Foraging Behaviour

9.3, 14.1-14.2, 14.4-14.5 Bush

Outline

- Optimal foraging models
- The effect of prey and predator density
- Human foraging and fisheries management

Foraging

- One major activity of animals is foraging for nutrients and energy
- What to eat, when and how?
  - food type
  - size/quality of prey items
- energy/nutrient content
  - handling time
  - search time
  - presence of toxins
- location of prey: mortality risk?

Maximizing energy gains

- Optimal foraging maximizes energy gain per unit time
  - Rate of energy gain = (energy gained)/time spent
  - Energy gained (E)
    - is related to food quality (size, nutritional content, lack of toxins, etc.)
  - Time spent (T)
    - = expected searching time + handling time (pursuit, eating, digesting)
- Should pick prey with maximal E/T (maximize rate of energy gain)

Foraging of the pied wagtail

Even if larger prey are most abundant, the wagtail most frequently eats insects ~7 mm long.
Generalizations in optimal foraging

- **Searchers:**
  - those that spend more energy on finding prey than on overcoming them, should be generalists
  - e.g. insectivorous birds

- **Handlers:**
  - those that spend more energy on overcoming their prey, should be specialists as they will need specific adaptations for handling prey
  - e.g. wolves, lions

Howler monkeys - searchers

- feed on fruits, flowers, & leaves of trees (96% species present in study area)
- 25% of their time, they are foraging on the three rarest of species

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The effects of prey density

- Expected searching time is proportional to $1/\text{prey density}$
- Choice should depend on handling time, energy gain, and search time
- Should be less choosy when prey are scarce:
  - widen diet breadth
- Organisms should ignore poor food no matter how abundant it is and start eating it when preferred items get sufficiently rare

Foraging of the Bluegill sunfish

<table>
<thead>
<tr>
<th>Bluegill sunfish</th>
<th>(a) Rare prey</th>
<th>(b) Abundant prey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio encountered</td>
<td>0 0.4 0.8</td>
<td>0 0.4 0.8</td>
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<tr>
<td>Prediction of optimal diet theory</td>
<td></td>
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<tr>
<td>Observed ratio in diet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large prey</td>
<td>Medium prey</td>
<td>Small prey</td>
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Stochastic food patches

- Patches differ in food quality and quantity
- Constant food sites may always provide a minimum amount for energy requirements while variable food sites may sometimes provide much more (or much less)
- Yellow-eyed Juncos (Junco phaeonotus) switch from being "risk-averse" (preferring constant food sites) to "risk-prone" (choosing variable food sites) as starvation increased
Manifold influences of a predator species on a food web

Predation and optimal foraging

Optimal foraging models

The effect of prey and predator density

Human foraging

Outline

Optimal foraging models

The effect of prey and predator density

Human foraging and fisheries management

Foraging of the Bluegill sunfish

Increasing eagle population might

- decrease the fox population
- change the behaviour of the fox population (may forage even more on rabbits and less on shrews)

Human foraging

- We are a top predator in most communities and so our effects can trickle down the food chain and affect many lower trophic levels

- Our foraging of fish fits well into optimal foraging models
  - We are very choosy with the seafood we like to eat
  - Switch our preferences only when our favorites are nearly extinct
Optimal Whale Foraging

Between 1920-1970, whalers targeted progressively smaller whales as large whales became too rare.

First blue whales and humpbacks were harvested, then fin and humpback whales, then sei whales, then minke whales.

Amount of fish caught

- Fishing has steadily increased this century
- Caused by:
  - Increase in human pop’n
  - Interest in healthy diet

Efficiency and large-scale fisheries

- Economic efficiency:
  - Up to 100 tons of fish/$15,000 = $150 per ton
  - Up to 2 tons per $1000 profit = $500 per ton

- Agricultural efficiency:
  - Ratio of energy expended versus energy obtained (calories)

Currency in human foraging

- Optimal foraging theory is different for humans due to the fact that costs and benefits of searching for rare prey are different

  - If a fish species is highly desirable the price of it can go up (this does not occur in other species)

By-catch and its effects on fisheries

- “By-catch” refers to species caught but not intentionally targeted by the fishery
- Shrimp fisheries
  - have the highest by-catch:target ratio
  - 8-10 kg by-catch per 1 kg shrimp caught
  - Some of this by-catch is red snapper, a fishery that has declined to 14% of its former size

Life history and fisheries

- Some fish have opportunistic life history while others have a competitive life history
- The effect of fishing is lessened when our target is opportunistic species (competitor species such as marlin, grouper, shark and halibut are in decline)
- Our impact is never zero (e.g., cod are opportunistic and have still crashed)
Other changes in fish populations

- Not only are fish less numerous, they are also smaller in size
- Fishers selectively target large fish, thereby reducing the reproductive output of the population

Eating our way down the food chain

- Preferred fish are top predators
- Top predators naturally have low population numbers
- When top predator supplies are exhausted, we typically start fishing for a member of a lower trophic level

Fishery impacts on coral

- Feeding down the food chain in the Caribbean has led there to be an increase in algae
- Algae block the sunlight causing a shift in coral community towards fast-growing species

Water quality and fisheries

- Chesapeake Bay
  Oysters control algal blooms by extracting plankton from the water
- Overexploitation of oysters has caused their decline, resulting in far greater planktonic productivity
- Algal blooms reduce the oxygen in the water, resulting in fish kills

General pattern of ecosystem decline

1. overexploitation of large top predators influence on grazers reduces habitat structure (e.g. kelp/sea grass or coral)
2. reduction of recruitment of fish species

Summary

- Optimal foraging models indicate that species must forage to maximize energy gain and minimize time spent
- Density of both lower and higher trophic levels alter the optimal foraging dynamics of a species
- Human beings are optimally foraging on fish species in the world and are threatening their existence
Review

- Next lecture – Film: “Why sex?”
- Midterm is coming up! – Feb. 28th 6:30-8:30 PM, Rooms ST140 & ST 141
- Review questions are on the web!
- Readings summary:
  – Chapters 1-4, 6-7, 9.3, 14.1-14.2, 14.4-14.5, 17, 22.4-22.6
- I am available for questions/tutorials!