



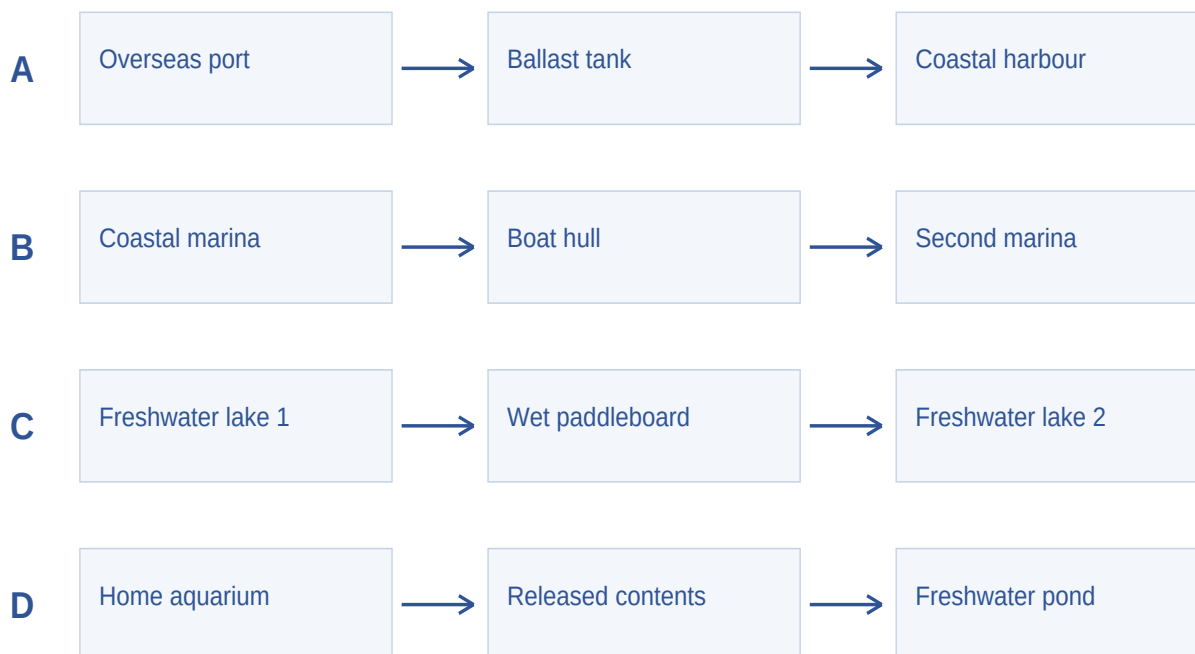
# Unwanted Passengers

C1 | AGES 16+ | 90 MINUTES | HOW DO INVASIVE SPECIES SPREAD?

S01

Four reports reach your school's environment desk after routine shipping, recreation and aquarium activities. Reconstruct plausible introduction pathways, assess the strength of competing explanations and justify proportionate preventive measures.

## THE ROUTE BOARD / FOUR SEPARATE CASES



Schematic movement routes, not a geographical map. Marine and freshwater cases involve different organisms. A possible route is not proof that a particular journey caused an introduction.

## YOUR COMMISSION

Read the science brief. Match four case files to possible pathways. Identify what is still unknown. Then produce an evidence-led briefing and a practical message for one audience.

**Teams of 3–4:** share the roles of evidence reader, pathway mapper, sceptic and editor. All case records, places and organisms labelled A–D are fictional teaching models. This is a desk-based investigation, not a collection activity.



# Arrival is not the whole story

SCIENCE BRIEF | ORIGINAL EDUCATIONAL TEXT BASED ON SOURCES [1–5]

S02

- 01 Human-mediated movement beyond a species' natural range constitutes an introduction. Non-native status does not, by itself, establish invasiveness: harmful effects on biodiversity or related systems must also be considered. The distinction prevents origin from being mistaken for evidence of damage. [1]
- 02 Ballast-water transfer and biofouling are distinct transport mechanisms: organisms travel within stabilising water or on submerged surfaces. Measures targeted at the first do not automatically control the second. A credible response must identify the mechanism it is intended to interrupt. [2, 3]
- 03 Local transfers can amplify wider introductions. Damp recreational equipment transports organisms between water bodies; releases from aquaria provide another route. Some aquatic plants regenerate from fragments. Pathway management consequently extends beyond international shipping to routine choices made close to home. [4, 5]
- 04 Introduction, establishment and subsequent spread are analytically distinct. Persistence requires a self-sustaining population rather than repeated arrivals alone. Secondary spread may involve renewed human transport or natural dispersal, while environmental conditions constrain survival and reproduction.
- 05 A detection does not reconstruct an invasion history. Temporal sequence alone cannot establish attribution, and a first recorded occurrence may postdate the actual arrival. Identification, baseline surveys and alternative pathways must inform confidence. Precaution does not require pretending that uncertainty has disappeared.

**Read actively:** underline the difference between non-native and invasive. Circle two transport mechanisms. Mark one sentence explaining why a plausible route is not proof of responsibility.

**Key terms:** pathway = route of movement; establishment = a self-sustaining population; vector = a carrier; biosecurity = measures that reduce biological transfer risks.



# Four ways to travel

CUT-OUT PATHWAY CARDS | MATCH MECHANISM TO PREVENTION

S03

Cut along the dashed borders. Use these cards to explain the case files on S04. Each card describes a possible mechanism, not a diagnosis of a real incident.

01



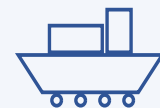
## INSIDE THE TANK

Small organisms may enter with ballast water and be transported to another port. [2]

### Interrupt the route

Professional ballast-water management addresses this pathway. It does not remove hull growth.

02



## ON THE HULL

Organisms attached to submerged surfaces can travel with a boat. This is biofouling. [3]

### Interrupt the route

Professional inspection and appropriate hull maintenance target attached growth. Uncontrolled scraping can release organisms.

03



## ON WET EQUIPMENT

Organisms or fragments can move on damp boards, boats, nets or footwear. [4]

### Interrupt the route

Check, clean and thoroughly dry equipment before moving to another water body; follow site-specific guidance.

04



## OUT OF THE AQUARIUM

Released pets, plants or water can carry organisms from captivity into outdoor waters. [5]

### Interrupt the route

Do not release aquarium organisms into the wild. Seek responsible rehoming and locally approved disposal advice.



# The evidence files

CUT-OUT CASE CARDS | ALL RECORDS BELOW ARE FICTIONAL

S04

The four cases concern different organisms. Letters are teaching labels, not species names. Expert identifications are assumed reliable within this simulation.

## A / HARBOUR SAMPLE

08 May: a ship discharged ballast water after travelling from Port East, where marine organism A is established. On 10 May, A was detected in harbour water. Experts identify it as non-native locally. No discharge sample or earlier harbour survey exists.

Could the ship have carried A? What else would you need?

## B / MARINA INSPECTION

A yacht moved from South Marina to North Marina. Inspectors then identified non-native marine organism B growing on its hull. Similar growth is seen on a pontoon, but that growth has not been identified. No earlier hull record exists.

What is directly observed? Is release or local establishment proven?

## C / PADDLEBOARD LOG

Plant C is already assessed as invasive in Lake 1. Boards travelled to Lake 2 while damp, without cleaning. A fragment of C was identified on a board before launch at Lake 2. No search of Lake 2 has yet taken place.

Which movement is confirmed? Which stage remains unknown?

## D / POND REPORT

An owner reports emptying aquarium plants, water and snails into a pond. Experts later identify non-native snail D in the pond. The aquarium snails were not identified. Reproduction and ecological impacts in the pond have not been studied.

Does release prove the source or prove that D is invasive?



# Build the case, not a rumour

INVESTIGATION SHEET | REFER TO EVIDENCE, NOT INTUITION

S05

Evaluate pathway attribution in each case. Distinguish observation, inference and alternative explanation. Specify the missing evidence that would most improve confidence.

| Case | Pathway + supporting evidence | What is not established? |
|------|-------------------------------|--------------------------|
| A    |                               |                          |
| B    |                               |                          |
| C    |                               |                          |
| D    |                               |                          |

## TRANSFER CHECK

In case C, a fragment has reached Lake 2's launch area on a board. Does this prove that C has entered the lake, formed a self-sustaining population or caused harm there? Explain each distinction.

---



---



---

**Extension:** describe how repeated introductions could mimic persistence. What evidence would distinguish continued arrivals from local reproduction?



# The headline test

LANGUAGE, EVIDENCE AND A PROPORTIONATE RESPONSE

S06

## DRAFT POST / NOT APPROVED FOR PUBLICATION

"Foreign species are taking over. The cargo ship caused the invasion. Ban all visitors and the problem disappears."

Analyse the post's framing, causal certainty and proposed remedy. Evaluate the assumptions behind it, then produce a 50–70-word alternative that communicates risk without overstating attribution.

---

---

---

---

## DESIGN A PREVENTION PLAN

Choose one case. Name the action, who should carry it out, and how it interrupts the specific pathway. Add one measure of implementation and one way to check the ecological outcome.

---

---

---

---

Consider feasibility and unintended effects. Explain how monitoring would distinguish compliance from biological effectiveness, and state a limitation of the proposed design.



# Your evidence-led briefing

INDIVIDUAL WRITING | SCHOOL ENVIRONMENT DESK

S07

Write 300–380 words answering: **How do invasive species spread, and what should we do about it?** Use the science brief and at least two case files. Write on your own paper or digitally.

## YOUR BRIEF MUST

Synthesize two contrasting pathways and evaluate the strength of attribution. Distinguish arrival, establishment, secondary spread and impact. Defend a proportionate response against an objection and propose a meaningful evaluation.

### Plan your argument

Main explanation / key distinction

---

---

Case evidence / what it does not prove

---

---

Response / justification / monitoring

---

---

**Writing standard:** qualify uncertain attribution without weakening well-established mechanisms. Avoid treating origin as a moral judgement or a substitute for evidence of harm.

**Peer review:** mark one supported claim, one uncertainty and one justified action. Revise any claim that goes beyond the evidence.



# Teaching the investigation

C1 | TEACHER GUIDE | 90 MINUTES + OPTIONAL EXTENSION

T01

**Learning outcomes:** explain four aquatic transfer pathways; distinguish non-native status from invasiveness; separate arrival, establishment and impact; evaluate attribution; justify pathway-specific prevention.

**Preparation:** print S01–S07 per group, S05–S07 per learner as needed. Cut S03 and S04, or use them as reference pages. No fieldwork, live organisms or internet are required.

| Time  | Activity                                                        |
|-------|-----------------------------------------------------------------|
| 0–8   | S01: launch; identify the separate marine/freshwater cases.     |
| 8–20  | S02: read; compare definitions and mark evidence limits.        |
| 20–38 | S03–S04: match pathways and cases; challenge a confident claim. |
| 38–50 | S05: complete the evidence matrix; discuss case C.              |
| 50–63 | S06: revise the headline and plan a targeted response.          |
| 63–83 | S07: write a briefing; extend writing time if needed.           |
| 83–90 | Peer review and revise one overstatement.                       |

## Differentiation

C1: require alternatives, proportionate judgement and monitoring limitations. Extend the briefing as homework or allow an additional 20 minutes for a sustained response.

**Access and participation:** allow paired rehearsal, enlarged cards or typed responses. Rotate roles so language confidence does not determine who interprets evidence.

**Safety:** do not collect, move or release organisms; do not scrape hulls or improvise chemical treatments. Real sightings require local reporting and biosecurity guidance.

**Responsible framing:** “non-native” is an ecological category. Do not use invasion terminology as an analogy for human migration.

# Evidence and answer key

MODEL REASONING / ACCEPT WELL-SUPPORTED ALTERNATIVES

T02

**A / Ballast water:** discharge and a later detection make the pathway plausible. There is no sample linking the discharged water to A and no baseline. Prior presence or another arrival remains possible; establishment and local harm are unproven.

**B / Biofouling:** attached growth is directly identified on the hull. Where it attached, whether it was released and whether the pontoon growth is B are unknown. A self-sustaining local population is not demonstrated.

**C / Wet equipment:** transfer of an identified fragment to the launch area is supported. Release into Lake 2, establishment and local effects are not shown. C's invasive status in Lake 1 does not demonstrate any of those events in Lake 2.

**D / Aquarium release:** the release event is reported and D is present in the pond. The aquarium organisms were not identified, so source attribution is incomplete. Non-native status alone does not prove invasiveness.

## S05 / INTRODUCTION IS NOT ESTABLISHMENT

An organism on a board has been transported but may not yet have entered the recipient water. Detection in water does not demonstrate reproduction. Repeated arrivals could explain repeated detections. Evidence of local recruitment over time would strengthen an establishment claim.

## S06 / Language and reasoning

"Taking over" amplifies fear; "caused" removes uncertainty; "all" and "disappears" promise an unsupported total solution. A cargo-ship-only explanation ignores other pathways. A blanket ban is not justified by the evidence supplied.

**Possible replacement:** "Non-native organisms have been detected, but the source and local impacts are not yet established. Targeted checks of ballast water, hulls and recreational equipment can reduce transfer risks. Follow local biosecurity guidance and report suspected sightings without moving organisms. Further observations are needed to assess establishment in these recipient waters."

**Key concept:** natural dispersal can contribute to secondary spread after human introduction. Do not classify every naturally moving species or climate-driven range shift as a human-mediated introduction.



# Responses and assessment

TEACHER REFERENCE | REASONING OVER A SINGLE RIGHT ANSWER

T03

| Case | Targeted response                                    | Evidence to review                                  |
|------|------------------------------------------------------|-----------------------------------------------------|
| A    | Professional ballast management                      | Treatment records + appropriate biological sampling |
| B    | Professional hull inspection and managed maintenance | Inspection records + repeat marina surveys          |
| C    | Check, clean, dry before transfer                    | Checks completed + repeated recipient-site surveys  |
| D    | Prevent releases; responsible advice                 | Rehoming/disposal arrangements + follow-up surveys  |

Measures reduce risk; none guarantees absence. A programme must consider detection limits, sampling effort and unintended transfer during cleaning. Monitoring should record the method and effort, not simply “nothing found”.

## Example analytical statement

The wet-board evidence in case C supports transport to the launch area more directly than the timing evidence supports ship attribution in case A. Nevertheless, neither case establishes a reproducing population in the recipient water. Cleaning equipment targets a plausible transfer mechanism, whereas further surveys address the separate question of establishment.

| Criterion           | Strong / 2             | Developing / 1          | Limited / 0        |
|---------------------|------------------------|-------------------------|--------------------|
| Scientific concepts | Accurate distinctions  | Partial distinction     | Confused / absent  |
| Evidence use        | Specific + qualified   | Specific but incomplete | Unsupported        |
| Response            | Mechanism + evaluation | Action with some reason | Unmatched / absent |
| Communication       | Coherent + precise     | Mostly understandable   | Meaning unclear    |

8-point formative rubric. Adjust language expectations to the edition. Reward justified alternatives; the resource is not an official examination paper.

# Sources and use

BACKGROUND REFERENCES / ORIGINAL CASE MATERIAL

T04

The science brief paraphrases background concepts from these sources. No published worksheets, case records, photographs or diagrams are reproduced. Guidance is educational; follow current local requirements for real activities.

## 1 / European Commission: Invasive alien species

OPEN SOURCE

## 2 / IMO: Ballast Water Management

OPEN SOURCE

## 3 / IMO: Biofouling

OPEN SOURCE

## 4 / National Biodiversity Data Centre: Check-Clean-Dry

OPEN SOURCE

## 5 / APHA: Tackling invasive species

OPEN SOURCE

### ORIGINAL AND FICTIONAL ELEMENTS

The four case files, organisms A–D, route board and draft post are invented for this resource. They model plausible mechanisms but do not describe real incidents or identify real people as responsible.

Free educational use and adaptation; not for resale. Supplied logos and linked publications retain their own rights. No endorsement by cited organisations is implied.

Last visited: 18 October 2026.