FOCUS QUESTIONS

- What does it mean for a species to be an ecosystem engineer and what are some examples of these species?
- What are some of the major anthropogenic (human caused) threats to the Earth's biodiversity and why?
- If some native species are now permanently extinct from a habitat, how can we still successfully restore their functions to those areas?
- How can the restoration and conservation of one species lead to the conservation of additional species?

OVERVIEW

"It's important to bring back the native species because they can restore function to landscapes." Derek Gow

In ***A Farm Goes Wild*** we meet sheep and cattle farmer-turned-conservationist, Derek Gow. Since the late 1990s Gow, through his environmental consulting organization, has been instrumental in helping restore beavers, water voles, and storks to the landscapes of Great Britain. Restoration of these species has contributed to the rewilding of farmland and the overall resurgence of biodiversity. In the film, we also meet one of Gow's recruits, ecologist Pete Cooper who helps Gow restore and monitor these important species as they work to return farmland to its original state, as a healthy, biodiverse ecosystem.

KEY CONCEPTS

- Threatened and Endangered Species: The International Union for the Conservation of Nature lists more than 44,000 species threatened with extinction. Habitat loss and destruction and agriculture are the major threats for more than 85% of these species.
- Biodiversity: Allowing patches of land like farmland to be returned to a more natural state can help mitigate the biodiversity threats.
- Conservation biology: The practice of conservation biology recognizes the intrinsic value of the Earth's natural diversity of organisms. Conservation biology works to understand how the natural world operates, how humans affect nature, and how we can use collective scientific and cultural knowledge to conserve Earth's biological diversity.
- Rewilding: A primary goal of some ecological restoration projects is to go beyond conventional restoration, where some level of management is required to maintain ecosystem processes, and emphasize the importance of truly wild ecosystems by embracing their unpredictable and dynamic abiotic (e.g. droughts and floods) and biotic (e.g. food webs and population cycles) natural processes.
- Ecosystem engineers: The beaver's natural behavior of building dams creates ponds and wetlands on the landscape that would not exist without them. Water voles help engineer the landscape by creating burrows along streams and pond shores that can be used by other animals. White storks can also engineer an ecosystem. The storks' large nests can provide future nesting sites for songbirds. The nests can also kill the trees within which they are built, creating snags that can become habitat and food sources for numerous other species.
- Keystone species: Together, beavers, water voles, and white storks are keystone species because the habitats they create through dam, burrow, and nest building provide food and homes for dozens of species including other mammals, birds, amphibians, fish, waterfowl, and invertebrates. The beavers also provide habitat for hundreds of plant species which in turn attract and support the animal diversity.

BACKGROUND

In the film ***A Farm Goes Wild*** we learn about one farmer's efforts to restore the Eurasian beaver (*Castor fiber*), the water vole (*Arvicola amphibius*), and the white stork (*Ciconia ciconia*) to the landscapes of Great Britain. Each of these species plays a key role in the functions of natural landscapes, but their populations have struggled for the last two centuries as much of the land area not occupied directly by humans has been

converted almost entirely to agriculture. Biologists estimate that by around 1880, beaver hunting and the conversion of natural habitats to agriculture had reduced the European and Asian populations to only about 1,200 individuals; they were extinct in most of their original habitats. Hunting bans and translocation programs instituted in many countries by the end of the 19th century put the Eurasian beaver on a long but astonishing road to recovery, and since 1955 the Eurasian beaver population has increased by more than 14,000%. A similar story has taken place in North America where nearly 300 years (1620-1900) of trapping North American beavers (*Castor canadensis*) for the fur trade reduced their numbers from roughly 60-400 million to near extinction.

Today, protection and recovery efforts have restored the North American beaver population to around 15 million, but still a fraction of its pre-European settlement abundance. These two species are the only representatives of the beaver family, Castoridae. Students will find it interesting that the two beaver species diverged from a common ancestor around 7 million years ago and became geographically isolated on their two continents. The two species are now genetically distinct and thus reproductively isolated from each other because at some point after divergence, eight chromosomes in the North American beaver fused into four, so today the Eurasian beaver has 48 chromosomes (n = 24) while the North American beaver has 40 (n = 20).

The water vole also used to be common throughout most of Great Britain's waterways but is now one of Britain's most endangered wild mammals. Water voles prefer natural meandering waterway banks with lush vegetation where they build their burrows, but the ditching and hydrological control of natural waterways removed and destroyed much of this critical habitat. Water voles are naturally preyed on by carnivores such as otters, owls, and foxes, and they cope with these natural predation pressures by breeding rapidly and escaping into their burrows. However, since the 1960s when many mink farms closed, the American mink (*Neovison vison*) has become an invasive predator of the voles that is more impactful than their natural enemies. For example, a female mink is slim enough to follow the water voles into their burrows and consume entire families. The drainage of wet meadows as they were converted to agricultural fields robbed the white storks of their food resources and led to dramatic population declines across Europe during the second half of the twentieth century. White storks are now protected under the European Union Birds Directive as an Annex I species. Annex I species require EU Member States to classify certain territories as special protection areas for the conservation of protected species in order to ensure their survival and reproduction in their area of distribution.

A Farm Goes Wild provides a hopeful example of how a landowner has taken the conservation of these three species literally into his own hands. But we also learn about how farmers like Derek Gow are replacing the traditional agricultural animals on their farms with animals whose behaviors mimic those of historical but absent species. For example, the now extinct Aurochs cow (*Bos primigenius*) used to roam the prehistoric lands of North Africa, Europe, and Asia. The huge body and range of the Aurochs allowed it to also have an oversized impact on the landscape, functioning as an ecosystem engineer. Farmers are using a Scottish breed of cattle called the Galloway (*Bos taurus*) to restore some of the lost functions of the Aurochs, like maintaining a more mosaic of a landscape with cattle-created clearings and even areas of bare ground.

BIODIVERSITY THREATS

The major threats to the Earth's biodiversity can be grouped into seven categories that spell the easily recalled acronym H.I.P.P.O.: **H**abitat destruction and fragmentation, **I**ntroduced species, **P**ollution, **P**opulation growth, and **O**verharvesting. Many species are threatened by a combination of these factors, but habitat loss is the greatest threat to biodiversity. In ***A Farm Goes Wild*** we learn that habitat destruction and fragmentation through the conversion of land to agriculture has led to the extinction of some keystone species and the significant reduction of the populations of others. However, this effect can be mitigated in part with a simple and straightforward solution: restoring nature farm by farm. And by doing this, we can deliberately improve natural function to the Earth's ecosystems.

DISCUSSION QUESTIONS

- [Before showing the film] Have students brainstorm what it means for a species to be an ecosystem engineer and have them list some species that they think function as ecosystem engineers.
- [Before showing the film] Have students discuss how the presence of a single species can influence the structure of the entire community of species within which it lives.
- In the film we learn that a particular conservation strategy in rewilding farmland is to return water to the land's surface. Have students discuss the various roles that water plays in rewilding a landscape.
- Ask students to discuss the possible social challenges to rewilding farmland and how might those challenges be overcome.

Curriculum Connections

NGSS

- HS-LS2 Ecosystems: Interactions, Energy, and Dynamics
    - LS2.A: Interdependent Relationships in Ecosystems
    - LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
    - LS2.C: Ecosystem Dynamics, Functioning, and Resilience
    - LS4.D: Biodiversity and Humans
- ETS1.B: Developing Possible Solutions

AP Biology (2021)

- Enduring Understandings
    - Energetics (ENE)
        - ENE-4: Communities and ecosystems change on the basis of interactions among populations and disruptions to the environment.
    - Systems Interactions (SYI)
        - SYI-1: Living systems are organized in a hierarchy of structural levels that interact.
        - SYI-2: Competition and cooperation are important aspects of biological systems.
        - SYI-3: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

IB Biology (First Exam May 2025)

A. Unity and Diversity: Common ancestry has given living organisms many shared features while evolution has resulted in the rich biodiversity of life on Earth.
    - A1.1 Water
    - A3.1 Diversity of organisms
    - A4.2 Conservation of biodiversity
B. Form and Function: Adaptations are forms that correspond to function. These adaptations persist from generation to generation because they increase the chances of survival.
    - B4.1 Adaptation to environment
    - B4.2 Ecological niches
C. Interaction and Interdependence: Systems are based on interactions, interdependence and integration of components. Systems result in emergence of new properties at each level of biological organization.
    - C4.1 Populations and communities
D. Continuity and Change: Living things have mechanisms for maintaining equilibrium and for bringing about transformation. Environmental change is a driver of evolution by natural selection.
    - D4.2 Stability and change

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CREDIT

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