Landscape scale analysis
of the value of
waterbirds in the
Alligator Rivers Region,
northern Australia

MG Bellio, P Bayliss & P Dostine

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Abstract

The coastal and alluvial floodplains of the Alligator Rivers Region (ARR) support an outstanding diversity and abundance of flora and fauna, and encompasses Kakadu National Park. The region is extremely important to Aboriginal people, and many communities still use the floodplains as a source of traditional food, in particular geese and ducks. Kakadu National Park is inscribed on the World Heritage List because of its outstanding cultural and natural universal values, and its wetlands are listed under the Ramsar Convention on Wetlands of International Importance.

In 1999 the World Heritage Committee recommended that landscape and ecosystem analyses of the entire region be undertaken to help protect the ecological and cultural integrity of Kakadu. In response to this recommendation the Supervising Scientist Division of Environment Australia has commenced a number of landscape-wide projects that link various threats and pressures to ecosystems of the ARR (e.g. mining, invasive species, climate change & salinisation), in particular wetlands, in order to outline risk management strategies. Waterbirds are a key component of tropical wetlands and occupy several trophic levels. They are also potential indicators of ecological condition and have high cultural and natural significance. We are developing a conceptual model which directly links waterbird dynamics to the quality of their wetland habitats, both in terms of the availability of food and nesting resources. Being able to use the abundance and diversity of waterbirds as key indicators of “wetland health” and determining the efficacy of this approach is a key issue.

Key words: waterbirds, world heritage values, landscape analysis, cultural and natural resource management
Landscape scale analysis of the value of waterbirds in the Alligator Rivers Region

M BELLIO – P BAYLISS - P DOSTINE – J BOYDEN-M FINLAYSON

The Alligator Rivers Region
• **KAKADU NATIONAL PARK**
  1. World Heritage Area (natural and cultural)
  2. Ramsar Convention

• **ABORIGINAL PEOPLE** own much of the land in the Region and several groups continue to utilise the natural resources in a semi-traditional manner

• **IMPORTANT MINERAL RESERVES (URANIUM)**

• **PASTORALISM**

• **TOURISM**

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**Background**

• Approval for a new uranium Mine (1998) – Jabiluka

• Meeting in Tokyo Nov 1998– Bureau of World Heritage Committee expressed its concern – threat to World Heritage Values

• Mission was sent to Kakadu – Jabiluka stopped

• ISP recommendation : comprehensive risk assessment of both the freshwater and terrestrial ecosystem at a landscape-catchment scale
Landscape projects Aims

- Collect baseline information at a landscape scale on flora fauna and their habitat
- Separate impact of mining from unrelated mining activities:
  - Highly variable environment
  - Different land uses
  - Weeds
  - Ferals
  - Climate change

What we need to assess

- When they occur (seasonal patterns)
- Identify vulnerability at each time of the year
- Identify ecological drivers (individual sp. – guilds)
- Identify habitat usage (individual sp.– guilds)
- Predictive aspect – how species respond to environmental perturbations (natural or human induced)
- How we maintain the ecological value of those areas (World Heritage Values)
What we already know


Developing Conceptual models

*Developing conceptual models incorporating the basic ecological factors affecting the functioning of the wetlands, and dynamics upon which these ecosystems are regulated.*

Discussion points:

- Habitat
- Food availability
- Diet food intake
- Individual condition
- Reproductive condition
- Population Dynamics
- Nesting – Spacing behaviour
- Distribution and Abundance
At the Level of Individual Green Pygmy Goose

- Small tropical duck largely unstudied
- Inhabits floodplains and lagoons of the ARR and Northern Australia
- Known to feed on water lilies and other aquatic plants, but also range of aquatic animals
- Processes which diminish diversity of diet items (weeds invasion, loss of habitat) will lower habitat quality for this species

Reproductive condition Green Pygmy Goose

Average dimension of follicles

<table>
<thead>
<tr>
<th>Season</th>
<th>EW-81</th>
<th>EW-81 82</th>
<th>EW-82</th>
<th>LW-83</th>
<th>LW-84</th>
<th>LD-83</th>
<th>LD-84</th>
<th>EW 83/84</th>
<th>LW 84</th>
<th>LD 84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-Dec</td>
<td>2.00</td>
<td>1.44</td>
<td>1.14</td>
<td>2.72</td>
<td>2.96</td>
<td>1.25</td>
<td>1.82</td>
<td>6.22</td>
<td>1.25</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Correlation female gonads development and rainfall

\[ y = 0.0099x + 1.402 \]

\[ R^2 = 0.8179 \, n=7 \, df=7 \, p<0.001 \]

EW – Nov Dec Jan
LW – Feb Mar Apr
ED - May June Jul
LD – Aug Sep Oct
**Reproductive condition**

**Green Pygmy Goose**

**Male gonads development across seasons** 1981 - 1984

<table>
<thead>
<tr>
<th>Season</th>
<th>EW - 81</th>
<th>EW - 81/82</th>
<th>ED - 82</th>
<th>EW - 82</th>
<th>LW - 83</th>
<th>LD - 83</th>
<th>EW - 83</th>
<th>ED - 83</th>
<th>LW - 83/84</th>
<th>LD - 83/84</th>
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<tbody>
<tr>
<td>1981-1982</td>
<td>22.75</td>
<td>19.95</td>
<td>22.32</td>
<td>16.11</td>
<td>29.81</td>
<td>16.11</td>
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<td>32.01</td>
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<td>1982-1983</td>
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<td>49.16</td>
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<td>1983-1984</td>
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</tbody>
</table>

**Average dimension of testes**

- ED (81) 86.06
- EW (81/82) 49.16
- ED (82) 49.16
- ED (83) 22.32
- LD (83) 19.95
- ED (83) 19.95
- ED (82) 19.95
- ED (81) 19.95
- EW (83/84) 49.16
- LW (84) 29.81
- ED (84) 32.01

**Correlation between male gonads and rainfall**

\[
y = 0.1198x + 21.466\\
R^2 = 0.6462\quad r=0.803\quad df=7\quad p<0.01
\]

**Individual condition**

**Body Weight**

**Pattern of body weight across seasons**

<table>
<thead>
<tr>
<th>Season</th>
<th>EW - 81</th>
<th>EW - 81/82</th>
<th>ED - 82</th>
<th>EW - 82</th>
<th>LW - 83</th>
<th>LD - 83</th>
<th>EW - 83</th>
<th>ED - 83</th>
<th>LW - 83/84</th>
<th>LD - 83/84</th>
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<tbody>
<tr>
<td>1981-1982</td>
<td>310.00</td>
<td></td>
<td>320.00</td>
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<tr>
<td>1982-1983</td>
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<td>330.00</td>
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<td>1983-1984</td>
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</tbody>
</table>

**Body weight and Rainfall**

\[
y = -0.0865x + 368.37\\
R^2 = 0.6832\quad r=0.827\quad df=7\quad p<0.01
\]

- EW – Nov Dec Jan
- LW – Feb Mar Apr
- ED - May June Jul
- LD – Aug Sep Oct
Aquatic plants seeding

<table>
<thead>
<tr>
<th></th>
<th>LW Jan</th>
<th>ED Feb Mar Apr</th>
<th>LD May Jun Jul</th>
<th>EW Aug Sep Oct</th>
<th>Nov Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nymphaea violacea</td>
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<tr>
<td>Blyxa echinosperma</td>
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<tr>
<td>Hydrilla verticillata</td>
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<tr>
<td>Hygrochloa aquatica</td>
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</tr>
<tr>
<td>Nymphaea macrosperma</td>
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</table>

Investigating population dynamics – Inductive approach

<table>
<thead>
<tr>
<th></th>
<th>Aug Sep Oct</th>
<th>Nov Dec</th>
<th>Jan</th>
<th>Feb Mar</th>
<th>Apr</th>
<th>May Jun Jul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
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<tr>
<td>Invertebrates</td>
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<tr>
<td>Body condition</td>
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<tr>
<td>Gonads dev.</td>
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<tr>
<td>Ducklings</td>
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</tbody>
</table>

Good wet season = plenty of food, good survival and recruitment?
### Investigating population dynamics – Inductive approach

<table>
<thead>
<tr>
<th></th>
<th>Aug Sep Oct</th>
<th>Nov Dec</th>
<th>Jan</th>
<th>Feb Mar</th>
<th>Apr</th>
<th>May Jun Jul</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plants</strong></td>
<td>√</td>
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<td><strong>Invertebrates</strong></td>
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<td><strong>Body condition</strong></td>
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</tbody>
</table>

Poor wet season = less food, stress for survival, low recruitment?

### Gaps in Knowledge

- **Life history parameters:**
  - fecundity rate
  - rate of survival
  - age structure of population
  - proportion of breeders

- **Movements across floodplains**
  - immigration and emigration
Population dynamics

Green Pygmy Geese - Rate of increase between seasons

1981-1982 good
1982-1983 bad
1983-1984 good

Rate of Increase and rainfall
Time lag response

\[ r = \sum (\text{birth} - \text{death}) + (\text{immig.}-\text{emigr.}) \]

\[ r = (\ln N_t - \ln N_{t0}) / t \]

recruitment
movements between floodplains immigration
movements between floodplains emigration

In situ –change in resources
Long term lag response

Movements
Short term lag response
Developing Conceptual models

Developing conceptual models incorporating the basic ecological factors affecting the functioning of the wetlands, and dynamics upon which these ecosystems are regulated.

- Rainfall Regime
- Food availability
- Diet food intake
- Individual condition
- Reproductive condition
- Population Dynamics
- Nesting – Spacing behaviour
- Distribution and Abundance

Resource Limitation

- Spacing behaviour: inter and intra competition nesting and foraging space
- Habitat usage – spatial distribution at a landscape scale
Habitat Features

The Alligator River Region encompasses diverse waterbirds habitat. Some of the areas are very remote and difficult to access.

Identify Habitat Features

- Investigate potential of remote sensing to map and to monitor waterbird habitats
- Develop indexes of habitat suitability
- Investigate patterns of distribution and abundance in relation to habitat suitability
- Assess threats to these habitats
- Management needs to maintain the ecological values of these habitats
- 90 Km² of swamp
- Important dry season refuge for waterbirds
- 75% Magpie Geese Top End population
- Decrease 18 years
- Hymenachne
- Buffalo

Remote sensing
Boggy Plain - ARR

![Remote sensing image](image_url)

![Remote sensing image](image_url)
Relating distribution to environmental data

- Investigate the use of GIS to correlate environmental data from a number of sources to bird distribution data
- Use of multivariate statistic to identify groups of species that are likely to respond in similar ways to environmental perturbations

Where from now

- Collate historical information and undertake gap analysis in knowledge
- Developing conceptual models to link ecological drivers to patterns of distribution
- Investigate the use of remote sensing to map habitat and assess and monitor threats to habitat
- Investigate the use of GIS to relate distribution to environmental data
**Outputs**


- Developing collaborations with other institutions NGO to develop modelling and explore the predictive aspect

- Feeding National and International Programs on Waterbirds Conservation

**Communication Strategy**

- Project in collaboration with Traditional Owners (TO)

- Parks Australia North

- PWCNT

- Other NGO – Universities and Institutions interesting in sharing information

- Raise awareness and provide information at a Local, National and International level