On the wing: Exploring aspect ratio

YEAR 5 BIOLOGICAL SCIENCES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Introduction

This learning resource has been designed to explore the features and adaptations that support and enhance the flight and survival of birds. Students make connections between form and function by investigating how the size and shape of a bird's wings influences the way in which it moves through the air.

Specimens from Queensland Museum's Mammals and Birds Collection are used within the resource to stimulate inquiry and facilitate discussion about the above concepts. Queensland Museum has been building collections of the natural heritage of Queensland, its surrounding waters and near neighbours, since its inception as the Queensland Philosophical Society in 1862. Our collections serve numerous roles. They underpin biodiversity research, can be used to recognise, differentiate between and count the numbers of species in Queensland and provide material for displays.

As this resource has been designed to complement classroom-based teaching and learning experiences, students are assumed to have developed knowledge about the following concepts:

- An adaptation is a characteristic of an organism that improves its chances of survival within its environment.
- There are three different types of adaptations:
  - Structural (a feature or part of an organism's body that helps it to survive)
  - Functional (a body process that helps an organism to survive)
  - Behavioural (actions made by an organism that help it to survive)

It is recommended that students complete the following activities independently or in groups of four.

Future Makers is an innovative partnership between Queensland Museum Network and QGC formed to encourage students, teachers and the community to get involved in science, technology, engineering and maths (STEM) education in Australia.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of young Australians in STEM-related careers — creating a highly capable workforce for the future.

Additional Queensland Museum learning resources that explore the topic of animal adaptations include:

Wild State exhibition, Queensland Museum, Brisbane

Wild State highlights Queensland's amazing array of diverse habitats and unpacks why this state has such a huge diversity of animals. Within each habitat in the exhibition, there is a showcase of animal specimens, images, interactives and multimedia for visitors to explore.

Wild State Teacher Resource

This resource contains an overview of the *Wild State* exhibition space, key teaching points for each habitat, a glossary, and curriculum links.

Animal Survivor

This activity requires students to analyse how an animal's features support its ability to survive in its environment. Students engineer new features for the animal to improve its chances of survival then make predictions about how the animal may survive if its environmental conditions were to change.

Queensland Museum Loans

Search the term 'flight' or explore kits related to the features and adaptations of animals.

Australian Curriculum Links

While this resource has been developed to support the delivery of the Year 5 Science Curriculum, it is possible to connect learning with other year levels. You are encouraged to adapt the resource to meet your individual needs and learning context.

YEAR 5

Science Understanding (SU)

Biological sciences
Living things have structural features and adaptations that help them to survive in their environment *(ACSSU043)*

Science Inquiry Skills (SIS)

With guidance, pose clarifying questions and make predictions about scientific investigations *(ACSIS231)*

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate *(ACSIS090)*

Compare data with predictions and use as evidence in developing explanations *(ACSIS218)*

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts *(ACSIS110)*

Mathematics

Number and Algebra
Use efficient mental and written strategies and apply appropriate digital technologies to solve problems *(ACMNA291)*

Measurement and Geometry
Choose appropriate units of measurement for length, area, volume, capacity and mass *(ACMMG108)*

Flight of Birds

MUSEUM PERSPECTIVES

Queensland Museum's biodiversity collections serve many different roles. They support biodiversity research and can be used to recognise, differentiate between and count the numbers of species throughout the Australasian region. These collections can also provide material for the displays you see when visiting Queensland Museum.

Queensland Museum fauna (animal) collections are stored in secure, climate-controlled conditions. At present, several millions of specimens are located within our collection and just over 700,000 of these specimens are registered on a computer database.

The Museum receives animal specimens, including birds, from a variety of sources. Some have died of natural causes, while others might have been hit by a vehicle or flown into a window. These animals might be found and shared with the Museum by national park rangers or registered wildlife carers. Some of these animals are made into study skins. If an animal is too damaged to be preserved in its entirety, its skeleton or wing might be added to the research collection to be used by scientists and artists.

All animals have adaptations that improve their chances of survival within their environment. Animals that are capable of moving through the air have additional adaptations that support and enhance this ability. Birds, for example, have many different features and adaptations that allow them to take to and remain in the skies. These features and adaptations reduce or increase the effects of forces experienced during flight, including lift, thrust, drag and gravity. Some are immediately obvious (wings provide an excellent means to increase lift and thrust), while others aren't as apparent!

Do you already know of some features or adaptations that allow birds to achieve flight? Share these with your class and record all ideas below.

Were wings included in your list? While all birds have wings, the size and shape of this feature varies between bird species. This variation influences the function of the wing and how the bird flies, improving its chances of survival within its environment.

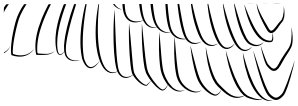
Aspect Ratio

One way in which we can identify the function of a wing is by exploring wing aspect ratio. Wing aspect ratio compares wing length to wing surface area and can be calculated using the following formula:

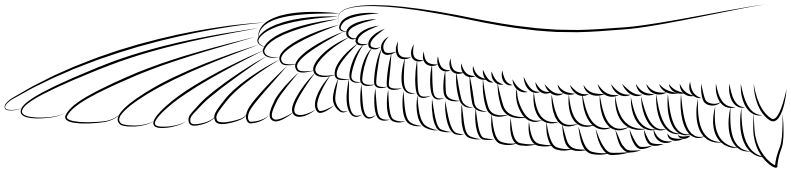
$$\text{Aspect Ratio} = \frac{\text{Wing Length}^2\ (\text{cm})}{\text{Wing Area}\ (\text{cm}^2)}$$

Generally, low aspect ratio wings are short and wide, while high aspect ratio wings are long and narrow. Both forms of aspect ratio have benefits and limitations which make them more suitable to the conditions and features of particular environments.

Low
Aspect Ratio



High
Aspect Ratio



You will now work in small groups to identify and explore the aspect ratio of various wings. The specimens you will examine are images taken of real bird wings from Queensland Museum's Mammals and Birds collection.

1. Select a wing image provided by your teacher. Look closely at the wing.

(a) What do you notice the size and shape of the wing?

(b) What do you notice about the size, shape and distribution of feathers?

(c) How might this wing influence the way in which a bird flies through the air?

Use the Wing Aspect Ratio Table on page 8 to complete the following questions:

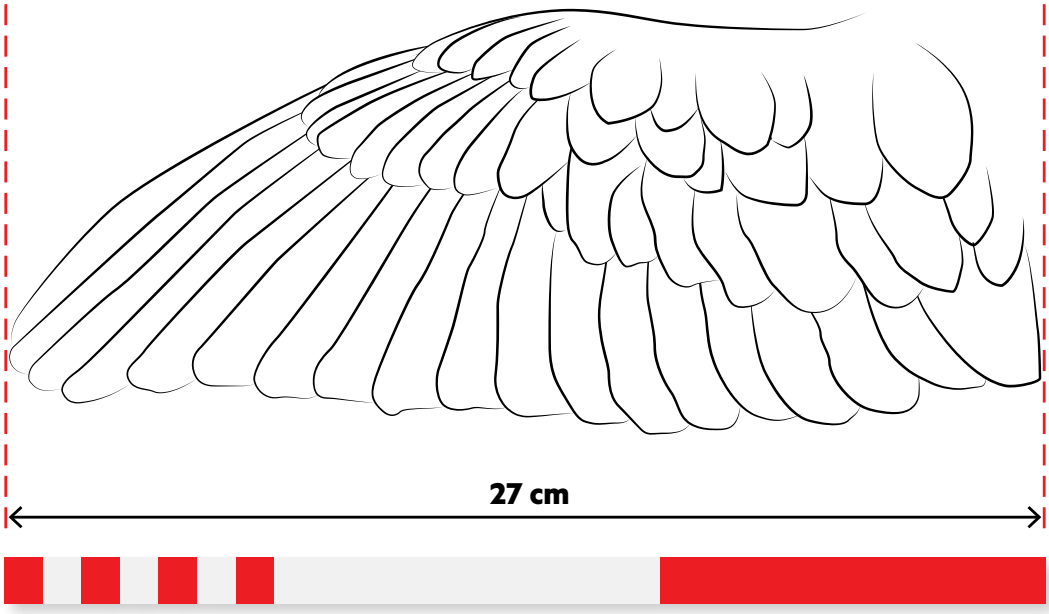
2. **Record the species of bird, including scientific and common names, from which this wing was taken.** *Hint: Use the bird's scientific name to identify its common name.*

3. **Make a prediction about the aspect ratio of the wing. Do you think your wing has a low or high aspect ratio?** *Hint: You may like to compare your wing to the examples included on page 5.*

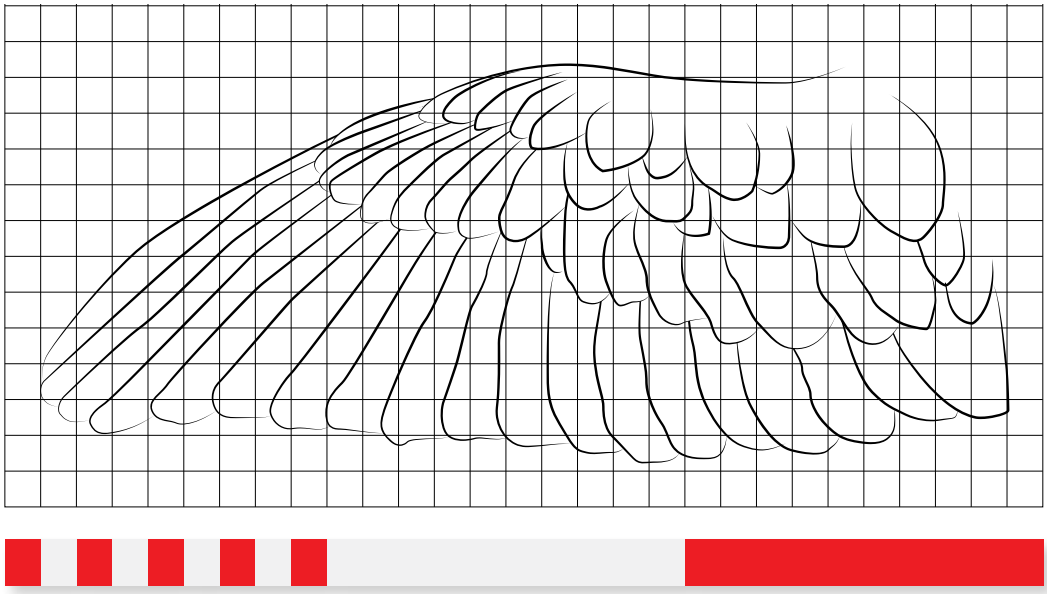
4. **Calculate the aspect ratio of the wing. To complete this task you will need to:**

   (a) Measure the length of the wing from the tip of the farthest feather to the wing base.

   Hint: Remember to use the scale! Each small interval represents 1 cm in length. You may also like to use the scale to construct a real-life model of the wing.



   (b) Calculate the approximate surface area of the wing. Use the provided outlines to complete this task. *Hint: Draw a grid over the wing using the scale to determine its surface area. Each small interval represents 1 cm in length.*



274 cm²

(c) Calculate the aspect ratio of the wing using the formula below. Remember to record each step of the calculation in your table.
Hint: If needed, round the aspect ratio to one decimal place.

$$\text{Aspect Ratio} = \frac{\text{Wing Length}^2\ (\text{cm})}{\text{Wing Area}\ (\text{cm}^2)}$$

$$\text{Aspect Ratio} = \frac{27^2\ (\text{cm})}{274\ (\text{cm}^2)}$$

$$\text{Aspect Ratio} = \frac{729\ (\text{cm})}{274\ (\text{cm}^2)}$$

$$\begin{aligned} \text{AR} &= 2.66 \\ &= 2.7 \end{aligned}$$

5. **Determine the actual aspect ratio of the wing using the results of your calculation.**
   Hint: Birds with an aspect ratio less than four should be classified as low. Birds with an aspect ratio equal to or greater than four should be classified as high. The wing used in the above example would therefore have a low aspect ratio

6. **Swap your wing image with another group.**
   Predict, calculate and determine the aspect ratio of the new wing.

   Swap your wing image again until your group has calculated and recorded the aspect ratio of all six wings.

Wing Aspect Ratio Table

Wing Specimen		Predict Aspect Ratio (Low or High)	Calculate Aspect Ratio		Actual Aspect Ratio (Low or High)
1			Length:	Area:	
2			Length:	Area:	
3			Length:	Area:	
4			Length:	Area:	
5			Length:	Area:	
6			Length:	Area:	

7. Construct a column graph to represent the data recorded in the wing aspect ratio table.

Make sure you include a:

- Graph title
- Axis titles
- Axis labels/units

8. Compare the data you have collected with the rest of your class. What do you notice?

Discuss and record:

- Why are your calculations not exactly the same?
- How could you improve the consistency of collected data?

Aspect Ratio & Flight Capabilities

Explore how aspect ratio influences the flight capabilities of these and other bird species. You will need to conduct online research to complete this task.

You may also choose to observe or view videos of birds with low and high aspect ratio wings in flight.

Influences	Low Aspect Ratio	High Aspect Ratio
Characteristics of Flight How do these birds move through the air? What are the benefits and limitations of this aspect ratio?		
Suitable Habitats Where are birds with this aspect ratio found? Why this location and not elsewhere?		
Example Bird Species		

Extension Activity

You have been asked to develop a plane that can glide long distances. Would you design a plane with a low or high aspect ratio? What other features would your plane need to make this journey?

You may design and construct a model of your plane, then explain the designed solution to your class.

Queensland Museum **ID#** 32245

Scientific Name: *Centropus phasianinus*

Common Name:

Sex of Specimen: Female

Location: Priors Pocket Rd & Moggill Rd

Date: 8 Aug 2004

Queensland Museum **ID#** 32245
Scientific Name: *Centropus phasianinus*
Common Name:
Sex of Specimen: Female
Location: Priors Pocket Rd & Moggill Rd
Date: 8 Aug 2004

Queensland Museum **ID#** 0.32622

Scientific Name: *Phaethon rubicavda*

Common Name:

Sex of Specimen: Not recorded

Location: 2.7km South of Poyungan Rocks, Eastern Beach, Fraser Island

Date: 31 May 2004

Queensland Museum **ID#** 0.32622

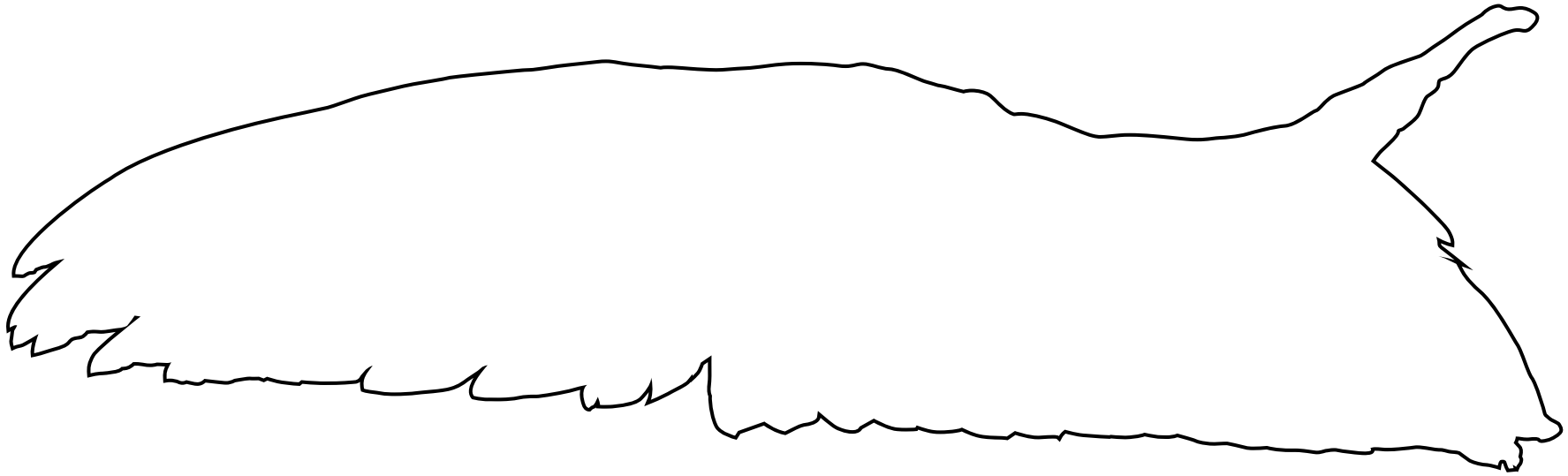
Scientific Name: *Phaethon rubicavda*

Common Name:

Sex of Specimen: Not recorded

Location: 2.7km South of Poyungan Rocks, Eastern Beach, Fraser Island

Date: 31 May 2004



Queensland Museum **ID#** 15930

Scientific Name: *Meliphaga lewini*

Common Name:

Sex of Specimen: Male

Location: Finch Hatton Gorge area

Date: 8 Aug 2004

Queensland Museum **ID#** 15930

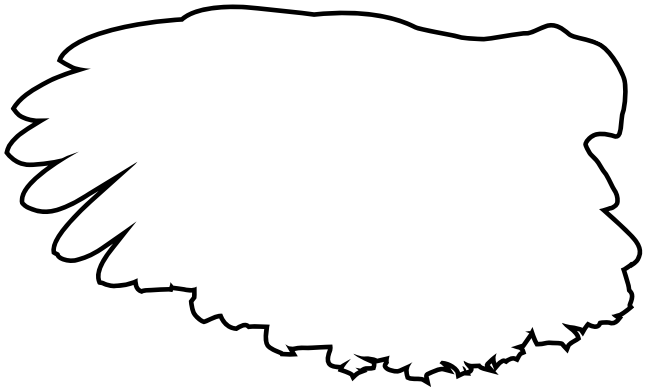
Scientific Name: *Meliphaga lewini*

Common Name:

Sex of Specimen: Male

Location: Finch Hatton Gorge area

Date: 8 Aug 2004



Queensland Museum **ID#** 25984

Scientific Name: *Puffinus griseus*

Common Name:

Sex of Specimen: Not recorded

Location: Cape Bridgewater, Victoria

Date: 21 Nov 1978

Queensland Museum **ID#** 25984

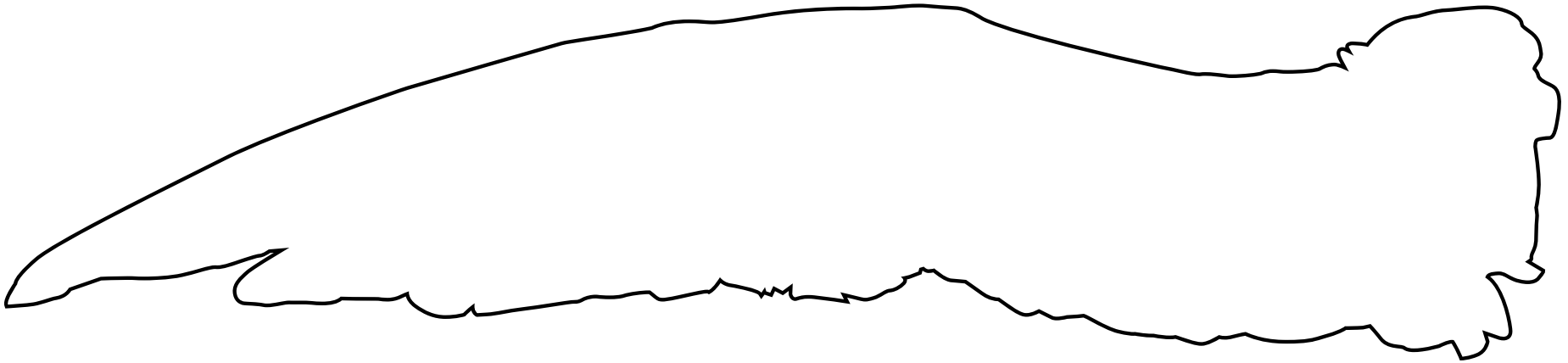
Scientific Name: *Puffinus griseus*

Common Name:

Sex of Specimen: Not recorded

Location: Cape Bridgewater, Victoria

Date: 21 Nov 1978



Queensland Museum **ID#** 14273

Scientific Name: *Hydropragne caspia*

Common Name:

Sex of Specimen: Female

Location: Cabbage Tree Pt, via Woongalba, SE QLD

Date: 27 Feb 1973

Queensland Museum **ID#** 14273

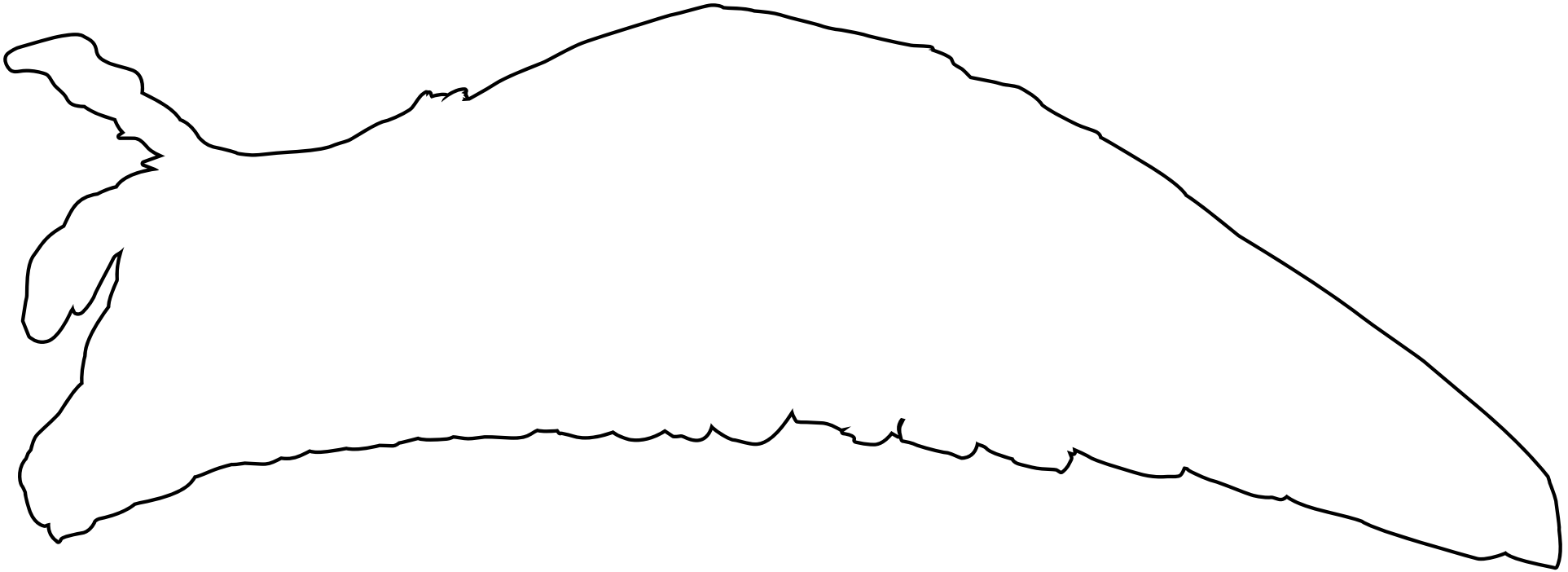
Scientific Name: *Hydropragne caspia*

Common Name:

Sex of Specimen: Female

Location: Cabbage Tree Pt, via Woongalba, SE QLD

Date: 27 Feb 1973



Queensland Museum **ID#** 0.32509

Scientific Name: *Podargus strigoides*

Common Name:

Sex of Specimen: Female

Location: Eumundie area

Date: May 2006

Queensland Museum **ID#** 0.32509

Scientific Name: *Podargus strigoides*

Common Name:

Sex of Specimen: Female

Location: Eumundie area

Date: May 2006