



THE GREAT LAWN FLAMINGO COUNT

STUDY INFORMATION — PAGE 1



1

This study set out to estimate the population of bright pink lawn flamingos displayed in front gardens across the entire metro area using one aerial drone survey.

Lawn flamingos are ideal for this kind of project because they are present at relatively few properties and they stand out clearly against green lawns and garden beds.



2

Where flamingo 'colonies' were identified, high-resolution drone images were collected during the 2024 summer season.

These images were analysed using a method that separates flamingos from grass, concrete and shadows. Ground counts of flamingos from eleven neighbourhoods were used to convert these detections into numbers using a statistical procedure.





THE GREAT LAWN FLAMINGO COUNT



STUDY INFORMATION — PAGE 2

3

Very little data existed about lawn-flamingo numbers before this study because visiting every private garden in the city is logistically difficult and time-consuming.

The last city-wide estimate, made more than a decade ago, was just 1 200 to 1 600 flamingos, and it was based on a few sampling surveys of selected neighbourhoods.



4

Eight new “colonies” were discovered and the locations of five previously suspected areas were confirmed, giving a total of 73 colonies across 1 200 km² of the city.

The 2024 breeding-season population was estimated as 25 000 flamingos, compared with the old estimate of 1 200 to 1 600. Based on the relationship between ornaments on display and spare-in-the-garage backups, this translates to a total population of about 62 500 flamingos!



5

To decide if a property might have flamingos and whether the images could be analysed, “quick-look” aerial images from three different sources were checked.

Where evidence of flamingos was found, high-resolution drone images were collected at those locations between May and July 2024.





QUESTIONS



Use the information from the study to answer the following questions.

- 1** Identify the aim of this investigation. [1]

- 2** Explain why there was so little data regarding lawn flamingo population numbers before this study. [1]

- 3** Describe **two** major differences between this study and other previous studies that estimated the population of lawn flamingos. [2]

1

2



- 4** State **two** reasons why lawn flamingos are particularly suitable for a study involving aerial drone imaging. [2]

1

2



- 5** State a potential ethical problem that is avoided by using aerial drone imagery to estimate the numbers of lawn flamingos. [1]



- 6** Describe how this study made use of previous studies that collected high-resolution aerial images. [1]





THE GREAT LAWN FLAMINGO COUNT – ANSWERS



1

To estimate the population of lawn flamingos using a single aerial drone survey/count of all lawn flamingos.

[1]



2

Because of difficulties accessing potential lawn-flamingo locations in private gardens that are not close to public access points.

[1]



3

- This study used a single survey/all data collected at the same time.
- This study attempted to count all the lawn flamingos rather than use a sampling technique.

[2]



4

- They occur at a (relatively) small number of properties.
- They stand out/have a high contrast with their surrounding environment, making them easier to count in aerial drone images.

[2]



5

It avoids entering or disturbing private gardens and their residents.

[1]

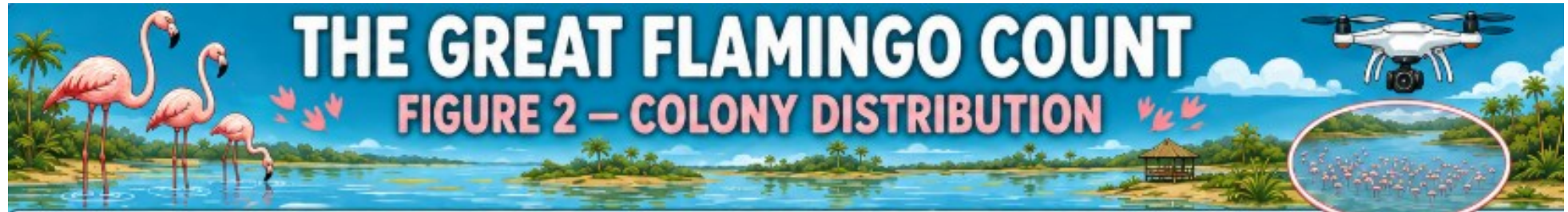


6

Previous studies identified locations where lawn-flamingo 'colonies' were thought to exist.

[1]





THE SUNCOAST SALT-LAGOON REGION





THE GREAT FLAMINGO COUNT



COLONY LIMITATIONS – A TO C

A

It is difficult to know whether unknown colonies were missed. Image quality, wind ripples, sun glare and cloud shadows can make flamingos difficult to identify. Small colonies containing fewer than 200 birds are also harder to detect.



Glare



Ripples



Shadows



Small colonies

B

Researchers expected few small colonies because small flamingo groups are less able to watch for predators and defend nesting areas. No minimum successful colony size has been established, but a lower limit is likely. Birds in small colonies may lose more eggs or chicks to predators and have fewer opportunities to find mates.



C

Although some small colonies may have been missed, their contribution to the total population would be small. Any resulting error should therefore be minor and fall within the confidence limits of the estimate.



=



Glare + ripples + shadows = tricky counting!





D

The researchers identified two main sources of error: methodological error and natural variability.

Methodological error



Examples: image quality, counting and detection.

Natural variability



Examples: weather, water level and flamingo behaviour.

E

Late April would be the best time to count because most breeding adults are present at nesting colonies before many chicks leave the nests. However, seasonal storms often flood access tracks and create heavy cloud, strong winds and rough water. These conditions can prevent ground surveys and produce poor or unusable drone images. The earliest reliable period with calmer weather and clearer images is usually June, so a region-wide April survey is not currently feasible.

LATE APRIL — BIOLOGICALLY IDEAL



Most breeding adults present at nesting colonies; many chicks have not yet left.

LATE APRIL — PRACTICALLY DIFFICULT



Flooded tracks

Heavy cloud

Strong winds

Rough water



Poor or unusable drone images.



Best counting time ≠ easiest survey time!



1

High-resolution drone photographs may show one or more flamingos.

Dispersed birds can be identified and counted, but in most colonies flamingos stand in dense groups. Their bodies and shadows overlap, so individuals cannot always be distinguished and a different approach is needed.



2

Statistical analysis was used to estimate adult numbers at each colony. Earlier aerial estimates differed from ground counts because pale birds, reflections, reeds and shadows were difficult to separate.

This study sharpened the images and used a colour filter, improving resolution and distinguishing flamingos from water, vegetation and shadows.

Original image



Improved image



Flamingos

Water

Vegetation

THE GREAT FLAMINGO COUNT

PRESENTATION AND ANALYSIS — PAGE 2

3 The improved method was applied to eight archived images from 2018 and 2019.

Estimates were compared with photographs taken at the same time as direct ground counts. Three further colonies were counted using matching drone photographs and ground surveys.

8 archived images (2018–2019)



improved image analysis



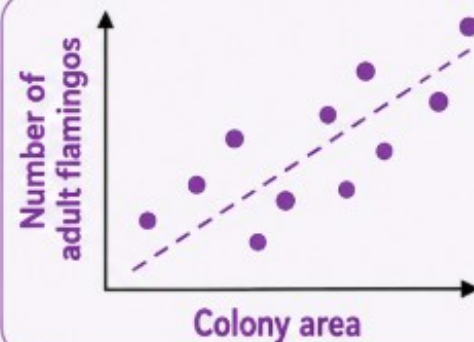
comparison with direct ground counts



+ 3 further colonies



4 Researchers graphed colony area against the number of adult birds using 11 colonies for which both drone-area estimates and direct counts were available.

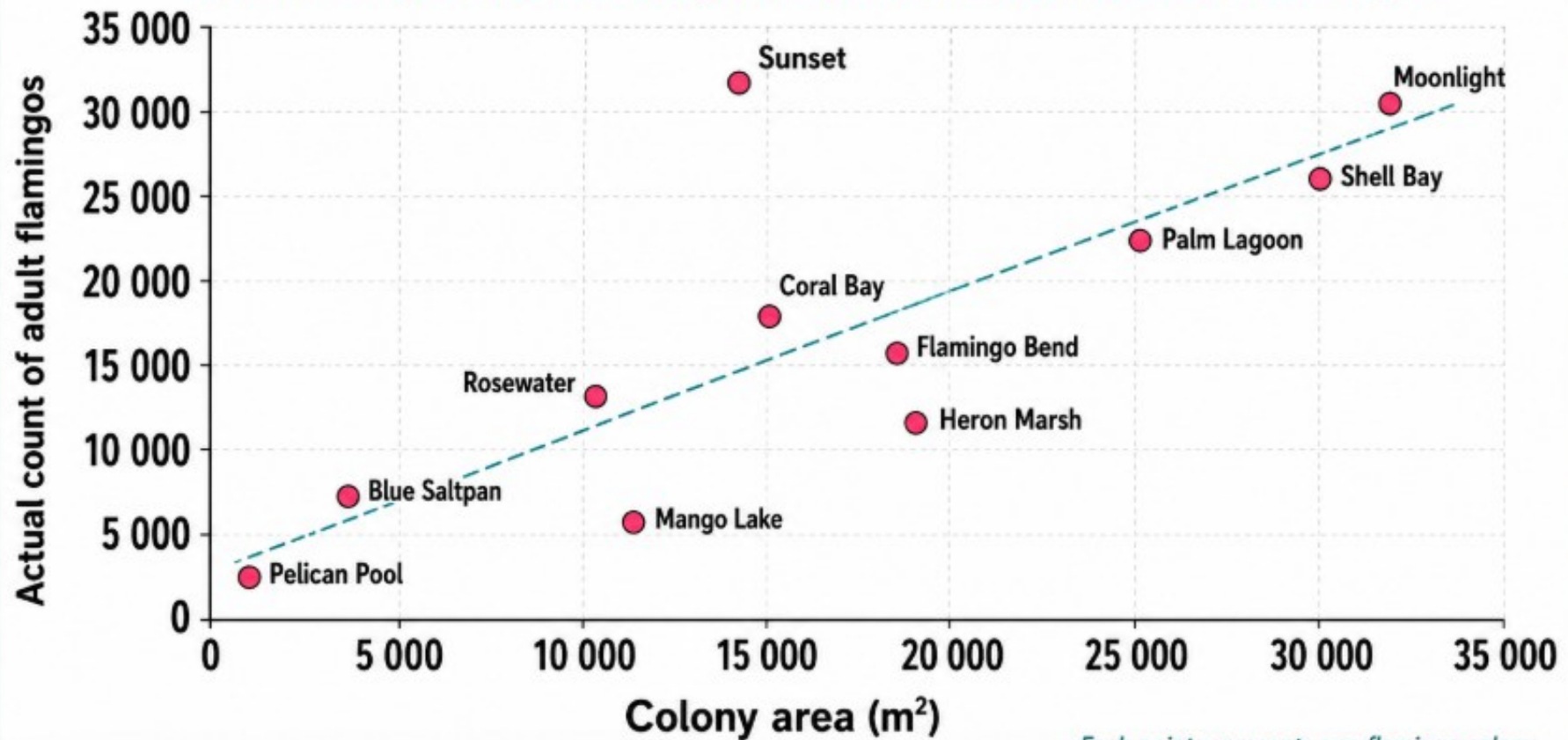


See Figure 1





Relationship between colony area and actual count of adult flamingos



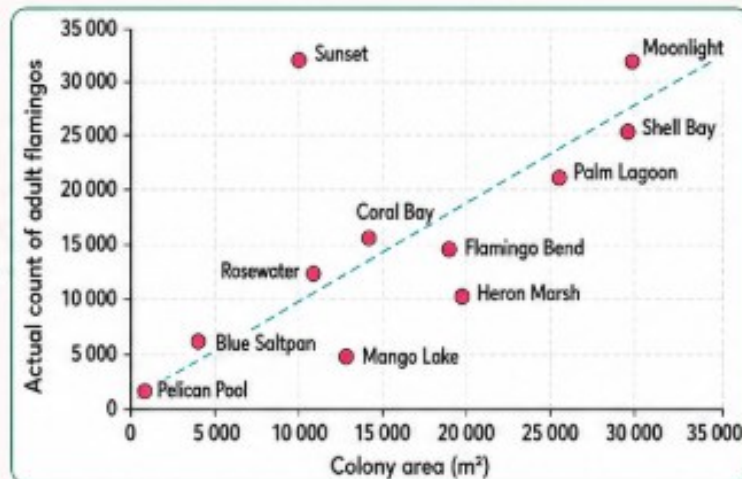
Each point represents one flamingo colony.



Use the information from the study to answer the following questions.

- 7** Figure 1 shows the relationship between colony area and the number of adult flamingos at sites for which both drone-area estimates and direct counts were available.

FIGURE 1
Relationship between colony area and actual count of adult flamingos



- (a) The researchers claimed that their data showed a strong positive correlation between colony area and the actual number of adult flamingos. Use Figure 1 to evaluate this claim. [2]
- (b) Explain how researchers could use this graph for other sites where only the colony area is known. [1]

- 8** Give one reason, apart from colony size, why a flamingo colony might not be identified. [1]

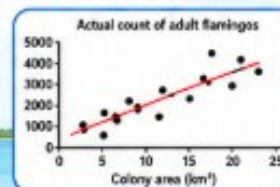
- 9** The researchers concluded that the number of small colonies containing fewer than 200 flamingos would be very limited.
- (a) Describe the biological disadvantage they suggested small colonies might face. [1]
- (b) What evidence did they use to support this suggestion? [1]
- (c) State the evidence they offered to justify that missing small colonies would not result in a major error in their population estimate. [2]

- 1 _____
- 2 _____



THE GREAT FLAMINGO COUNT

ANSWERS 7-9



7(a)

There is a strong correlation because most/many of the points are close to the line of best fit. [1]

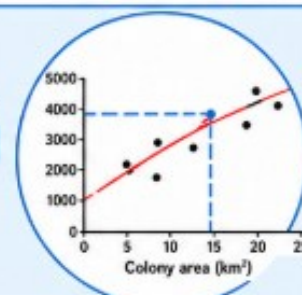
There is a positive correlation since, as colony area increases, the actual count of adult flamingos increases. [1]



[2]

7(b)

Use the graph to estimate adult flamingo numbers. [1]



8

Cloud cover or poor image quality. [1]



9(a)

Watching for predators and defending nesting areas is less effective in groups of this size. [1]



9(b)

They cited evidence from previous research. [1]



9(c)

Their contribution to the overall total population size would be small. [1]

The value would be within the acceptable range/confidence limits of error. [1]



[2]



THE GREAT FLAMINGO COUNT

QUESTIONS 10–11

Use the information from the study to answer the following questions.

- 10** The researchers suggested that there were several sources of error. State two areas identified by the researchers from which sources of error may arise. [2]

1

2





- 11** The researchers suggested that it would be better to estimate the flamingo population in late April rather than in June.



- (a) Explain why late April is a better time to estimate the flamingo population. [1]

- (b) Suggest why it is not currently feasible to estimate flamingo numbers across the whole region in late April. [1]





THE GREAT FLAMINGO COUNT

ANSWERS 10-11

10

- Methodological error. [1]
- Natural variability. [1]

[2]



Methodological error:
image quality, counting
or detection



Natural variability:
weather, water level
or behaviour

11(a)

Most breeding adults
are present at the nesting
colonies in late April,
before many chicks leave
the nests.

[1]



11(b)

Seasonal storms can flood access
tracks and produce heavy cloud,
strong winds and rough water.
These conditions can prevent
ground surveys and make drone
images poor or unusable.
Accept any suitable reason. [1]

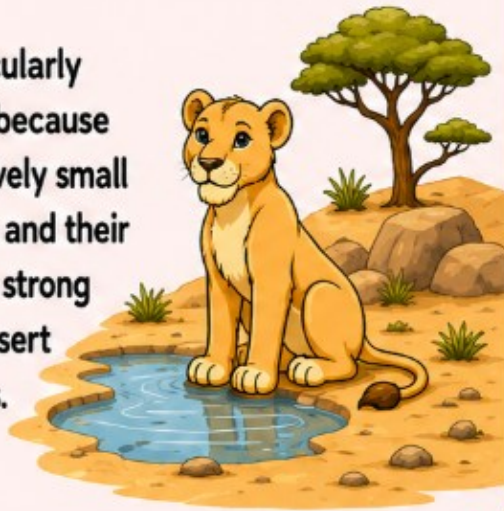


THE GREAT DESERT LION SURVEY

STUDY INFORMATION – PAGE 1

- 1** This study attempted to estimate the population of desert lions using a single survey. The whole study region of the Sahara was examined using aerial images to identify possible lion locations.

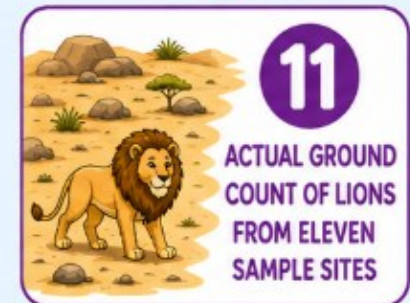
Desert lions were particularly suitable for this project because they gathered at a relatively small number of water sources and their warm bodies produced a strong contrast with the cool desert ground in thermal images.



- 2** Where lions were identified, very high-resolution thermal drone images were obtained during the 2025 dry season.



The images were analysed using a method that separated lions from rocks, shrubs and shadows. Actual ground counts of lions from eleven sample sites were used to convert the image results into an estimate of the total number of lions using a statistical procedure.



THE GREAT DESERT LION SURVEY

STUDY INFORMATION – PAGE 2



- 3** The lack of data about desert-lion population size was largely due to the logistical difficulties of reaching possible habitats in remote parts of the Sahara that were far from research stations.
- The last population estimate, completed nearly two decades earlier, was based on several previous reports that used sampling techniques.



- 4** Four new lion groups were found and the locations of three previously suspected groups were confirmed. This gave a total of 46 lion groups across 18 000 km of survey routes.
- The 2025 breeding population was estimated at approximately 238 breeding pairs, compared with the previous estimate of 135 to 175 pairs. Using published information about the relationship between breeding and non-breeding lions, researchers calculated a total population of approximately 595 adult lions.



- 5** To assess whether lions could be detected and whether the images could be analysed, researchers first examined 'quick-look' images from three previous studies.
- Where there was evidence of lions, high-resolution thermal drone images were then collected. Particular attention was given to newly identified groups, unconfirmed sightings and locations where an earlier aerial survey had failed to produce usable images.
- Using drone images also avoided approaching, handling or disturbing the lions.



Can you spot the lions before the drone does?

THE GREAT DESERT LION SURVEY

QUESTIONS

Use the information from the study to answer the following questions.

1

Identify the aim of this investigation.

[1]



2

Explain why there was so little data regarding desert lion population numbers before this study.

[1]



3

Describe two major differences between this study and previous studies that estimated the population of desert lions.

[2]



1

2

4

State two reasons why desert lions are particularly suitable for a study involving thermal drone imaging.

[2]

1

2



5

State a potential ethical problem that is avoided by using thermal drone imagery to estimate the number of desert lions.

[1]



6

Describe how this study made use of images collected during previous aerial surveys.

[1]



THE GREAT DESERT LION SURVEY

ANSWERS

1 To estimate the population of desert lions using a single survey/ count across the whole study region.



2 Because of the logistical difficulties of reaching possible desert-lion habitats in remote parts of the Sahara that were far from research stations.



3

- This study used a single survey/all data were collected at the same time.
- This study attempted to survey the whole study region rather than use only a sampling technique.



4

- Desert lions gathered at a relatively small number of water sources.
- Their warm bodies produced a strong contrast with the cooler desert ground, making them easier to detect in thermal drone images.



5 It avoided approaching, handling or disturbing the lions.



6 Researchers first examined 'quick-look' images from three previous aerial studies to identify locations where lions were thought to be present.



THE GREAT DESERT LION SURVEY

PAW PRESENTATION AND ANALYSIS – PAGE 1 PAW

1 High-resolution thermal drone images may show one or more desert lions.

When lions are separated, individuals can be identified and counted. However, lions often rest close together near water sources or rocks. Their thermal outlines may overlap, so individuals cannot always be distinguished and a different approach is needed.



2 Statistical analysis was used to estimate the number of adult lions in each group. Earlier aerial estimates differed from ground counts because warm rocks, shrubs and shadows were sometimes confused with lions.

This study sharpened the thermal images and used temperature filters, improving resolution and distinguishing lions from rocks, vegetation and shadows.



ORIGINAL THERMAL IMAGE



IMPROVED THERMAL IMAGE



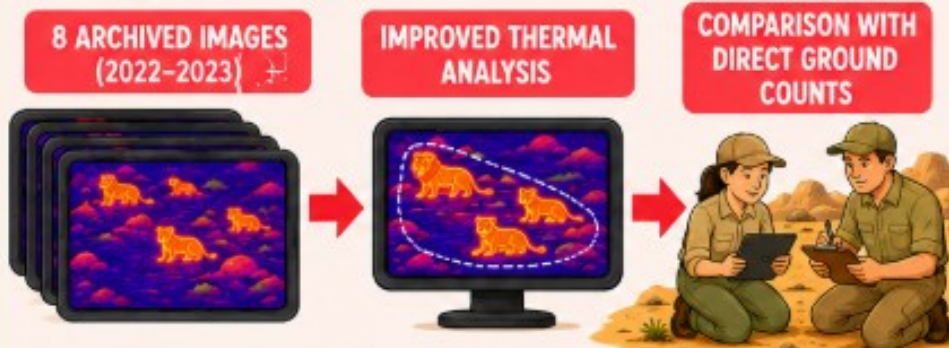
- Lions
- Warm rocks
- Vegetation
- Shadows

THE GREAT DESERT LION SURVEY

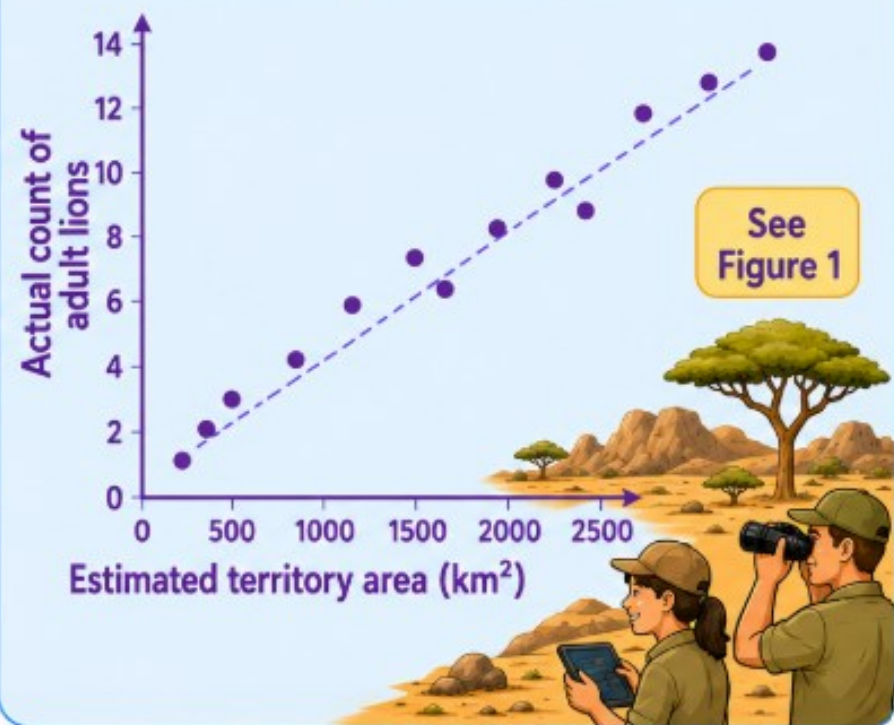
PAW PRESENTATION AND ANALYSIS – PAGE 2 PAW

3 The improved method was applied to eight archived thermal images from **2022 and 2023**.

Estimates were compared with images taken at the same time as direct ground counts. Three further lion groups were counted using matching thermal drone images and ground surveys.

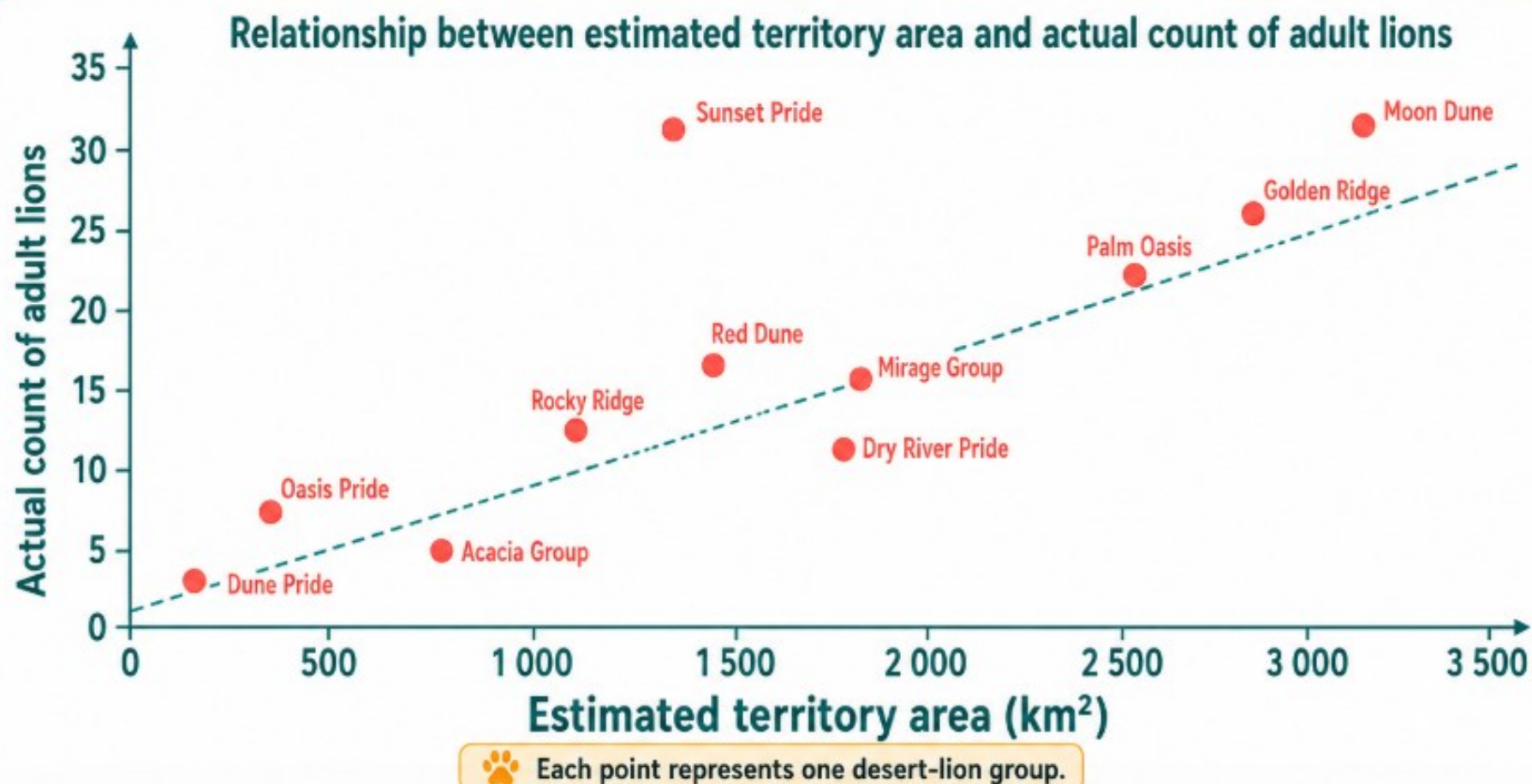


4 Researchers graphed the estimated territory area against the number of adult lions using 11 groups for which both drone-area estimates and direct counts were available.



THE GREAT DESERT LION SURVEY

FIGURE 1 — TERRITORY AREA AND ADULT COUNT



THE GREAT DESERT LION SURVEY

DETECTION AND SMALL-GROUP LIMITATIONS – A TO C

A

It is difficult to know whether unknown lion groups were missed.

Poor image quality, airborne dust, shadows and sun-heated rocks can make lions difficult to identify in thermal images. Small groups containing fewer than four lions are also harder to detect.



- HOT ROCKS
- DUST
- SHADOWS

B

Researchers expected few very small groups because small prides are less effective at cooperative hunting and defending cubs from rival predators. Previous field studies found lower hunting success and lower cub survival in prides containing fewer than four adults.



COOPERATIVE PRIDE
= STRONGER



SMALL PRIDE
= LESS EFFECTIVE



C

Although some small groups may have been missed, their contribution to the total population would be small.

Any resulting error should therefore be minor and fall within the confidence limits of the estimate.



Hot rocks + dust + shadows = tricky thermal counting!



THE GREAT DESERT LION SURVEY

PAW SOURCES OF ERROR AND TIMING – D TO E PAW

D

The researchers identified two main sources of error: **methodological error** and **natural variability**.



METHODOLOGICAL ERROR

Examples: thermal-image quality, counting and detection.



NATURAL VARIABILITY

Examples: weather, water availability and lion behaviour.



E

Late August would be the best time to count because most adult lions gather near the remaining permanent water sources during the late dry season.

However, the sun-heated desert ground reduces the temperature contrast between lions and their surroundings. Dust storms, heat haze and high temperatures can also produce poor images, reduce drone battery performance and make ground surveys unsafe. Cooler conditions in October usually produce clearer thermal images, so a region-wide late-August survey is not currently feasible.

LATE AUGUST – BIOLOGICALLY IDEAL



Most adult lions concentrated near permanent water sources.

LATE AUGUST – PRACTICALLY DIFFICULT



Hot ground; low thermal contrast; dust; heat haze; overheating batteries; unsafe ground surveys.



Best counting time $\neq$ easiest thermal survey time!



THE GREAT DESERT LION SURVEY

QUESTIONS 7-9



Use the information from the study to answer the following questions.

7

Figure 1 shows the relationship between estimated territory area and the number of adult lions for groups where both drone-area estimates and direct counts were available.

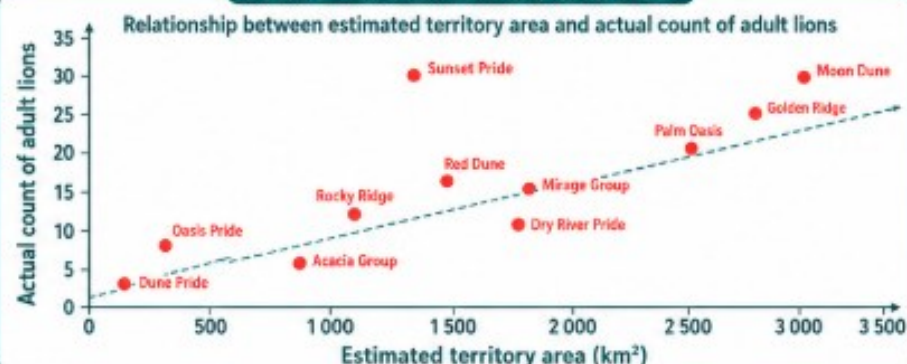
- (a) The researchers claimed that their data showed a strong positive correlation between estimated territory area and the actual number of adult lions. Use Figure 1 to evaluate this claim.

[2]

- (b) Explain how researchers could use this graph for other lion groups where only the estimated territory area is known.

[1]

FIGURE 1 – TERRITORY AREA AND ADULT COUNT



8

Give **one** reason, apart from group size, why a desert-lion group might not be identified.

[1]

9

The researchers concluded that the number of very small groups containing fewer than four lions would be limited.

- (a) Describe the biological disadvantage they suggested small groups might face.

[1]

- (b) What evidence did they use to support this suggestion?

[1]

- (c) State the evidence they offered to justify that missing small groups would not result in a major error in their population estimate.

[2]

1

2

THE GREAT DESERT LION SURVEY

ANSWERS 7-9

7(a)

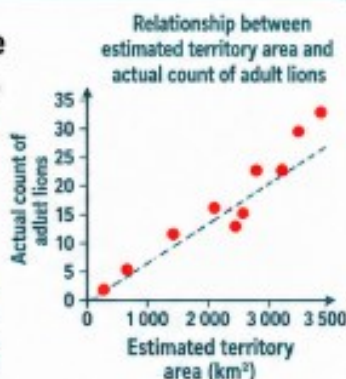
There is a strong correlation because most/many of the points are close to the line of best fit.

[1]

There is a positive correlation since, as estimated territory area increases, the actual count of adult lions increases.

[1]

[2]



8

Poor image quality, airborne dust, shadows or sun-heated rocks.

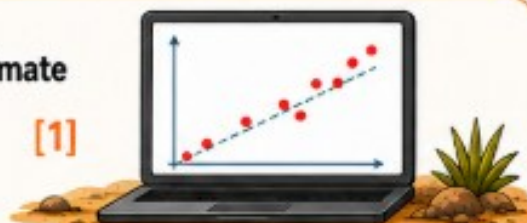
[1]



7(b)

Use the graph to estimate adult lion numbers.

[1]



9(a)

Cooperative hunting or defending cubs is less effective in groups of this size.

[1]



9(b)

They cited evidence from previous field studies.

[1]



9(c)

Their contribution to the overall total population size would be small.

[1]

The value would be within the acceptable range/confidence limits of error.

[1]

[2]





Use the information from the study to answer the following questions.

10

The researchers suggested that there were several sources of error.

State **two** areas identified by the researchers from which sources of error may arise.

[2]

1

2

11

The researchers suggested that it would be better to estimate the desert-lion population in late August rather than in October.

(a) Explain why late August is a better time to estimate the desert-lion population.

[1]

(b) Suggest why it is not currently feasible to estimate desert-lion numbers across the whole region in late August.

[1]



THE GREAT DESERT LION SURVEY

ANSWERS 10–11

10

Methodological.

[1]



Natural variability.

[1]



[2]

11(a)

Most adult lions are gathered near the remaining permanent water sources in late August.

[1]



11(b)

The sun-heated ground would reduce the thermal contrast, so lions could not be identified reliably.

[1]

