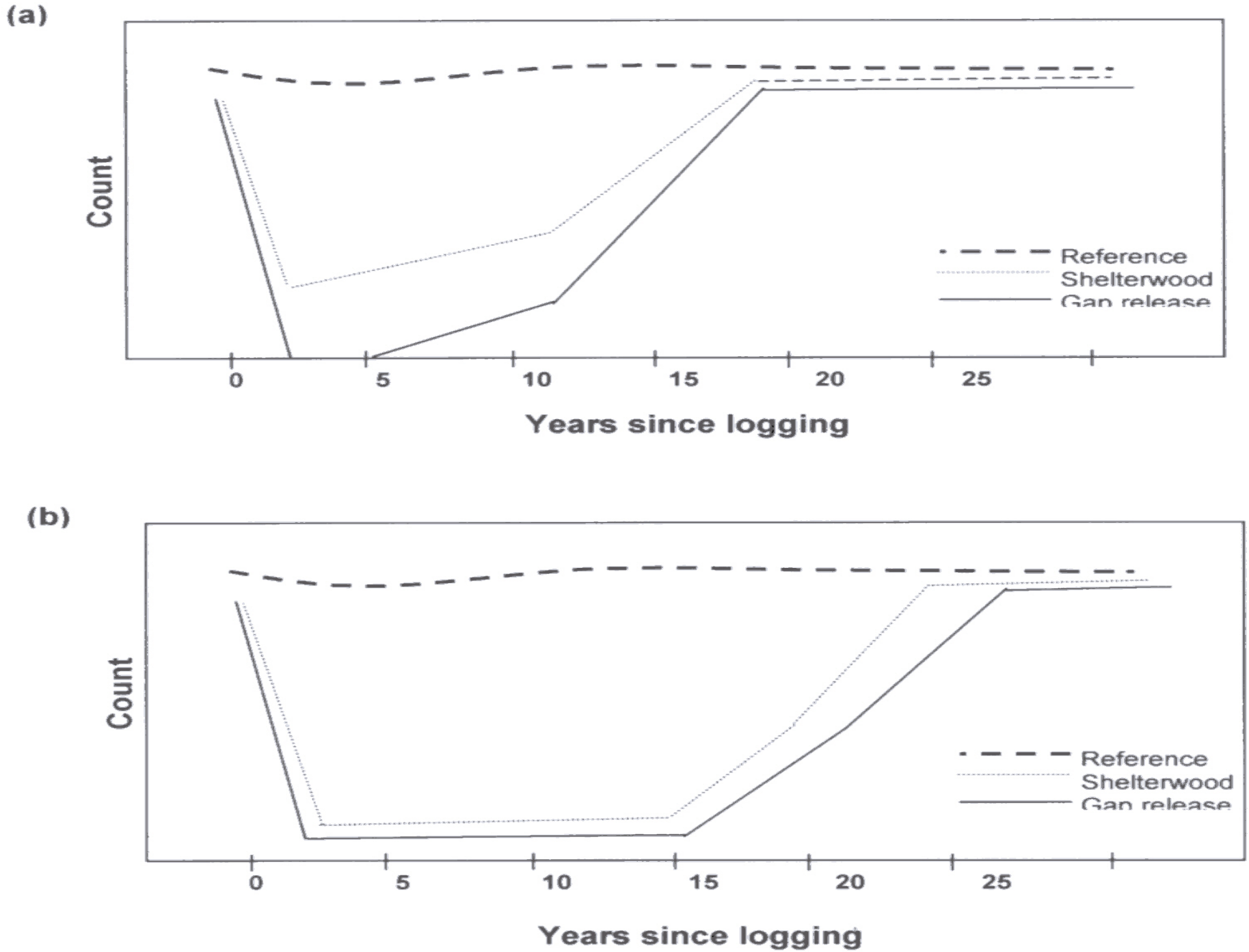
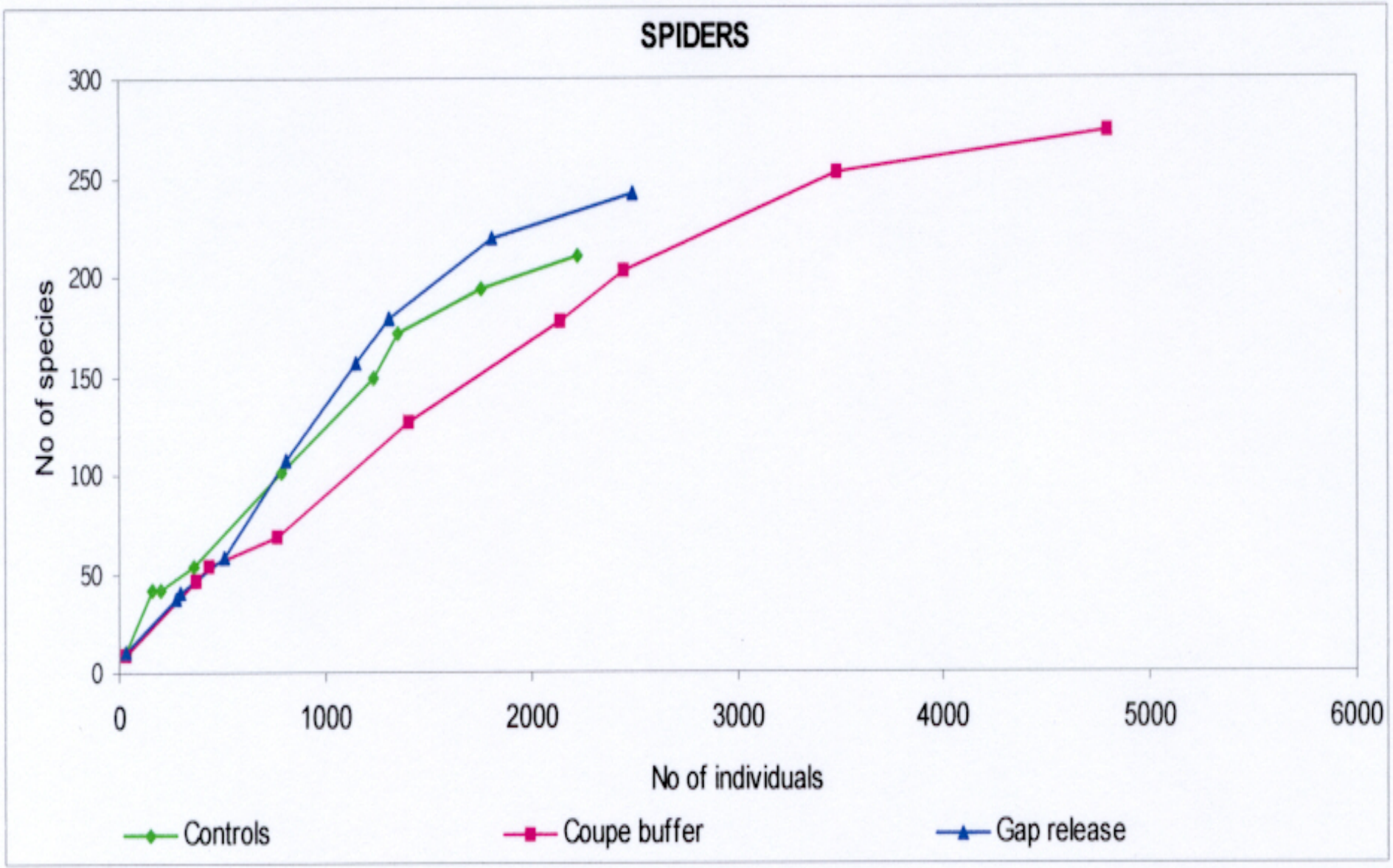


Figure 4. Annual increases in cumulative numbers of species and individual reptiles and amphibians captured at Rainbow Bay. Rainbow Bay is a temporary freshwater wetland habitat (geologically defined as a Carolina bay) and has been completely encircled with a drift fence and pitfall traps since 1978 (18 years).

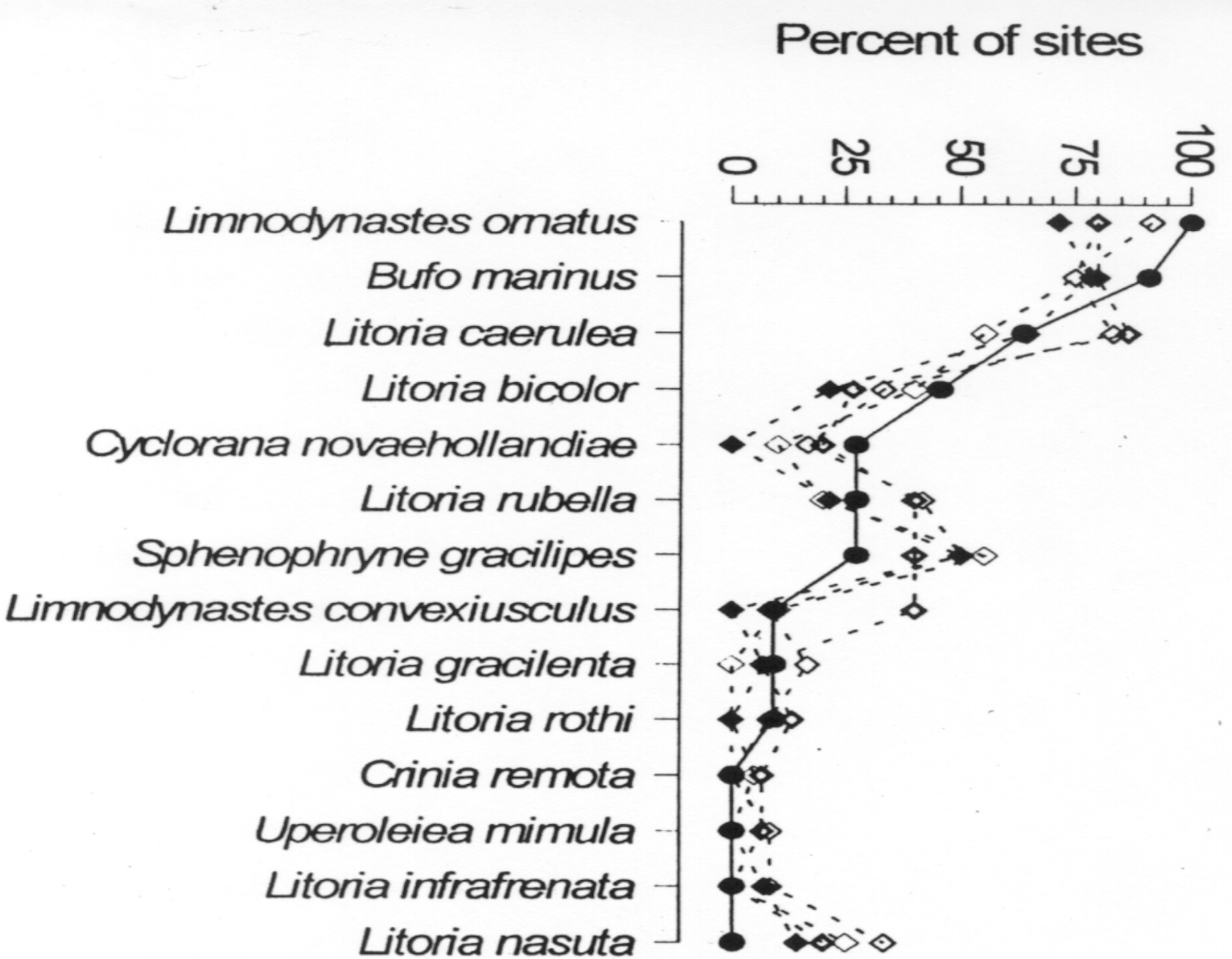

(a)
Count
Reference
Shelterwood
Gap release
0
5
10
15
20
25
Years since logging
(b)
Count
Reference
Shelterwood
Gap release
0
5
10
15
20
25
Years since logging


SPIDERS
No of species
300
250
200
150
100
50
0
Aut 94
Spr 94
Aut 95
Spr 95
Aut 96
Spr 96
Aut 97
Spr 97
Aut 98
Spr 98
Aut 99
Spr 99
Aut 00
Spr 00
Controls
Coupe buffer
Gap release


SPIDERS
No of species
300
250
200
150
100
50
0
0
1000
2000
3000
4000
5000
6000
No of individuals
Controls
Coupe buffer
Gap release

Profile diagrams

- These show the proportion of treatment sites at which species have been recorded.
- When the species are sorted in order of their frequency of occurrence in reference sites, it is straightforward to determine which species have recovered in treated sites


Percent of sites
0
25
50
75
100
Limnodynastes ornatus
Bufo marinus
Litoria caerulea
Litoria bicolor
Cyclorana novaehollandiae
Litoria rubella
Sphenophryne gracilipes
Limnodynastes convexiusculus
Litoria gracilenta
Litoria rothi
Crinia remota
Uperoleiea mimula
Litoria infrafrenata
Litoria nasuta

Proposed community involvement

- Use of volunteers to help collect data
- Scrutiny of analyses by independent scientists
- Roadshow presentations of data collected in graphical format
- Public access to databases (transparency)
- Website access to ongoing results

Next steps?

- Aquatic invertebrate fauna
- Fire (prescribed and wild)
- Karri forest?
- Elsewhere in WA?