| **Title:** | The Guardian Frogs of Borneo |
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| **SubTitle:** | Why exceptions matter in biology and everyday life |
| **shortTitle:** | guardianFrogs |
| **Module:** | NA |

[**Client Goals Worksheet**](https://drive.google.com/file/d/14OjmIVuIx0KR1s9dlZf6uem2Q09Rr9Ns/view?usp=sharing)

**Sponsored By** (blurb ~30 words):

| Johana Goyes, PhD |
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| **Est. Time:** | 3 x 45 min |
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| **For Grades:** | 5-8 |
| **Target Subject:** | Science |
| **Lesson Hook:** | Are guardian frogs exceptions to the rule? |
| **Driving Questions:** | * Across animal species, is there truth to the stereotype that males are “competitive,” while females are “caring”, or is this an oversimplification? * Are the smooth guardian frogs of Borneo the first known species of frog with “competitive females” and “caring males”? |
| **Essential Questions:** | * How can we use scientific methods to identify a general pattern? * Why do exceptions matter in science and in life? |
| **Learning Targets:** | Students will be able to:   1. Explain how animal behavior facilitates in reproduction 2. Understand the concepts of sexual selection and sex role reversal; understand the factors that contribute to sex role reversal 3. Understand that biological data are variable; Use statistical language (*e.g.* mean, range) and data visualization to describe variation in biological data; Learn to test hypotheses by interpreting data that shows variability, using scatter plots of real biological data 4. Cite textual evidence from a scientific text to support analysis of what the text says explicitly as well as inferences drawn from the text. 5. Understand that there there are exceptions in biology by integrating evidence from scientific text and graphs of real biological data [and understand why it is important to study these exceptions in biology and other disciplines] 6. Extra: Understand the relationship between biodiversity and geography, with focus on the geography of Borneo |
| **Tags (up to 10):** | animal behavior, sexual signaling, frogs, sex role, sexual selection, biological exceptions |

## Standards Alignment

[See Alignment Doc](https://docs.google.com/spreadsheets/d/1F7oT8YqNsyVoLS0aX5n5hhg7Xct3Z4Fe/edit#gid=1279887393)

Generic standards alignment notes:

| Target Standard (NGSS): *Disciplinary Core Idea (DCI)*   * **LS1.B-M2** Animals engage in characteristic behaviors that increase the odds of reproduction. |
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## Other info

Field site coords: 4.550000, 115.150000 / 4°33'00.0"N 115°09'00.0"E

# New Outline

## Itinerary:

#### Day 1: Defining a Pattern in Nature:

Engagement Hook + Knowledge Scaffolding: Have students derive the general rule that “males tend to compete and advertise more; females tend to be choosy and provide more parental contributions”. But there’s a lot of variation, and some species with the opposite pattern “showy females, caring males”.

**Day 2**

Introduce Borneo and the system and begin data analysis. Set up hypothesis testing for “showy females + nurturing males”. Introduce data, which they’ll finish analyzing for homework. Include reflection about

#### Day 3

Quick review and opportunity for discussion (10min) to close out. Option for extensions.

Future Extensions

Probably continue another stage of analysis and conclusion. Analyze data on Bornean biodiversity loss (maybe this is a very small thing). Discuss and reflect on why exceptions matter and what the loss of such exceptions means for humanity.

Research on what’s causing most of the deforestation in Borneo and what individuals can do about it.

## Detailed Outline

#### Part I: Deriving the Rule (and discovering exceptions): “Role with It” simulated data collection

Warm-Up (10 min): Categorize the following. Among nonhuman animals, what sex is:

* showy
* large
* competitive
* loud
* caring
* protective

Side note:

* We will always use the word “sex”, not “gender” in this lesson.
* Not talking about humans
* Sex refers to male and female, determined by size of gametes (sperm and egg)
* Gender is a concept that applies to how humans identify with a particular group (male, female, or nonbinary). Whether animals have gender or not is hard to test, since they cannot tell us how they perceive themselves.

Are their consistent sex differences in which species is caring and which is competitive?

* To answer this question, we’re going to collect data by doing an activity.
* Across animal species, organisms have evolved behaviors that help them survive and reproduce.
* Some traits, like showy feathers or dancing behaviors help attract mates (ornaments), while others help compete against rivals (armaments).
* These ornaments and armaments could be in the form of sounds, or visual signals.
* And sometimes the same signal can have both functions--like if large antlers are intimidating to rival males, but also attractive to females. Or in birdsong, if a well-executed song deters rival males and is attractive to females.

30min Student activity: “Role with It” (Interactive data collection)

* Students are distributed 20 cards (m & f for 10 species); some students may get more than 1 (you can give more than 1 student the same card if you have a big class)
* All but 2 (jacana and pipefish) have M only or M & F mate attraction/competition (conventional sex roles); But wrens have both, and we have the 2 sex role reversed species. What do these 3 all have in common that is unusual/missing in the others? Male parental investment.
* Activity “Role With It”:
  + Presentation goes through each species and sex in a haphazard order
  + If you have that card, you look at the value and signal accordingly. Each has a visual & an acoustic signal value. Visual signals go from 1-3; acoustic: 0-3.
    - Acoustic Signaler: Say your name 3 times (at an audible, but respectful volume according to an acceptable classroom level)
    - Visual Signaler: Do a little dance according to your level; (Gif of fortnight celebration or Steve Zissou doing very subtle dance) to accommodate introverts
    - Does not signal: Quietly raise your hand
    - Teacher will call on you: You read your script: “Male bullfrogs croak to attract females. They do not care for offspring, they only pass on their genes.”
    - Presentation prompts them to fill in answers on the worksheet
    - BEFORE activity begins, opportunity to trade cards (to be more or less boisterous)
* Students finish worksheet, combining results into a summary table.
* Ask to calculate what proportion had greater male than female display score.
* Ask to calculate what proportion had greater female than male display score
* Ask to calculate what proportion equal male and female display scores.
* Same for parental investment.

TAKEHOME: We want students to get invested in the storyline (have fun). Collect data. Use the data to recognize that 1) there is variation in who is choosy/flamboyant and how much parental investment there is; 2) males tend to be more flamboyant, with females contributing more to offspring (conventional sex roles); 3) in cases of sex role reversal, males contribute more to offspring.

**Part II: Let’s Go to Borneo: Testing a hypothesis with data from the field (You’re testing whether this is the first known frog species with competing females and caring males)**

1. Start class with playing [atmospheric Borneo video](https://www.youtube.com/watch?v=G7xvfIhL6bU)
2. Where are we going?
3. Borneo is a large island in Southeast Asia
4. It is the territory of 3 different countries:
   1. Indonesia
   2. Papua New Guinea
   3. Brunei
5. We’re focusing on Brunei
6. [Introduce frogs & Brunei with Johana’s videos.](https://www.youtube.com/watch?v=eX5abcrmE7g)
7. You’re going to use Dr. Goyes Vallejos’s data to test whether this frog species could be the first sex role reversed frog species known to science.

## Media

* [Frog soundscapes](https://soundcloud.com/frogvoicesofborneo/sungai-belalong-megophrys-nasuta-soundscape)
* [Guardian Frog calling behavior](https://youtu.be/LAqSHDdTKMw)
* [Johana’s presentation](https://youtu.be/eX5abcrmE7g)
* [Johana’s website](https://jogoyesvallejos.weebly.com/sci-comm.html)
* [Frogging at Kuala Belalong](https://www.youtube.com/watch?v=TOwQ8xQH9O4&t=1s)

**Abstract (<250 words)**

| (151 words so far)  In sexually reproducing animals, males and females typically behave differently—in predictable ways that help ensure their survival and reproduction. These differences in behavior are called “sex roles,” and while this term can be applied to humans, usage in this lesson is restricted to nonhuman animals (mostly frogs). In a majority of species, males compete intensely for mates and provide little parental care, while females carefully select a mate and provide the bulk of parental care. However, it is often said that “The only rule in biology is that there’s an exception to every rule.” This is the case with sex roles, and in some extreme cases (e.g. seahorses), species exhibit complete sex role reversal—males engage exclusively in “female-typical” behaviors (like protecting and nurturing offspring), while females engage only in “male-typical” behaviors (competing for mates and contributing little parental care).  In this 3-day lesson, students will be introduced to guardian frogs, a small amphibian from Borneo–a large island in southeast Asia. Females of this species engage in many “male-typical” behaviors, and males engage in many “female-typical” behaviors. Students will examine real biological data to test the hypothesis that guardian frogs are a sex-role reversed species, using statistics and graphical analyses to evaluate and interpret biological patterns and address research questions. |
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**Scientific Background (200–350 words)**

| ### Scientific Background  Further Reading: Add links with markdown format: [*link text*](*link URL*)  - |
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**Previous notes from consultation with Johana:**

| **Matt:**   * I like the idea of framing this around "there are exceptions to every rule"   + Elaine: We'll need some other examples of "exceptions" in science but also in other disciplines. * Do we make a science-targeted lesson out of it? * What if we had them analyze some calls to answer a question, don't mention the sex * Do some storytelling, building up the setting in Borneo   + She's got some really [good media for this ready to go](https://jogoyesvallejos.weebly.com/sci-comm.html) * Maybe play some soundscapes to really set the scene. * Have them do some data aggregation or something   + Maybe IDing frog calls using some resource (spp. ID) * Then bombshell halfway--these are female frogs. * Why do these females call? Why do they not normally?   + Sex role reversal/male parental care * Some stats about number of frog species and how many do/don't call. * Spend time w/ denouement, reflection   + Is there a general lesson about exceptions to every rule?   + Explain conservation status   **Elaine:**   * Definitely a science focused lesson, I'm thinking earth science and some bio. We can blend with english (reading/writing), maybe some math, and geography (of Borneo and where it is relative to US, unique features of Borneo, ?) * Topics: * 1. Guardian frog - looks, location, male frog call, why different from other frogs (males stay with eggs, Borneo vs. South American frogs, etc.). * 2. Sex Role Reversal - defining it, how it's exhibited in nature, why this is significant.   + - Activity: observe some animals (maybe pre-recorded on youtube or something) and determine what the sex roles are: "standard" (?) or Reversal (I don't know what not reversed sex role is called). * 3. Frog call calls (male then female)   + - * Why do frogs make calls?       * comparing male/female frog calls       * Maybe create visualization of data (graph?) - I don't want to copy too much from the other lesson, but this is also a standard practice in research. * 4. "rules" of nature and how there are exceptions (and why exceptions exist)   + - * Biology is sometimes referred to as “the **science** of **exceptions**.”       * Outliers.       * Maybe how outliers are identified in data/graphs       * What finding an outlier could mean for science discovery       * What other rules of nature do we know - and what's an exception to that rule? This could be an activity. Maybe like "what goes up must come down. Except when... (students finish this statement with) there's no gravity" or something like that. * 5. what these findings mean for science / rules of nature, etc. * Johanna's website includes some lesson ideas she's done with students in the past. I wonder if we could incorporate her "methods for observing animal behavior" as an integrated "experiential learning" activity? Ask students to observe some animals in their own community, develop research questions with help from the teacher, and create a science poster (which can be created virtually or hardcopy). This actually could be a good activity for schools that still do science fairs (do schools still have those?) and students can use their behavior observations and poster in the science fair. |
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