

Six Pressures and the Words Engineers Use

Learning target: I can use the chapter's terms to classify human pressures on ecosystems, connect them to design solutions, and tell criteria, constraints and tradeoffs apart.

Vocabulary in action

About 35 min

Individual

MS-LS2-5 · supports

MS-ETS1-1 · practice

MS-ESS3-4 · supports

independent practice

visual modeling

writing

Standards connections

MS-LS2-5 (supports): Students build the language needed to evaluate solutions for maintaining biodiversity and ecosystem services: naming the pressure, the service at risk and the kind of design that responds. No solution is evaluated yet.

MS-ETS1-1 (practice): Part C has students sort statements about a real design problem into criteria, constraints and tradeoffs and justify each choice, which practices defining a design problem precisely.

MS-ESS3-4 (supports): The per capita calculation in Part D is a skill the Grade 8 PE relies on (population times use per person). In California MS-ESS3-4 is a Grade 8 performance expectation; it is background here and is not assessed.

Purpose: build · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

per capita

Per person. Take a group's total (water used, energy used, money earned) and divide it by how many people share it.

natural resource

A material or energy source from nature that people use, such as fresh water, soil, wood, minerals or fossil fuels.

ecosystem services

Benefits people get from working ecosystems, such as clean water, pollination of crops, flood protection, food and the recycling of nutrients.

biodiversity

The variety of life in a place: how many different species live there, the variety within each species, and the variety of ecosystems.

over-exploitation

Taking living things from the wild faster than their populations can replace themselves, so their numbers fall.

by-catch

Animals caught by accident while fishing for something else, such as sea turtles in a shrimp net or young fish too small to sell.

pollution

Harmful materials or energy that people add to an environment, such as plastic, extra nutrients from fertilizer or sewage, or toxic chemicals.

habitat degradation

Damaging or destroying a natural area so it can no longer support its usual living things and processes, such as clearing a forest for farms.

invasive species

A species that people have moved outside its native range, where it spreads and causes harm to ecosystems or to the economy.

emerging disease

A disease that is new to people, or is suddenly reaching many more of them, often after people and their farm animals come into new contact with wildlife.

climate change

A long-term shift in Earth's climate patterns, including average temperatures and how often severe weather happens. Today's warming is caused mainly by burning fossil fuels.

criteria

What a design must do or achieve to count as a success. One criterion, many criteria.

constraints

The limits a design must work within, such as cost, time, available materials, laws, or what people will accept and use.

tradeoff

Giving up some of one benefit to gain more of another.

Part A: Name the pressure

The six pressures are over-exploitation, pollution, habitat degradation, invasive species, emerging disease and climate change. Each headline below describes one of them. These headlines are written for this worksheet; they describe realistic situations, not specific news stories.

1. For each headline, write the pressure that fits best and the clue word or fact that decided it.

Answer: 1. Invasive species (from another continent, spreads, causes harm to pipes and the lake). 2. Habitat degradation (woodland replaced by houses and roads). 3. Pollution (fertilizer is a harmful added nutrient). 4. Over-exploitation (caught faster than the population can replace itself). 5. Emerging disease (a virus newly reaching people through animals). 6. Climate change (warmer air and rising seas over the long term). 7. Pollution (plastic waste). 8. Over-exploitation, as by-catch (an accidental catch of non-target animals during harvest).

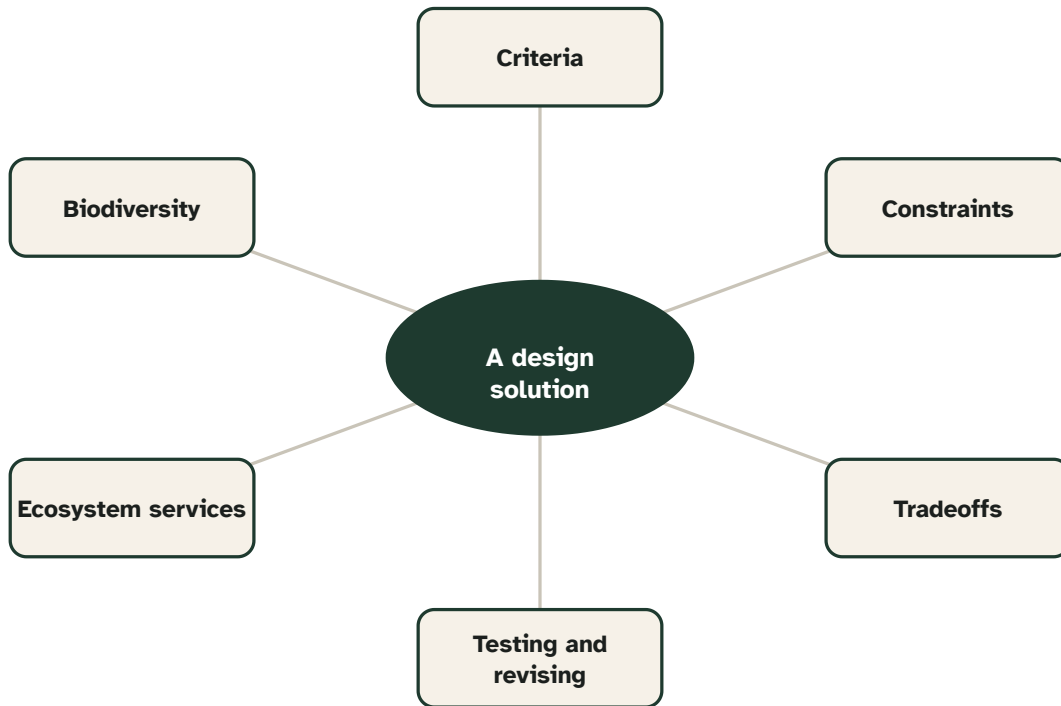
Why: Each headline contains a clue matching one definition. Item 8 is the chapter's by-catch problem; it is a side effect of harvesting, which is why it is grouped with over-exploitation.

Also acceptable: Item 8: accept 'by-catch' alone. Item 3: accept 'pollution leading to habitat degradation' if both are explained. Item 7: accept pollution only.

- Correct pressure for at least 7 of 8 headlines
- A clue word or fact given for each

Part B: Connect the ideas

What goes into a design solution for an ecosystem



Concept map with the linking words missing. Each line joins the center to one idea.

2. Write a linking phrase for each line so that 'A design solution ___ [idea]' becomes a true sentence. Then add an example from this chapter.

Answer: Criteria: 'must meet' (the Lake Malawi nets must leave snail-eating fish). Constraints: 'must work within' (the nets must be cheap and use local materials). Tradeoffs: 'usually involves' (shade coffee gives fewer beans but more birds). Testing and revising: 'is improved by' (Long Island Sound nitrogen limits were monitored and adjusted). Ecosystem services: 'should protect' (clean water, fish for food, flood protection by marshes). Biodiversity: 'should maintain' (forest birds on coffee farms, native fish in the Great Lakes).

Why: Each linking phrase must make a true sentence with the center. The examples check that students can tie each term to a real case.

Also acceptable: Accept other accurate verbs ('is limited by' constraints, 'is judged by' criteria, 'is checked by' testing, 'aims to keep' biodiversity).

- Six linking phrases that make true sentences
- At least four accurate chapter examples

Part C: Criterion, constraint or tradeoff?

Fishing families around Lake Malawi, in southeastern Africa, want to reduce a snail-spread disease called bilharzia by protecting the small fish that eat snails. Each statement below is about their net design, or about a design problem from another part of the chapter.

3. Label each statement criterion, constraint or tradeoff, and give a reason.

Answer: a. Criterion (what success must achieve). b. Constraint (a cost limit). c. Criterion (success includes families' food and income). d. Constraint (a materials limit). e. Tradeoff (fewer fish now in exchange for more snail-eaters). f. Constraint (a time limit). g. Tradeoff (fewer beans in exchange for habitat). h. Criterion (a measurable target for success).

Why: Criteria describe the goal; constraints are the limits; a tradeoff names what is given up and what is gained.

Also acceptable: Statement c can be argued as a constraint ('the design cannot leave families without food'); accept it with that reasoning.

- At least 7 of 8 correct
- A reason that uses the definition for each

Part D: Tell the words apart

4. Town A has 10,000 people and uses 1,500,000 liters of water a day. Town B has 2,000 people and uses 400,000 liters a day. Which town uses more water in **total**? Which uses more **per capita**? Show both per capita calculations.

Answer: Total: Town A uses more (1,500,000 L vs 400,000 L per day). Per capita: Town A $1,500,000 \div 10,000 = 150$ L per person per day; Town B $400,000 \div 2,000 = 200$ L per person per day. Town B uses more per capita.

Why: Totals depend on population; per capita values remove population size so towns of different sizes can be compared. This is the population $\times$ use-per-person idea behind MS-ESS3-4.

Also acceptable: Accept answers with units written as 'liters per person' or 'L/person/day'.

5. A wetland holds 40 kinds of birds, and it also soaks up floodwater before it reaches a town. Which fact describes **biodiversity** and which describes an **ecosystem service**? Explain how losing the first could affect the second.

Answer: Forty kinds of birds describes biodiversity. Soaking up floodwater describes an ecosystem service. If the wetland's plants and animals are lost (for example, the plants that slow and hold water), the wetland can do less of that work, so the town floods more.

Why: Biodiversity is the variety of life; ecosystem services are the benefits people receive. The link is that the living parts of the wetland do the work.

Also acceptable: Accept a link through birds or fish that people value, if the student explains why a less diverse wetland may provide fewer benefits.

- Correctly labels each fact
- Explains a connection through the living parts of the ecosystem

6. Oranges and tomatoes grown on California farms first came from other parts of the world. Are they invasive species? Use both parts of the definition in your answer.

Answer: No. They were brought by people from outside their native range, which is the first part of the definition, but they do not spread into wild areas and cause ecological or economic harm, so the second part does not fit. They are non-native crops, not invasive species.

Why: An invasive species must be both moved by people and harmful; being non-native alone is not enough.

Also acceptable: Accept 'non-native but not invasive' with the harm reason.

- Says no
- Uses both parts: moved by people and causes harm

7. Which one does **not** belong with the others?

Answer: C. A concrete seawall built in front of a town.

Why: The other three are ecosystem services provided by living ecosystems (pollination, water purification, food). A seawall is built infrastructure; it may protect the town, but it is not a service from an ecosystem.

Also acceptable: Accept C with any reason that names the others as ecosystem services.

8. Which term fits? (a) A plan must cost less than \$2 million; that limit is a _____. (b) Dolphins caught in a net set for tuna are _____. (c) Cutting a forest to plant one crop is an example of _____. (d) Average energy used by each person on Earth is the world's _____ energy use.

Answer: (a) constraint. (b) by-catch. (c) habitat degradation. (d) per capita.

Why: Each blank tests the meaning of one term in a new situation rather than a memorized definition.

Also acceptable: (c) Accept 'habitat loss'. (b) Accept 'by-catch (over-exploitation)'.

Part E: Use the words

9. Write three or four sentences that explain why a growing human population puts more pressure on ecosystems than a growing hare population does. Use **per capita**, **natural resource** and **ecosystem services** correctly, and underline each one.

Answer: Example: Hares eat only what grows near them, and their numbers crash when food runs low or predators catch up. People use far more natural resources, such as water, wood, metals and fossil fuels, and per capita use has risen over the last century, so each added person adds more demand than before. When those resources are taken faster than ecosystems can replace them, the ecosystems lose some of their ability to provide ecosystem services like clean water and fish to eat.

Why: The answer should combine population and use per person and connect heavy use to lost services.

Also acceptable: Accept answers that also mention technology changing how much harm each unit of use causes.

- Uses all three terms correctly
- Mentions both population size and per capita use
- Connects resource use to a loss of ecosystem services

Teacher notes

The headlines in Part A are written for the worksheet and are realistic composites. Item 1 resembles quagga and zebra mussels; item 4 resembles the collapse of Atlantic cod in the early 1990s; item 5 is the chapter's Nipah virus case. The textbook never uses the words 'criteria' or 'tradeoff' in the lesson body (only in its

standards box), so Part C is students' first real practice with them. Watch for students who call any non-native species invasive (q6) and for students who label a seawall an ecosystem service (q7).

Scaffold offered to students: Questions to ask yourself

For Part A, ask: Is someone taking too much (over-exploitation)? Adding something harmful (pollution)? Wrecking a place (habitat degradation)? Moving a species to a new place (invasive species)? Is a germ reaching people in a new way (emerging disease)? Is the long-term climate shifting (climate change)? For Part C, ask: Does the statement describe success (criterion), a limit (constraint), or something given up to get something else (tradeoff)?

Extension: When one problem is two pressures

Real problems often combine pressures. Choose one headline from Part A that could fit two pressures (for example, plastic fishing line is pollution, and a net lost at sea that keeps catching fish is also a kind of over-exploitation). Write a paragraph explaining both labels, then explain why naming both might lead an engineer to a better solution than naming only one.