

BIODIVERSITY & BIOTECHNOLOGY

Stage 6 - Year 12 Biology

Outcomes

BI-12-03 - analyses changes in ecosystems and strategies for biodiversity conservation

BI-12-04 - evaluates the use of biotechnologies in medicine, agriculture and biodiversity conservation

BI-12WS-05 - analyses and evaluates primary and secondary data and information



WHAT TO EXPECT IN OUR ZOO WORKSHOP

In this lesson, students investigate how data-driven science is used to understand and manage changes in Australian ecosystems by analysing real-world data related to invasive species, genetic diversity, and conservation.

Students examine ecosystem changes caused by introduced species and interpret ecological data to justify the selection of indicator species for monitoring environmental change. They also explore the role of bioinformatics in ecosystem monitoring and how these tools inform evidence-based conservation decisions for threatened Australian species.

Students will also investigate a contemporary Australian conservation case study to explore genetic drift resulting from population bottlenecks and founder effects. Through this example, they will evaluate conservation programs, disease management and quarantine strategies, and the application of biotechnology to support biodiversity conservation and improve genetic diversity in threatened populations.



SPECIES & GENETIC DIVERSITY

Discuss biodiversity in relation to the diversity of genes and species in ecosystems

Factor	Rainforest A	Rainforest B
 Species diversity (selected groups)	Plants: 16,000 species Mammals: 427 species Birds: 1,300 species Amphibians: 427 species	Plants: 12,000 species Mammals: 222 species Birds: 620 species Amphibians: 300 species
 Habitat fragmentation (% of original forest remaining, main causes)	~80% remaining Fragmentation increasing due to logging, agriculture and road construction.	~50% remaining Fragmentation high due to palm oil plantations, logging and urban development.
 Relatedness of individuals (genetic diversity indicators)	Average inbreeding coefficient: 0.03 Heterozygosity (example species): 0.72	Average inbreeding coefficient: 0.08 Heterozygosity (example species): 0.58

1. Which rainforest is likely to be more resilient to disease outbreaks, drought and climate change? **Justify** your answer by comparing the species and genetic diversity.

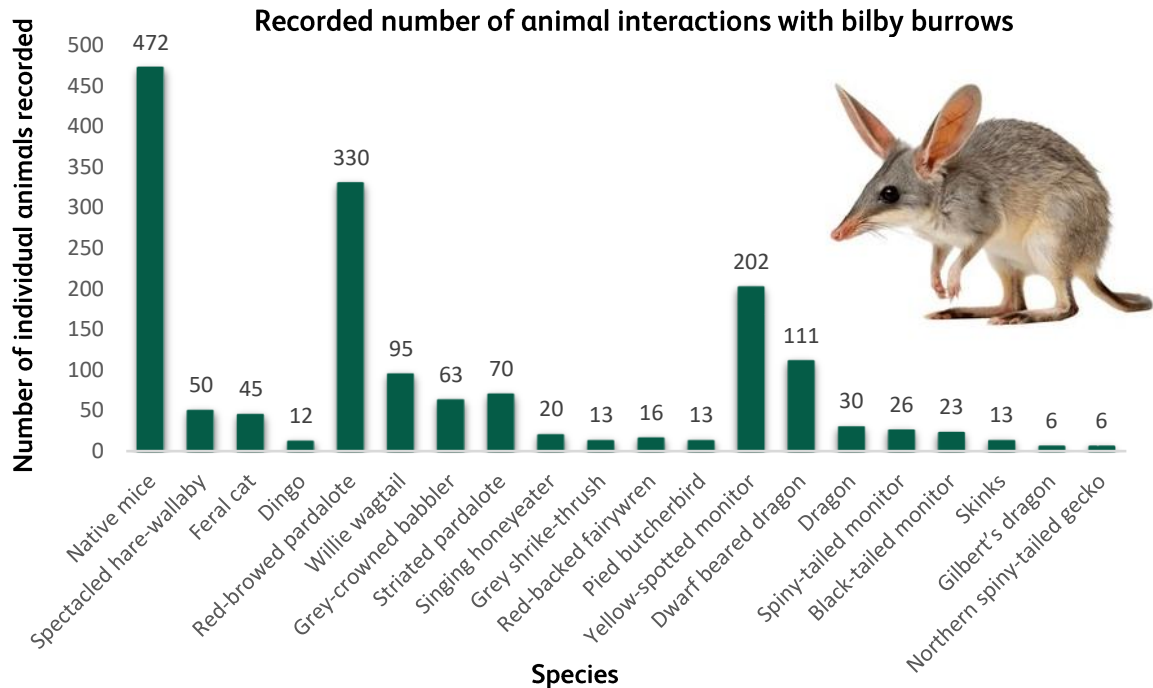
2. **Explain** why species diversity is important for an ecosystem?

3. **Explain** why genetic diversity is important for the long-term survival of species?



KEYSTONE SPECIES

Describe the role of a keystone species in the health of an ecosystem
Analyse data on a keystone species and predict the outcomes of removing the species from an Australian



Source: Dawson et al. (2019), *Journal of Zoology*, 308(3), 149-163. <https://doi.org/10.1111/jzo.12663>

1. **Analyse** the data to explain why bilbies are considered a keystone species.
- _____
- _____
- _____
- _____
2. **Predict** the impact if bilbies were no longer present in this ecosystem. Which species would be most impacted?
- _____
- _____
- _____
- _____



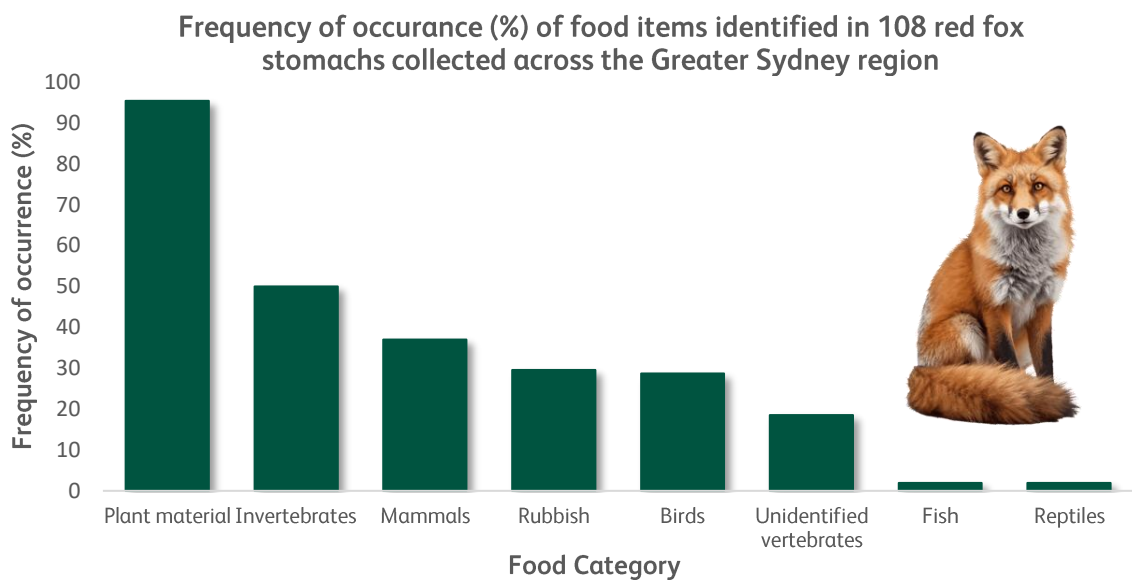
WORKSHOP ACTIVITY





INVASIVE SPECIES

Explain ecosystem changes that have occurred as a result of the introduction of invasive species
Interpret data to demonstrate the effects of invasive species on the local environment

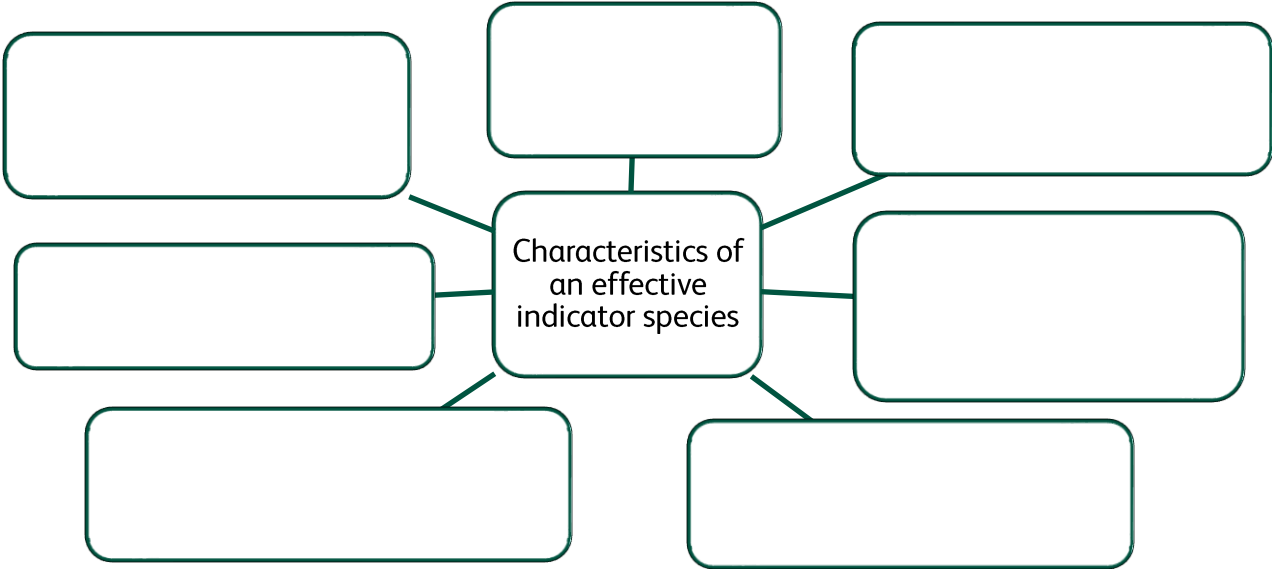


Using the data provided, **explain** the effect of Red Foxes on the environment in the Greater Sydney region.



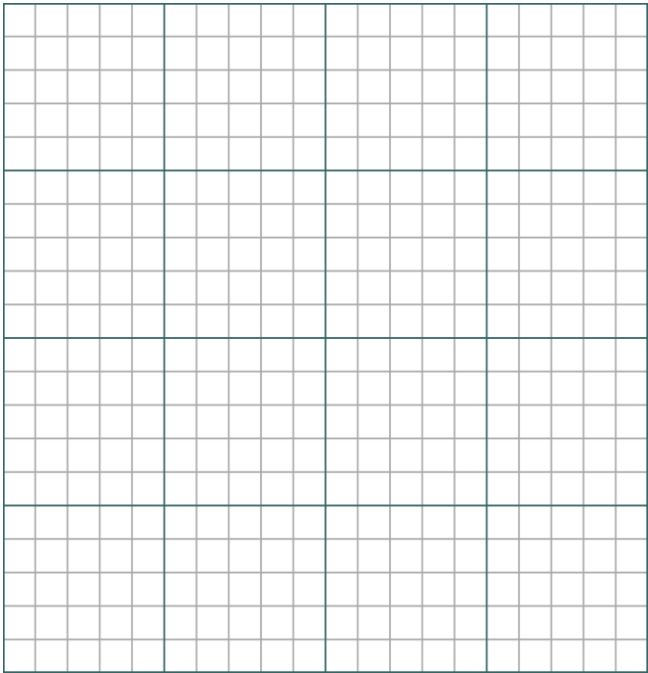
INDICATOR SPECIES

Analyse data to justify the choice of an indicator species to determine a change in an Australian ecosystem



Graph the data below which represents the **mean annual river flow and adult Booroolong Frog counts in a monitored creek section.**

Year	Mean River Flow (ML/day)	Number of Adults
2010	120	42
2011	115	38
2012	80	25
2013	60	15
2014	55	10
2015	90	20
2016	110	35
2017	100	32
2018	45	8
2019	40	5
2020	95	28



Source: *Saving Our Species Booroolong Frog report (2016–21) and Water Requirements of the Booroolona Froo (NSW Water 2024)*



INDICATOR SPECIES

Analyse data to justify the choice of an indicator species to determine a change in an Australian ecosystem

1. **Identify** the years with **lowest frog abundance**. What happened to river flow in those years?
2. When did frog populations **recover**? **Describe** how this correlates with environmental conditions.
3. With reference to this data, **justify** the choice of Booroolong Frogs as an indicator species to determine a change in an Australian ecosystem.
4. **Identify** any **anomalies** in the data. Suggest other factors that could influence frog abundance besides river flow.





BIOINFORMATICS – INFORMING CONSERVATION

Discuss how bioinformatics is used to determine the health of an ecosystem
Use an example to account for the use of bioinformatics to inform decisions about the conservation of an Australian species

Common Name	A	B	C	D	E
Duck-billed platypus	183	16	492	2125	801
Koi carp	1644	94	0	0	0
Mallard duck	659	88	111	183	205
European perch	26	863	7	0	193
Cattle	145	304	16	334	262
Mountain galaxias	183	0	139	154	453
Mayfly	542	119	24	31	80
LeSueur's treefrog	0	0	393	0	391
Oligochaete worm	314	163	146	6	114
Dog	24	0	0	0	0
Rodents	0	213	0	0	0
Worm	240	38	8	10	200
Aquatic worm	0	34	133	10	268
Caddisfly	46	6	137	103	118
Dusky moorhen	336	0	0	51	0
Freshwater jellyfish	0	0	110	0	219
Hydra	169	54	0	5	26
Rainbow trout	39	203	0	0	7

1. Suggest why the abundance of the **bolded** organisms in the eDNA data are significant to the release of captive bred Duck-billed platypus.



2. Based on this data, **justify** which section of the river you would consider the ‘healthiest’.

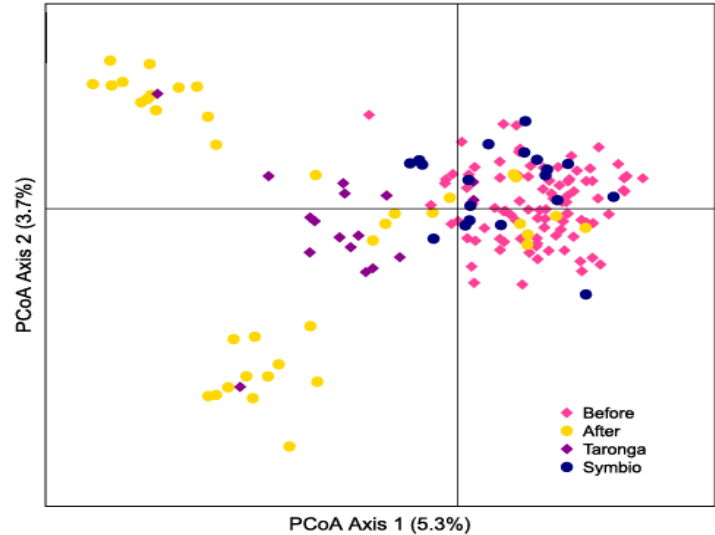
3. Based on this data, **justify** which section of the river you would recommend for the release of captive bred Duck-billed platypus?.



BIOTECHNOLOGY & BIODIVERSITY CONSERVATION

Use examples to explain how biotechnology is currently used in Australian research, agriculture, biodiversity conservation and health
Conduct a scientific investigation to evaluate an Australian conservation program that aims to improve genetic diversity of a threatened population

Principal coordinates analysis (PCoA) of genome-wide diversity of Bellinger River Turtles using genetic sequencing comparing 460 SNP markers.



Source: Nelson et al. (2024). Conservation Science and Practice 6(10), e13204. <https://doi.org/10.1111/csp2.13204>



Evaluate the effectiveness of strategies (including DNA based biotechnology) used in the Bellinger River turtle conservation program to maintain and improve genetic diversity.



WORKSHOP ACTIVITY





REINTRODUCTION OF EXTINCT AUSTRALIAN SPECIES

Analyse the benefits, limitations and ethical issues associated with the reintroduction of an extinct Australian species

The thylacine (*Thylacinus cynocephalus*), also known as the Tasmanian tiger, was Australia's largest marsupial predator. The last known individual died in captivity in 1936 and the species is now extinct.

Recent advances in biotechnology, including genome sequencing, genetic engineering and cloning technologies, have led scientists to investigate whether the thylacine could potentially be recreated using DNA from preserved specimens and closely related living species.



Consider each of the following statements and **classify** them as a benefit (B), limitation (L) or ethical issue (E).

Statement	B, L or E?
The return of a native apex predator may help restore ecosystem balance.	
De-extinction technologies require large amounts of funding.	
Scientists could develop techniques that also benefit threatened species conservation.	
The recreated animals may not be genetically identical to the original thylacine.	
Resources used for de-extinction could instead support endangered species that still exist.	
Reintroduced predators may affect existing populations of prey species.	
Humans caused the extinction and may have a responsibility to reverse it.	
Suitable habitat may no longer exist across much of the species' former range	



REINTRODUCTION OF EXTINCT AUSTRALIAN SPECIES

Analyse the benefits, limitations and ethical issues associated with the reintroduction of an extinct Australian species

Conduct a class debate on the proposal question below. Working in either the affirmative or negative team, use the scaffold to research, organise and justify your arguments with relevant scientific evidence.

Debate Question

Should Australia use biotechnology to recreate and reintroduce the extinct thylacine?

Opening Statement:

Main Arguments & Supporting Evidence:

Rebuttal:

Closing Statement:



POST WORKSHOP ACTIVITY

