

Bats, Pigs and People: Choosing a Plan to Prevent Nipah

Investigation question: Fruit bats near Green Valley's pig farms can carry Nipah virus, but the same bats pollinate fruit trees and spread forest seeds. With \$6 million for ten years, which plan or package should the district choose to protect people, the bats and farm families, and does the answer hold up when different people's priorities are weighted and the estimates turn out worse than expected?

Data-driven decision

Groups of 4

1 session

Setup 5 · Activity 50 · Cleanup 3 min

MS-LS2-5 · assesses

MS-ETS1-2 · assesses

Scientific purpose

Students act as an advisory group for an invented farming district in Southeast Asia, each speaking for a stakeholder: a pig farmer, the district health officer, a durian orchard grower and the district budget officer. They read real background on Nipah virus and fruit bats and simulated data on five competing plans and six two-plan packages, negotiate one agreed set of criteria weights with weight chips, turn the data into scores with fixed scoring rules, compute weighted totals, recheck the ranking under every stakeholder's weights and under worst-case estimates, and write a recommendation that separates what the data show from what the group values.

Why this helps students with this chapter

Real environmental decisions rarely have one right answer, and students often swing between 'science decides' and 'it is all opinion'. A weighted matrix puts each in its place: data become scores through rules anyone can check, and values become weights that people argue about openly. This case adds a twist from the lesson's emerging-disease section: the fix that sounds simplest, getting rid of the bats, scores worst once biodiversity and ecosystem services are counted. Rechecking with each stakeholder's weights shows why a pig farmer and a health officer can read the same data and disagree, and the worst-case check shows that the highest score is not always the safest bet.

Standards connections

MS-LS2-5 (assesses, evaluating competing design solutions for maintaining biodiversity and ecosystem services, with scientific, economic and social constraints): Students evaluate five competing solutions and six packages against criteria that include a wild species and the ecosystem services it provides (fruit bats that pollinate durian and spread forest seeds), human health, farm income, cost, fairness and certainty, then defend a choice. This matches the PE as written, including the scientific, economic and social constraints named in its clarification statement.

MS-ETS1-2 (assesses, a systematic, weighted evaluation of competing solutions with sensitivity and worst-case checks): Students apply one systematic process, fixed scoring rules and weighted totals, to every competing plan and package against the same criteria and the \$6 million constraint, then test how the

ranking holds up under each stakeholder's weights and under worst-case estimates. That is the PE as written: the process is supplied, and students carry it out, check it and judge what the results mean.

Roles (rotate each session)

- **Pig farmer and facilitator:** Speaks for the district's 60 pig farms, keeps the discussion moving and makes sure every stakeholder speaks before the group agrees on weights.
- **District health officer and recorder:** Speaks for farmworkers and their families and records the agreed weights, the score matrix and the totals.
- **Durian orchard grower and checker:** Speaks for the fruit growers whose trees bats help pollinate and checks every score against the scoring rules and every multiplication.
- **District budget officer and timekeeper:** Speaks for the district's \$6 million fund, keeps the group on schedule and confirms that any package stays within budget.

Materials

Item	Quantity	Per	Note
Case file: background, the two data tables and the scoring rules	1	group	Two pages; double-sided printing saves paper.
Stakeholder cards (pig farmer, health officer, orchard grower, budget officer)	1 set of 4	group	
Weight chips: paper squares worth 5 points each	20	student	Cut from scrap cardstock; students spend them to show weights.
Calculators	2	group	
Recording sheet	1	student	
Class results chart on the board	1	class	

Estimated cost: 2 to 4 per class (estimate) (an estimate; About 3 printed pages per student (about 90 for a class of 30) plus a two-page case file and a card sheet per group (about 25 more for 8 groups), at roughly 2 to 3 cents a page on a school copier; weight chips are cut from scrap cardstock.)

Safety

- Paper-only activity: the only physical hazards are paper edges and scissors. Use blunt-tip scissors if students cut their own weight chips.
- The case involves a disease that has killed people. Some students may have family experience of serious illness or of farming; keep the discussion about evidence and choices, not about blame, and let students step out of a role if it is uncomfortable.
- Stakeholder roles are perspectives, not judgments of real people or places; the district is invented.

Teacher preparation and setup

1. Print the case file and stakeholder cards for each group and the recording sheet for each student. Cut 20 weight chips per student, or have students cut them in the first minutes.
2. Assign stakeholder roles so every group has all four; in a group of three, the facilitator also speaks for the budget officer.
3. Draw the class results chart: group, agreed weights, top single plan, chosen package, and the winner in the worst-case check.
4. Score plan A yourself with the scoring rules so you can model the step from data to score.
5. Tell the class that Green Valley District and all of its numbers are invented for teaching, while the background facts about Nipah virus and fruit bats are real. The topic is a deadly disease, so keep the focus on prevention and on how communities make choices.

Investigation design

Independent variable	The set of weights (practice, the group's agreed set and the four stakeholder sets), the estimate used (central or worst case) and, in step 6, the plan or package being scored.
Dependent variable	Each plan's weighted total and its rank.
Controlled	The same case-file data for every group; The same scoring rules; Weights that always total 100; The \$6 million, ten-year budget
Trials	Six weight sets and two estimate cases per group; class results are pooled on one chart.
Comparison	Rank order across weight sets; central versus worst-case estimates; the best single plan versus the best package.

Student procedure

1. Read the background and both data tables aloud as a group, one section per stakeholder. Each stakeholder underlines the numbers their person cares about most.
2. Stakeholder case (5 minutes). Read your card. Lay out your 20 weight chips (5 points each) to match your stakeholder's weights, prepare a 30-second case for your top criterion, and answer q1.
3. Negotiate (10 minutes). Put everyone's chips on the table. The facilitator asks each stakeholder for their 30-second case. Agree on one set of weights that totals 100 and that every member can accept, record it in the weights table and answer q2.
4. Score (8 minutes). Use the scoring rules to turn each single plan's data into a score from 0 to 4 on each criterion and fill the score matrix (q3). The checker confirms every score against the rules.
5. Compute. For each plan, multiply each score by its weight and add the six products. Do it first with the practice weights (q4), then with your agreed weights; split the four stakeholder columns among the group so the totals table is complete (q5, q6).
6. Package. Choose one package from the package table, score it with the same rules and compute its total with the practice weights and with your agreed weights (q7).

7. Worst-case check. Rescore human health for plans A and B and for your package using the top of each likely range, and recompute their practice-weight totals (q8).
8. Recommend. Write the group's recommendation to the district council (q11), post your weights, winners and package on the class chart, and answer the remaining questions on your own.

Expected observations

- Score matrix (central estimates; human health, bats, farm income, cost, fairness, certainty): A 4, 4, 3, 1, 3, 3; B 3, 4, 4, 2, 3, 2; C 2, 0, 1, 4, 1, 1; D 2, 4, 2, 3, 4, 3; E 1, 4, 4, 4, 4, 1.
- Practice-weight totals: A 320, B 310, D 285, E 280, C 155. Packages: B + E 340, B + D 335, A + D 305, A + E 305, D + E 290, C + D 155.
- Stakeholder winners among single plans: pig farmer E (325, with B close at 320), health officer A (330), orchard grower B (345, with A at 340), budget officer E (295). Including packages: pig farmer B + D or B + E (335), health officer B + D (340), orchard grower B + D (365), budget officer still E alone (295).
- Worst case with practice weights: A 320; A + D, A + E and B + D 305; B and B + E 280; D 255; E 250; C 95.
- Plan C ranks last for every stakeholder, including the budget officer, whose weights favor its low cost.

Likely difficulties

- Groups argue about weights before reading the data. Insist on the 30-second cases first, each tied to a number from the case file.
- Scoring fairness: B counts as 'users pay a small cost' (3), A as 'a group loses some income for 3 years or less' (3), C as 'loses income for good with no payment' (1). Have the checker read the 'Who pays or loses' column aloud for each plan.
- Mixing up the central estimate and the likely range. Score with the central number until the worst-case check in step 7.
- Arithmetic load: six products per plan for each weight set. Split the stakeholder columns among the group and have the checker verify one column.
- Treating the top score as the answer. Require the second-place option and the accepted tradeoff in every recommendation.

Structured debrief

1. Post every group's agreed weights and winner. Ask why groups that read the same data chose different plans. The data were identical; the weights were not.
2. Show the stakeholder results: moving the pens (A) wins for the health officer, bat-proof sheds (B) for the orchard grower, and feeding the bats elsewhere (E) for the pig farmer and the budget officer. With the practice weights, the package B + E scores highest of all (340). Ask which option every stakeholder could live with, even if it is nobody's first choice.
3. Run the worst-case check together. Using the top of each range, B falls from 310 to 280 and B + E from 340 to 280, while A holds at 320 because even its worst case stays at 10 percent. Discuss what a

district should do when the best-scoring package is also less certain: choose the sure thing and its costs, or choose the package and monitor closely so it can switch plans quickly.

4. Spend a minute on plan C. Removing the bats sounds like removing the problem, yet it scores worst: it barely lowers the risk, may scatter the bats toward other farms, destroys a pollinator and seed spreader, and shifts the cost onto orchard growers. Connect to the lesson's Nipah section: the fixes that worked kept bats and pigs apart rather than destroying the bats.
5. Close on the lesson's final section: science supplied the chances, costs and colony sizes; the weights are a community's values.

Recording sheet: what students fill in

Lab 3 recording sheet: Bats, Pigs and People

About this case — Green Valley District is invented, and every number in the two data tables is a teaching estimate. The background facts about Nipah virus and fruit bats are real.

Background. Large fruit bats called flying foxes are the natural host of Nipah virus; infected bats usually do not get sick. In Malaysia and Singapore in 1998 and 1999, pigs on farms with fruit trees caught the virus, most likely from bitten fruit and saliva that feeding bats dropped into the pens, and passed it to the people who worked with them. More than 300 people fell ill and more than 100 died, and more than a million pigs were killed to end the outbreak. Since 2001, people in Bangladesh and India have caught it mostly from fruit or raw date palm sap that feeding bats contaminated, and it can also spread from person to person. There is still no approved vaccine or medicine for people. Health agencies advise protecting pig feed and pig sheds from bats and thinking about bats when choosing where to build a pig farm. Fruit bats are valuable too: flying foxes help pollinate durian, one of Southeast Asia's most valuable fruit crops, and carry the seeds of many forest trees. Bat experts warn that chasing a roost away can simply move the bats to other trees, and there is no evidence that killing or chasing bats stops Nipah from spreading.

Green Valley District. The district has 60 pig farms, durian and other fruit orchards, and a forest roost of about 15,000 flying foxes 2 km from the nearest farms. Last year Nipah virus was found in pigs in a neighboring district. The health office estimates that with no action, the chance of a Nipah outbreak in people here within 10 years is about 40 percent. The district has \$6 million to spend over 10 years.

Five single plans (science team estimates; teaching data)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Plan	10-year cost (\$ million)	Chance of an outbreak in people in 10 years (%)	Likely range (%)	Bat colony kept (%)	Farm income kept (%)	Who pays or loses	Certainty of the estimate
A. Move pig pens away: farms within 1 km of the roost move their pens, and no fruit trees grow within 50 m of any pen	4.5	6	3 to 10	100	93	Pig farmers lose some income for 2 years while they move; the district pays moving costs	Medium-high
B. Bat-proof the sheds: wire-mesh netting over pens and roofs over feed troughs	2.5	15	8 to 30	100	98	Each farm pays about \$50 a year to keep the nets repaired	Medium
C. Remove the roost: cut the roost trees and drive the bats away with noise	1.0	30	10 to 60	10	85	Orchard owners lose part of their harvest for good, with no payment	Low
D. Protect workers and catch outbreaks early: gloves, masks and training; fast testing of sick pigs; quarantine of infected farms	1.5	25	15 to 35	100	90	No one loses income; culled pigs are paid for	Medium-high
E. Feed the bats elsewhere: plant figs and other fruit trees by the forest, far from farms, plus a radio and school campaign	0.8	35	20 to 45	100	100	No one	Low

Two-plan packages within the budget (science team estimates; teaching data)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Package	10-year cost (\$ million)	Chance of an outbreak in people in 10 years (%)	Likely range (%)	Bat colony kept (%)	Farm income kept (%)	Who pays or loses	Certainty of the estimate
A + D	6.0	3	2 to 6	100	93	Pig farmers lose some income while moving	Medium-high
A + E	5.3	5	2 to 9	100	93	Pig farmers lose some income while moving	Medium-high
B + D	4.0	8	4 to 15	100	98	Farms pay to keep nets repaired	Medium-high
B + E	3.3	10	5 to 22	100	98	Farms pay to keep nets repaired	Medium
C + D	2.5	18	8 to 40	10	80	Orchard owners lose part of their harvest for good, with no payment	Low
D + E	2.3	20	12 to 32	100	90	No one	Medium

Package A + B (\$7.0 million) is over budget. Combined chances are the science team's estimates; they are not found by adding or multiplying the single-plan numbers.

Scoring rules (0 = worst, 4 = best)

Criterion and what the score is based on	4	3	2	1	0
Human health: chance of an outbreak in people (%)	10 or less	11 to 20	21 to 30	31 to 40	over 40
Bats and their services: bat colony kept (%)	95 or more	75 to 94	50 to 74	25 to 49	under 25
Farm income kept (%)	98 or more	93 to 97	88 to 92	80 to 87	under 80
Low cost: \$ million over 10 years	1.0 or less	1.1 to 2.0	2.1 to 3.5	3.6 to 5.0	5.1 to 6.0
Fairness: who pays or loses	No one loses income	Users pay a small cost, or a group loses some income for 3 years or less	A group loses income for good but is paid	A group loses income for good with no payment	
Certainty: the science team's rating	High	Medium-high	Medium	Low	

Stakeholder cards

1 Pig farmer (farm income 35, fairness 25, human health 15, cost 10, certainty 10, bats 5)

Your family raises 400 pigs. Moving your pens would mean two hard years, and an outbreak would mean losing your whole herd. You want your workers safe, but you cannot afford a plan that sinks the farm.

2 District health officer (human health 45, certainty 20, farm income 10, cost 10, fairness 10, bats 5)

In the 1998-1999 outbreak more than 100 people died, and there is still no vaccine or medicine. Your job is to keep farmworkers and their families safe, and you want a plan you can count on.

3 Durian orchard grower (bats and their services 35, farm income 25, human health 15, fairness 10, certainty 10, cost 5)

Your durian trees are your income, and flying foxes help pollinate their flowers at night. Getting rid of the bats might sound simple, but it could shrink your harvest for good.

4 District budget officer (cost 40, human health 20, certainty 15, farm income 10, fairness 10, bats 5)

The \$6 million must last ten years, and the same fund pays for roads and clinics. You want the most protection for each dollar and no surprises.

Weights (each column totals 100)

Criterion	Practice set	Pig farmer	Health officer	Orchard grower	Budget officer	Our agreed weights
Human health	30	15	45	15	20	
Bats and their services	20	5	5	35	5	
Farm income	15	35	10	25	10	
Low cost	15	10	10	5	40	
Fairness	10	25	10	10	10	
Certainty	10	10	20	10	15	
Total	100	100	100	100	100	

1. Your stakeholder's case: name their top criterion and give one number from the case file that shows why it matters to them.

Answer: Role-specific. Examples: pig farmer, farm income, because plan A costs farmers income for 2 years while they move and an outbreak could mean losing the herd; health officer, human health, because with no action the chance of an outbreak is about 40 percent and there is no vaccine; orchard grower, bats and their services, because plan C keeps only 10 percent of the colony that helps pollinate durian; budget officer, cost, because plan A alone uses \$4.5 million of the \$6 million fund.

Why: Credit a top criterion that matches the card and an accurate number from the case file that supports it.

- Names the stakeholder's top criterion
- Cites an accurate number from the case file

2. How did your group reach its agreed weights? Name one compromise a stakeholder made and why they accepted it.

Answer: Group-specific. Example: 'We averaged our four sets and then adjusted. The health officer accepted a human-health weight of 30 instead of 45 because the pig farmer agreed to lower farm income from 35 to 20, and we all kept bats at 15 because the orchard grower showed that durian depends on them.'

Why: Look for a real process (discussion, averaging, trading points) and a specific compromise. Weights must total 100.

- Describes how agreement was reached
- Names a specific compromise
- Agreed weights total 100

3. Score matrix: use the scoring rules to score each single plan from 0 to 4 on each criterion.

Answer: A: 4, 4, 3, 1, 3, 3. B: 3, 4, 4, 2, 3, 2. C: 2, 0, 1, 4, 1, 1. D: 2, 4, 2, 3, 4, 3. E: 1, 4, 4, 4, 4, 1. (Order: human health, bats and their services, farm income, low cost, fairness, certainty.)

Why: Human health: 6 percent (4), 15 (3), 30 (2), 25 (2), 35 (1). Bats: 100 percent kept (4) except C at 10 percent (0). Farm income: 93 (3), 98 (4), 85 (1), 90 (2), 100 (4). Cost: \$4.5 million is in the 3.6 to 5.0 band (1); \$2.5 million (2); \$1.0 and \$0.8 million (4); \$1.5 million (3). Fairness: A and B (3), C (1), D and E (4). Certainty from the team's ratings: Medium-high 3, Medium 2, Low 1.

Weighted totals (score × weight, added across the six criteria)

Plan	Practice weights	Our agreed weights	Pig farmer	Health officer	Orchard grower	Budget officer
A						
B						
C						
D						
E						
Package: _____						

Analysis questions: answer key

4. Compute each single plan's total with the practice weights (human health 30, bats 20, farm income 15, cost 15, fairness 10, certainty 10). Show the work for one plan and rank all five.

Answer: $A = 30 \times 4 + 20 \times 4 + 15 \times 3 + 15 \times 1 + 10 \times 3 + 10 \times 3 = 120 + 80 + 45 + 15 + 30 + 30 = 320$. $B = 90 + 80 + 60 + 30 + 30 + 20 = 310$. $C = 60 + 0 + 15 + 60 + 10 + 10 = 155$. $D = 60 + 80 + 30 + 45 + 40 + 30 = 285$. $E = 30 + 80 + 60 + 60 + 40 + 10 = 280$. Ranking: A 320, B 310, D 285, E 280, C 155.

Why: Each total is the sum of six score × weight products. A and B are close, so small weight changes can swap them.

Also acceptable: Accept correct totals from a student's own score matrix if a single scoring slip carried through consistently.

5. With your group's agreed weights, which single plan ranks first? Is it the same as with the practice weights? Explain which weight made the difference.

Answer: Group-specific. Example: 'Our weights were human health 25, bats 20, farm income 20, cost 20, fairness 10, certainty 5. B came first with 315, E second with 310 and A third with 305, unlike the practice set, because we gave more weight to farm income and cost, where B scores higher than A.'

Why: Check the totals against the group's weights and the q3 matrix. A useful shortcut: A and B tie on bats and fairness, so A beats B exactly when the human-health plus certainty weights are larger than the farm-income plus cost weights. Credit an explanation that names the weight that moved and the scores that made it matter.

- States the top plan under the agreed weights
- Compares with the practice ranking
- Names the weight change that made the difference

6. Use the four stakeholder columns. Which single plan wins for each stakeholder? What pattern do you see, and what does it tell you about where disagreement comes from?

Answer: Pig farmer: E wins (325; B 320, A 300, D 280, C 140). Health officer: A wins (330; B 285, D 260, E 205, C 170). Orchard grower: B wins (345; A 340, E 325, D 305, C 95). Budget officer: E wins (295; D 285, B 260, A 245, C 235). Pattern: the stakeholder who weights health and certainty picks A, the plan most likely to prevent an outbreak; the stakeholders who weight income or cost pick E or B, which keep income and cost less. Every stakeholder ranks C last. The disagreement comes from the weights (values), not from the data, which everyone shared.

Why: Totals follow from the q3 matrix and each stakeholder's weights.

- Correct winner for each stakeholder
- Describes the pattern linking weights to winners
- Concludes that disagreement comes from weights, not data

7. Score your chosen package with the scoring rules and compute its total with the practice weights and with your agreed weights. Does it beat the best single plan? Show the scores.

Answer: Package-specific. Example B + E: human health 10 percent (4), bats 100 percent (4), farm income 98 percent (4), cost \$3.3 million (2), fairness (3), certainty Medium (2). Practice total = $120 + 80 + 60 + 30 + 30 + 20 = 340$, which beats the best single plan, A (320). Other packages with the practice weights: B + D 335, A + E 305, D + E 290, C + D 155.

Why: B + E pushes the chance into the top health band while keeping income and cost moderate. Note that A + D and A + E score below A alone because their cost falls into the lowest cost band.

- Package scored correctly with the rules
- Totals computed with both weight sets
- Compared with the best single plan

8. Worst-case check: rescore human health for plans A and B and for your package using the top of each likely range, then recompute their practice-weight totals. Which wins now, and what should the district learn from this?

Answer: Worst case: A's chance becomes 10 percent, still in the top band, so A stays at 320. B's becomes 30 percent, so human health drops to 2 and B falls to $60 + 80 + 60 + 30 + 30 + 20 = 280$. B + E becomes 22 percent, so it also drops to 2 and falls to 280. A wins the worst case. The district learns that B + E scores best only if the estimates hold; A's narrow range makes it the safest bet, though it costs more and farmers lose income while moving. A district that chooses B + E should monitor closely and be ready to add or switch to A.

Why: This tests robustness: a plan with a wide range can lose its lead when the estimate is wrong. Accept other packages' worst-case totals if computed correctly (B + D falls to 305; A + D and A + E stay at 305; D + E falls to 230).

- Rescored values and totals correct
- Identifies the worst-case winner
- Draws a conclusion about uncertainty and choice

9. Plan C removes the bats, the animals that carry the virus, yet it ranks last. Use at least two criteria to explain why, and name the ecosystem services the district would lose.

Answer: Plan C keeps only 10 percent of the bat colony (bats score 0), cuts farm income to 85 percent because durian loses its bat pollinators (score 1), lowers the outbreak chance only to 30 percent with a range up to 60 percent because scattered bats may settle near other farms (health 2, certainty 1), and leaves orchard owners with a permanent loss and no payment (fairness 1). Its only strength is cost. The district would lose pollination of durian and other fruit trees and the spreading of forest tree seeds, which helps forests regrow.

Why: This is the heart of MS-LS2-5: a solution that ignores biodiversity and ecosystem services can fail even on the problem it was meant to solve.

- Uses at least two criteria with numbers or scores
- Names pollination and seed spreading as lost services
- Notes that C does not reliably lower the risk

10. Which parts of your recommendation came from science (data and predictions) and which came from values (weights)? Give one example of each.

Answer: Science: the chance of an outbreak under each plan, its likely range, the bat colony kept, farm income kept and the costs (for example, A's 6 percent chance). Values: how much human health matters compared with farm income, and whether it is fair for pig farmers to lose income while moving (for example, our weight of 30 for health and 15 for income).

Why: This applies the lesson's point that science predicts results but people decide what to do.

- One correct example from science
- One correct example from values

11. Write your recommendation to the district council: the plan or package, two pieces of evidence from your matrix, the tradeoff you accept, and what the district should monitor to know whether the plan is working.

Answer: Group-specific. Example: 'We recommend package B + D: bat-proof sheds plus worker protection and early testing, for \$4.0 million. With our weights it scored highest, cutting the chance of an outbreak to about 8 percent while keeping the whole bat colony and 98 percent of farm income. Even in the worst case (15 percent) it scores 305. We accept that every farm pays about \$50 a year to keep its nets repaired. The district should inspect nets twice a year, test sick pigs quickly and count the bat roost each year, and move pens away from the roost (plan A) if Nipah is found in any district pig.'

Why: Full credit requires all four parts. Any plan or package within budget can earn full credit if the evidence supports it under the group's weights and the tradeoff is honest.

- Names a plan or package within budget
- Two pieces of matrix evidence
- States the accepted tradeoff
- Names what to monitor and a trigger for changing course

12. Describe one way the scoring rules could mislead the district, using an example from the data tables.

Answer: Any one with an example: A + E (5 percent) and B + E (10 percent) both score 4 for health although one chance is twice the other; A at \$4.5 million scores 1 for cost but A + D at \$6.0 million scores 0, so adding worker protection to A lowers its total; B (15 percent) and D (25 percent) are only one band apart although D's risk is much higher; the bat score counts only colony size, not how well the bats can still pollinate; certainty is a rating, not a measurement.

Why: Scoring bands simplify continuous data, which can hide real differences or exaggerate small ones; a careful district looks back at the raw numbers.

- Names a specific weakness in the rules
- Supports it with an example from the tables

Individual evidence of learning

Each student submits the stakeholder case (q1), the score matrix (q3), the weights and totals tables, and their own answers to q4 to q12, including the written recommendation (q11). The recommendation, the stakeholder comparison (q6), the worst-case check (q8) and the plan C explanation (q9) are the evidence for evaluating competing solutions for maintaining biodiversity and ecosystem services.

Assessment criteria

Criterion	Proficient looks like
Scoring from data	Every score in the matrix follows the scoring rules and matches the data tables (q3).
Weighted totals	Totals are correct for the practice weights and at least one other weight set, with the work shown for one plan (q4, q6).
Sensitivity and uncertainty	Explains with numbers how changing the weights or using worst-case estimates changes the ranking (q6, q8).
Biodiversity and ecosystem services	Explains why removing the bats fails on several criteria and names the pollination and seed-spreading services at stake (q9).
Science and values	The recommendation cites matrix evidence, states the accepted tradeoff, names what to monitor and separates data from values (q10, q11).

Accessibility adaptations

- For students who need support, pre-score plan A in the matrix as a model and provide a multiplication grid for the weighted totals.
- Stakeholder cards can be read aloud in pairs; multilingual learners can prepare their case with the frame 'My stakeholder cares most about ___ because the case file shows ___.'
- Weight chips make the negotiation physical; a student who prefers not to speak can show their weights with chips and a written card.
- Print the data tables in large type, or give students with low vision a digital copy they can zoom.

Low-cost alternative

Project the case file and data tables instead of printing them, and have students record weights and scores in their notebooks; tally marks in rows of five can replace the paper weight chips.

Model limitations

Green Valley District and every number in its data tables are invented for teaching, although the background facts about Nipah virus and fruit bats are real. Real risk estimates would come from disease surveillance and bat studies and carry wider, messier uncertainty than these ranges. The scoring bands turn continuous data into whole numbers, so different values can tie and small differences can jump a band. The six criteria leave out others a real district would weigh, such as animal welfare, laws protecting bats, and spillover through foods other than pork. This activity has not been tested with students by the authors.

Teacher notes

All totals in the expected observations were computed from the scoring rules exactly; check student matrices first, because one wrong score carries through every total. With the practice weights, A (320) and B (310) are close, which is deliberate: small weight changes swap them, and the worst-case check pulls them apart again. If a group finishes early, ask it to show why A beats B whenever the human-health plus certainty weights exceed the farm-income plus cost weights. Background facts come from the WHO Nipah fact sheet, CDC, and Aziz and colleagues (2017) on flying foxes pollinating durian; the district, its plans and all of their numbers are invented.