Urban Ecology Study Guide

1. What is Urban Ecology?

Definition

Urban Ecology is the study of how living organisms, including humans, interact with each other and their surroundings in urban environments. It examines cities as unique ecosystems where ecological and societal processes are equally important.

Key Characteristics

- Studies cities as **ecosystems** with living and non-living components
- Focuses on interactions between species in human-dominated landscapes
- Integrates ecological processes with social, economic, and political factors
- Examines how organisms adapt to urban environments
- Addresses environmental justice and equity issues

Important Distinction: Traditional ecology removes humans from the equation. Urban ecology recognizes that people are integral to the ecosystem and that societal processes (like residential segregation, gentrification, and housing insecurity) are as important as ecological processes.

2. Why Urban Ecology Matters

Urban Growth Statistics

- Currently over 50% of world's 7.8+ billion people live in cities
- By 2050: 68% of global population will reside in urban areas
- Streets and public spaces make up 25-50% of urban land in North America
- Cities are rapidly expanding, requiring sustainable design

Critical Reasons to Study Urban Ecology

1. Ecosystem Services in Cities

Urban nature provides essential services even in built environments:

- Storm water management and flood protection
- Water filtration and air purification
- Pollination of plants and food crops
- Temperature regulation and cooling
- Pest control (bats eat mosquitoes, birds control insects)

2. Human Health and Well-being

- Nature boosts mood and mental health
- Improves focus and productivity
- Reduces stress and enhances quality of life
- Provides spaces for recreation and social interaction

3. Disease Prevention

- Cities are interconnected hubs mixing species that might not otherwise interact
- Understanding zoonotic diseases (diseases that leap from animals to humans)
- Examples: COVID-19, Ebola, rabies, SARS
- Urban ecology helps minimize human-wildlife contact risks

4. Climate Change Adaptation

- Green spaces and trees cool cities (combat urban heat island effect)
- Manage stormwater and reduce flooding
- Sequester carbon and improve air quality
- Make cities more resilient to extreme weather

3. Urban Biodiversity

Definition and Importance

Biodiversity refers to the presence of different living organisms (species of flora and fauna) in a specific place. In cities, biodiversity is a key indicator of ecosystem quality and urban sustainability.

Urban Wildlife

Contrary to common belief, cities contain significant biodiversity:

> **Common Urban Species:**
>
> - **Mammals:** Raccoons, squirrels, skunks, hedgehogs, rats, dogs, cats
> - **Birds:** Pigeons, crows, hawks, owls, swallows, swifts, kestrels, falcons
> - **Insects:** Bees, butterflies, mosquitoes, cockroaches
> - **Reptiles:** Lizards, dragons (in some regions)
> - **Amphibians:** Frogs, toads (most threatened group)

Where Urban Wildlife Lives

- **Parks and green spaces:** Often the only available habitat
- **Buildings and structures:** Walls, roofs, crevices for nesting
- **Street trees and gardens:** Food sources and shelter
- **Water features:** Fountains, ponds, rivers
- **Vacant lots:** Unexpected biodiversity hotspots

Advantages of Urban Living for Wildlife

- Fewer natural predators
- Access to human food sources
- Safe structures for nesting and raising young
- Warmer temperatures (urban heat island effect)
- Year-round food availability

4. Urban Systems Framework

Cities can be understood as composed of three interconnected systems:

The Grey System

- Buildings, walls, infrastructure
- Streets, squares, underground systems
- Can become habitats for various species
- Architecture can support biodiversity if designed properly

The Green System

- Plots of land, trees, green areas
- Parks and gardens
- Forest areas and vegetation
- Critical for ecosystem services

The Blue System

- Fountains, ponds, rivers
- Coastal areas and ports
- Water features and wetlands
- Support aquatic and amphibious species

> **Key Insight:** The grey system (human constructions) can become habitat for many species. Buildings and structures aren't necessarily hostile to biodiversity—they can be designed to support it.

5. The Street as Urban Ecology

Streets: An Overlooked Resource

- Streets comprise 25-50% of urban land
- They are the "soul" and "lifeline" of cities

- Provide proximity, access, and encounter opportunities
- Currently dominated by vehicle use (vehicle hegemony)

Reimagining Streets as Ecological Spaces

Instead of viewing streets as flat surfaces for movement only, consider them as complex **urban ecologies**—places where multiple activities, species, and systems coexist and interact.

Three Dimensions of Streets

1. The Fixed Dimension

- Physical elements: design, materials, infrastructure
- Composition of businesses (independent businesses support ecology better)
- Permanent features that shape activity

2. The Floating Dimension

- Most ambiguous and uncomfortable to plan for
- Unpredictable activities that move on demand
- Vendors, performers, informal gatherings
- The dimension we're least comfortable addressing

3. The Fleeting Dimension

- Temporary transformations (events, festivals)
- Programmed activities that completely change the space
- North American cities excel at this dimension

Functions of Ecological Streets

When streets work as urban ecologies, they become places for:

- Walking, driving, and all forms of movement
- Socializing and seeing/being seen
- Cooking, eating, drinking

- Making and mending things
- Preaching, praying, playing
- Economic exchange and informal commerce
- Learning social skills and civic engagement
- Children's play and exploration

6. Urban Ecology Research Methods

Unique Challenges

- Restricted access to study sites
- Human interference in research areas
- Loss of study subjects due to human activities
- Habitat fragmentation (parks scattered throughout city)
- Small study areas limiting species types

Research Approaches

Fieldwork Examples:

- Trapping, tagging, and tracking animals (e.g., bats in Toronto's High Park)
- Mapping species distributions and territories
- Studying habitat use patterns (where animals feed, sleep, nest)
- Observing behavioral adaptations to urban environments

Community Science:

- Crowdsourcing data collection from local residents
- Tracking flowering times, animal sightings
- Engaging everyday people in scientific observation
- Example: Urban Redbud Community Science Program

Quantitative Studies:

- Mapping where people congregate and why
- Measuring temperature effects of urban trees
- Analyzing water quality in urban lakes
- Testing sediment phosphorus release rates

7. Key Urban Ecology Case Studies

Case Study 1: Urban Trees and Cooling (Dr. Carly Zeder)

Research: Used mobile weather stations on bicycles in Madison, Wisconsin

Finding: Urban trees cool air more in summer than pavement heats it up

Critical Threshold: ~40% of neighborhoods need tree canopy coverage to reap cooling benefits

Application: Results inform how trees are planted to combat extreme heat

Case Study 2: Bats in Urban Parks

Species: Over 1,400 bat species worldwide—only mammals that can fly

Ecosystem Services:

- Pollinate agave (tequila), cocoa (chocolate), durian
- Distribute seeds in landscapes
- Pest control for agriculture

Research Focus: How bats use space in urban parks, feeding and sleeping locations

Goal: Conserve bats while minimizing human-wildlife contact

Case Study 3: Urban Flowering and Pollinators (Charlotte DeKaiser)

Shift: From Rocky Mountain bees to Urban Redbud Community Science Program

Method: Hundreds of community members track redbud flowering times

Purpose: Understand how flowering time changes in cities and impacts native bee communities

Case Study 4: Road Salt Impact on Urban Lakes (Ellen Foley)

> **Location:** Church Lake, Grand Rapids, Michigan
>
> **Problem:** Road salt from highways creates dense saline layer at lake bottom
>
> **Effects:**
>
> - Prevents seasonal lake turnover
> - Creates low oxygen (anoxic) conditions
> - Causes internal phosphorus loading
> - Phosphorus levels exceed 7,000 µg/L (vs. 1-2 µg/L in Lake Michigan)
> - Risk of severe algal blooms if phosphorus reaches surface
>
> **Management:** Need to remove excess phosphorus before addressing high chloride

8. Urban Wildlife Adaptations

Behavioral Changes

- **Timing:** Cross roads when car density is reduced
- **Cognition:** Increased problem-solving abilities and innovation
- **Communication:** Birds change song frequencies and incorporate urban sounds (fire engines, alarms)
- **Risk-taking:** Animals become bolder in urban environments
- **Feeding:** Exploit human food sources and altered landscapes

Physical Adaptations

- Using building structures for nesting instead of natural cavities
- Adapting to artificial light cycles
- Tolerance for noise and human proximity
- Modified foraging strategies

Important Insight: Animal behavior is extraordinarily attuned to human activities. Wildlife adapts to cities through behavioral flexibility, not just physical changes.

9. Environmental Justice and Urban Ecology

The Equity Issue

Amenities within cities are not equally distributed. Urban ecology reveals how social inequality creates ecological inequality.

Key Disparities

- **Wealthy areas typically have:**
    - More green spaces and parks
    - High-quality vegetation
    - Access to natural water sources
    - Better tree canopy coverage
    - Lower pollution levels
- **Low-income neighborhoods typically have:**
    - Less green space
    - Higher pollution levels
    - Fewer trees and natural areas
    - Limited access to quality parks

Historical Context: Redlining

Redlining was a racist practice where Black and brown people were prevented from buying homes in certain areas. This historical discrimination still influences:

- Where nature exists in cities today
- Who has access to best parks and green spaces
- Whose homes back onto ravines or natural areas
- Who gets to benefit most from urban nature

Critical Perspective (Dr. Chris Schell): "Economic and social inequality are not just social justice issues. These are ecological ones too." Understanding this makes for better science and more equitable cities.

Implications for Urban Ecologists of Color

- Face racist encounters while conducting fieldwork
- Experience racial profiling and police being called on them
- Must deal with racism embedded in urban environments
- Study how prejudice shapes the biodiversity they research

10. Urban Environmental Challenges

Pollution

- **Air pollution:** Vehicle emissions, industrial sources
- **Water pollution:** Runoff, sewage, chemical contaminants
- **Light pollution:** Affects animal behavior and migration
- **Noise pollution:** Changes animal communication

Urban Heat Island Effect

- Built-up areas absorb and retain heat
- Cities become warmer than surrounding rural areas
- Pavement and buildings amplify temperatures
- Solution: Increase tree canopy to 40%+ coverage

Habitat Fragmentation

- Natural habitats broken into smaller patches
- Creates "edge effects" affecting wildlife
- Limits species movement and gene flow
- Solution: Create wildlife corridors and connected green spaces

Altered Water Flow

- Impervious surfaces increase runoff
- Changes natural drainage patterns
- Increases flooding risk
- Solution: Green infrastructure, permeable surfaces

Eutrophication

Excess nutrients (especially phosphorus) cause:

- Algal blooms

- Low dissolved oxygen
- Fish kills
- Harmful algal blooms (toxins)
- Degraded water quality

Salinization

Excess salt from road de-icing causes:

- Dense saline layers in lakes preventing turnover
- Anoxic conditions at lake bottom
- Internal phosphorus loading
- Toxicity to freshwater organisms (EPA threshold: 230 mg/L)
- Altered water chemistry

Critical Issue: Road salt usage increased by 23 million metric tons over last 50 years in US. While it increases driving safety, current practices impair water quality. Need to find better alternatives.

11. Solutions and Urban Design Strategies

Urban Naturalization

Aims to boost biodiversity in city structures where inhabitants coexist with nature and benefit from ecosystem services.

Design Strategies

Green Infrastructure:

- Green roofs on buildings
- Rain gardens for stormwater management
- Bioswales along streets
- Permeable pavement

- Urban wetlands

Tree Planting Programs:

- Strategic placement for maximum cooling
- 40% canopy coverage as target
- Native species selection
- Equitable distribution across neighborhoods

Wildlife-Friendly Design:

- Preserve wall holes for bird nesting
- Avoid rehabilitation during nesting season
- Design new buildings to be permeable to biodiversity
- Create wildlife corridors connecting habitats
- Protect existing nesting sites

Sustainable Building Practices:

- LEED-certified buildings
- Renewable energy use
- Incorporation of biodiversity in design
- Environmental impact assessments

Policy Approaches

- Urban forestry programs
- Green space requirements in development
- Wildlife protection ordinances
- Environmental justice considerations in planning
- Pollution reduction regulations
- Alternative de-icing strategies

12. The Role of Citizens in Urban Ecology

Community Engagement

- Participate in citizen science projects
- Track wildlife sightings and plant phenology
- Report environmental concerns
- Advocate for green space preservation
- Support local conservation efforts

Individual Actions

- **Observe:** Pay attention to nature in your city
- **Learn:** Identify trees, birds, and other species
- **Protect:** Advocate for wildlife-friendly practices
- **Create habitat:** Plant native species in yards
- **Accept coexistence:** Share space with urban wildlife

> **Vision:** Imagine if every one of the 4+ billion people living in cities saw enough nature that they decided to make a small change to protect it. The collective impact would be transformative.

Educational Initiatives

- Urban ecology centers (e.g., Milwaukee Urban Ecology Center)
- School programs teaching outdoor sciences
- Community nature walks and education
- Creating awareness about urban biodiversity

13. Benefits of Urban Ecology Understanding

For Cities

- Better urban planning decisions
- More resilient infrastructure
- Improved public health outcomes
- Enhanced livability and property values
- Climate change adaptation

For Biodiversity

- Protection of urban wildlife populations
- Maintenance of ecosystem services
- Connected habitats through corridors
- Species conservation in human-dominated landscapes

For Human Communities

- Access to nature for all residents
- Improved air and water quality
- Mental and physical health benefits
- Environmental education opportunities
- Stronger sense of place and community

For Science

- Understanding rapid evolutionary adaptation
- Studying human-wildlife coexistence
- Informing conservation strategies
- Developing new ecological theories

14. Key Principles and Takeaways

1. **Cities are ecosystems** where humans, wildlife, and environment constantly interact
2. **Urban nature matters** for ecosystem services, human health, and quality of life
3. **Biodiversity persists in cities** despite concrete—species adapt in remarkable ways
4. **Equity is ecological**—social and economic inequality directly impacts biodiversity distribution
5. **Streets are ecological spaces** with potential far beyond vehicle movement
6. **Wildlife adapts through behavior** more than physical evolution in urban environments
7. **Green infrastructure provides solutions** to multiple urban challenges simultaneously
8. **Community engagement is essential**—residents are critical to urban ecology success
9. **Design matters**—how we build cities determines biodiversity outcomes
10. **Local stewardship can motivate global conservation** when people value nearby nature

15. Important Terms and Concepts

- **Urban Ecology:** Study of interactions between organisms and environment in cities
- **Biodiversity:** Variety of living organisms in a specific place
- **Ecosystem Services:** Benefits humans receive from functioning ecosystems
- **Urban Heat Island Effect:** Cities being warmer than surrounding areas
- **Habitat Fragmentation:** Breaking of habitats into smaller, isolated patches
- **Zoonotic Diseases:** Diseases that transfer from animals to humans
- **Eutrophication:** Excess nutrients causing algal blooms
- **Salinization:** Accumulation of salts in water or soil

- **Internal Phosphorus Loading:** Release of phosphorus from sediments into water
- **Redlining:** Historical racist housing discrimination affecting current urban ecology
- **Urban Naturalization:** Boosting biodiversity in city structures
- **Community Science:** Public participation in scientific research
- **Edge Effects:** Changed conditions at boundaries of habitat patches
- **Wildlife Corridors:** Connections between habitat patches allowing species movement

16. Critical Questions to Consider

- How does your city balance human needs with biodiversity conservation?
- What wildlife have you noticed in your urban environment?
- Are green spaces equally distributed in your community?
- How might historical policies affect current biodiversity patterns?
- What ecosystem services do you benefit from daily?
- How can streets be reimagined beyond vehicle movement?
- What role can you play in urban ecology as a citizen?
- How do urban wildlife adapt their behavior to city life?
- What environmental challenges face your local urban ecosystems?
- How can cities be designed to support both people and nature?

Conclusion

Urban ecology reveals that cities are not concrete jungles devoid of nature, but complex ecosystems where humans and wildlife coexist. As urban populations grow, understanding these interactions becomes critical for creating sustainable, healthy, equitable cities.

The field integrates ecology with social justice, recognizing that environmental quality is unevenly distributed and that historical inequities shape current biodiversity patterns. By

studying urban ecosystems, we can design cities that provide ecosystem services, support biodiversity, enhance human well-being, and address environmental justice.

Perhaps most importantly, urban ecology reminds us that the spaces where we live, work, and breathe are just as important as pristine wilderness. When people learn to see and value nature in cities, they develop the environmental stewardship needed for global conservation. Every person living in an urban area has the opportunity to participate in urban ecology—by observing, learning, protecting, and advocating for the nature that surrounds them.

Final Thought: Cities are inevitable. By embracing urban ecology and understanding cities as complex, living systems, we can create places where both humans and nature thrive together.