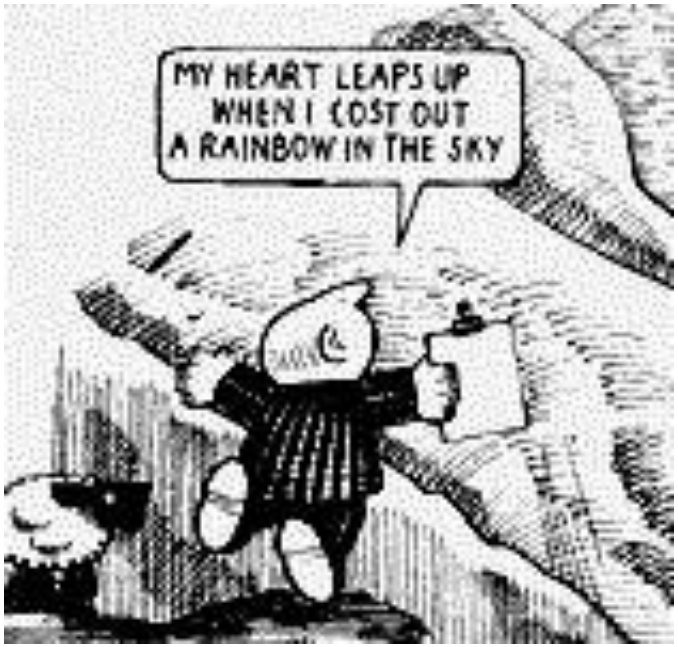
VALUING THE ENVIRONMENT

Concepts and Methods

Valuing the Environment

- Concepts of economic value
  - Definition
  - Types
  - Uses
- Methods
  - Stated-preference
  - Revealed-preference
  - Production-function approach
  - Benefits transfer



Source of Cartoon: Bowers 1990

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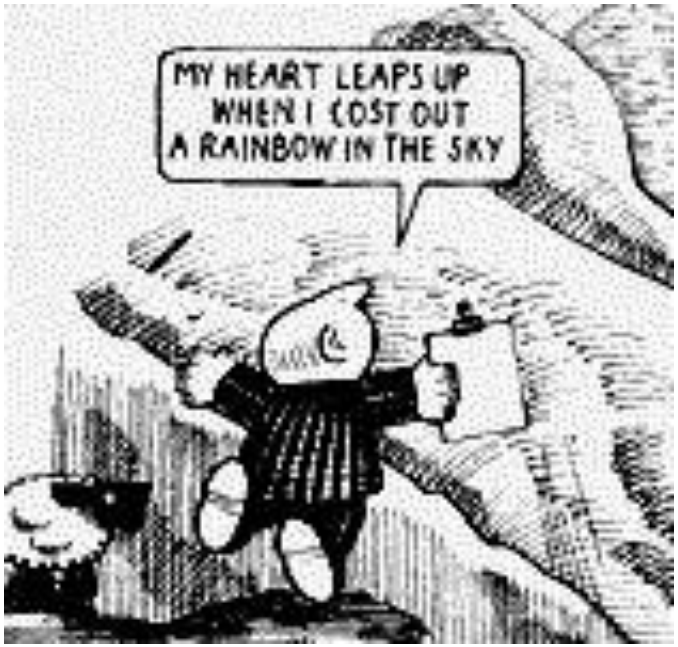

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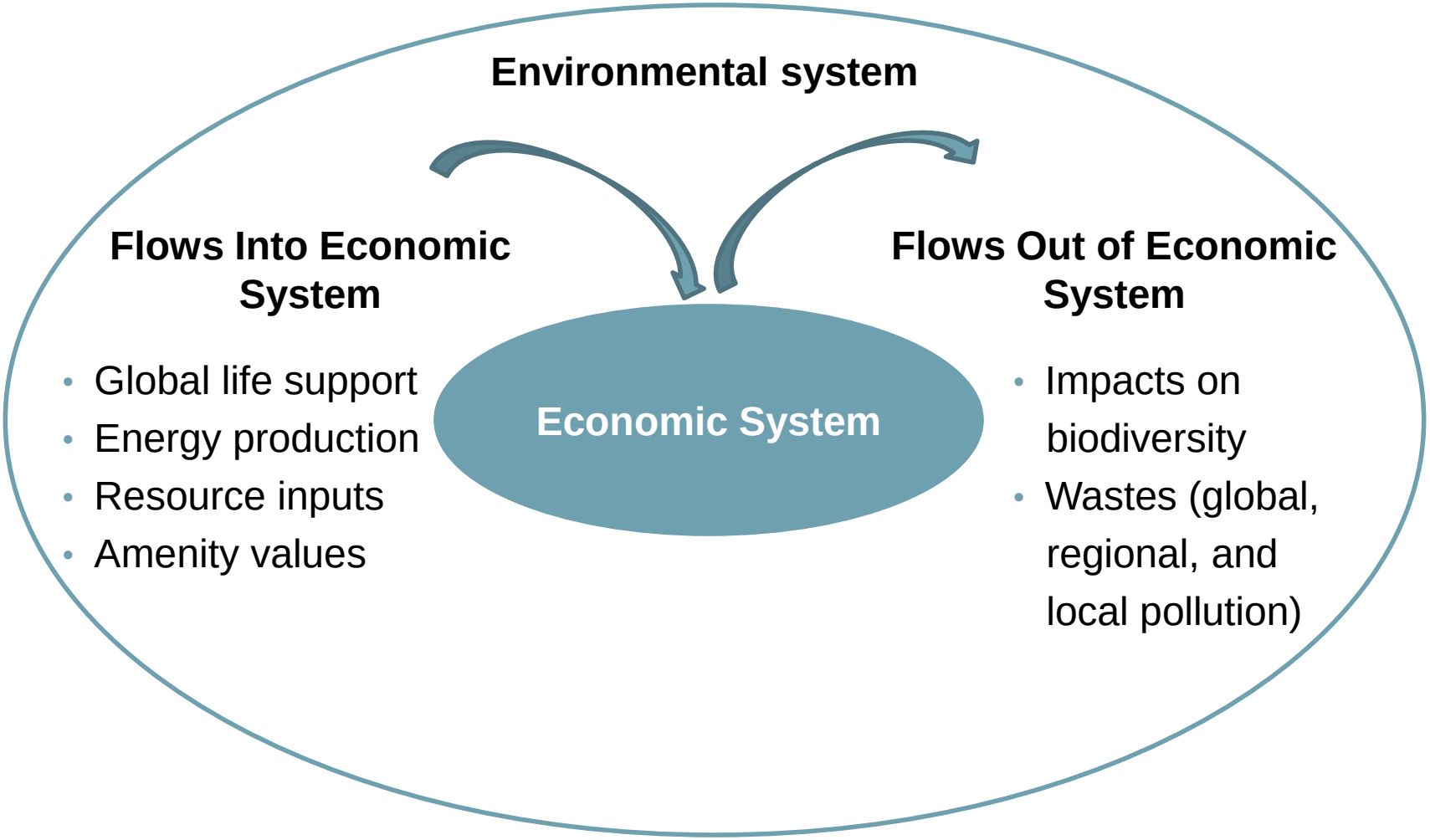
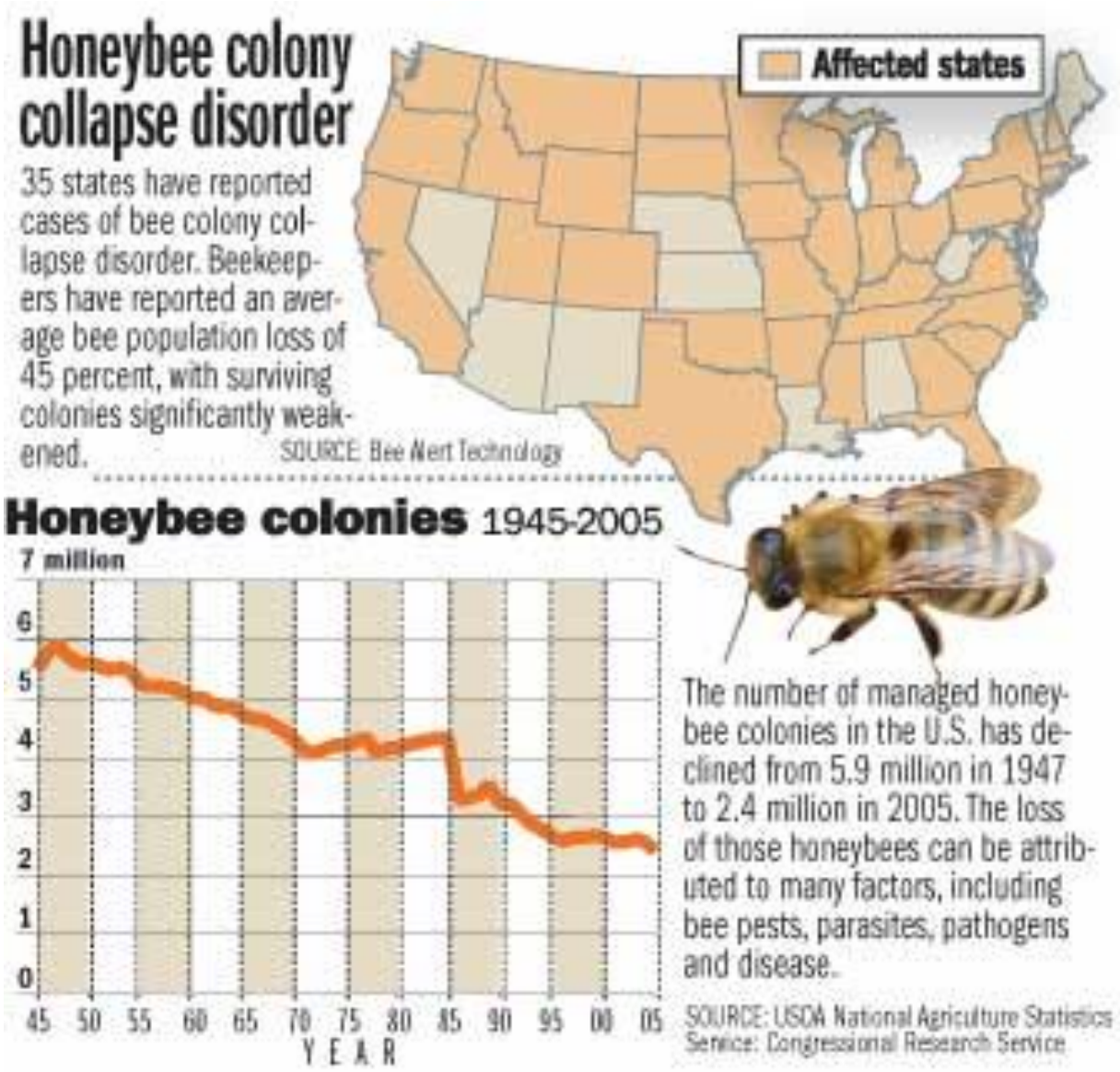
Economic Value



Valuing honey bee decline

- Pollination
- Food security
- Impacts across regions



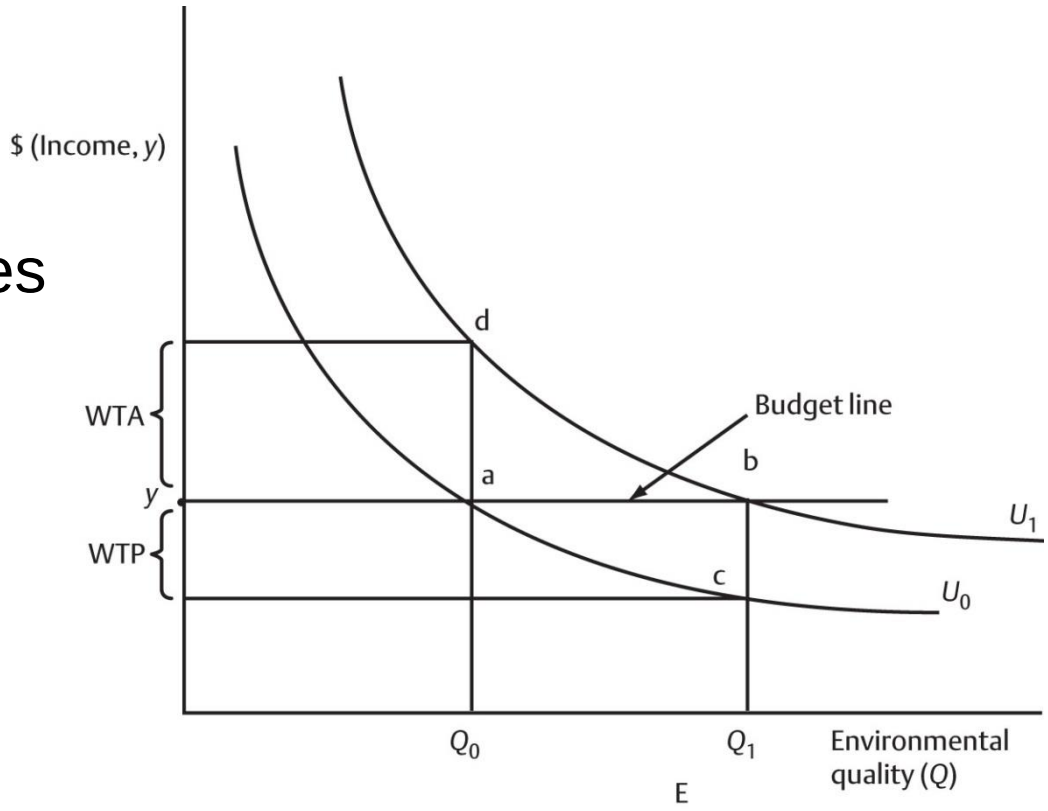
WTP vs WTA

- Willingness to pay (WTP) – maximum willingness to pay for a change in environmental quality

- Willingness to access (WTA) – minimum you would accept to go without a change in environmental quality

WTA>WTP

- Reasons
  - Physiological endowment effect
  - Availability of substitutes matter
  - Characteristics of the good matter
- When to use WTA/WTP



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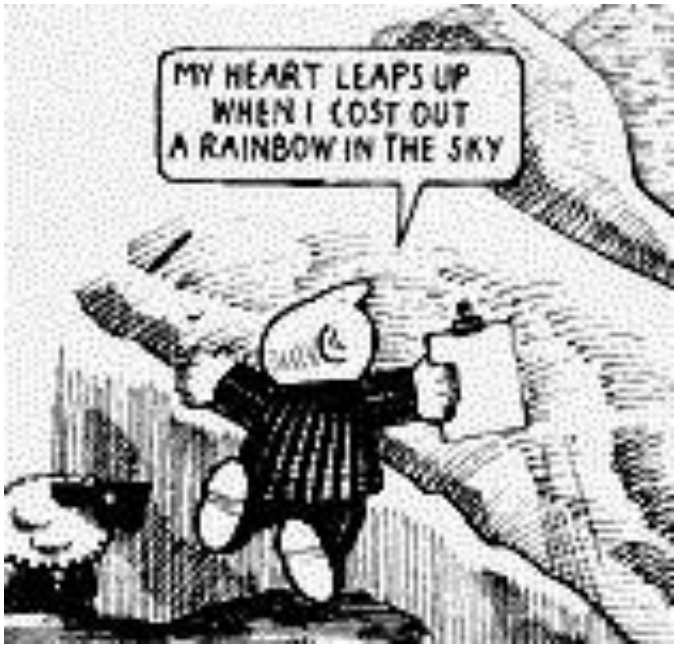

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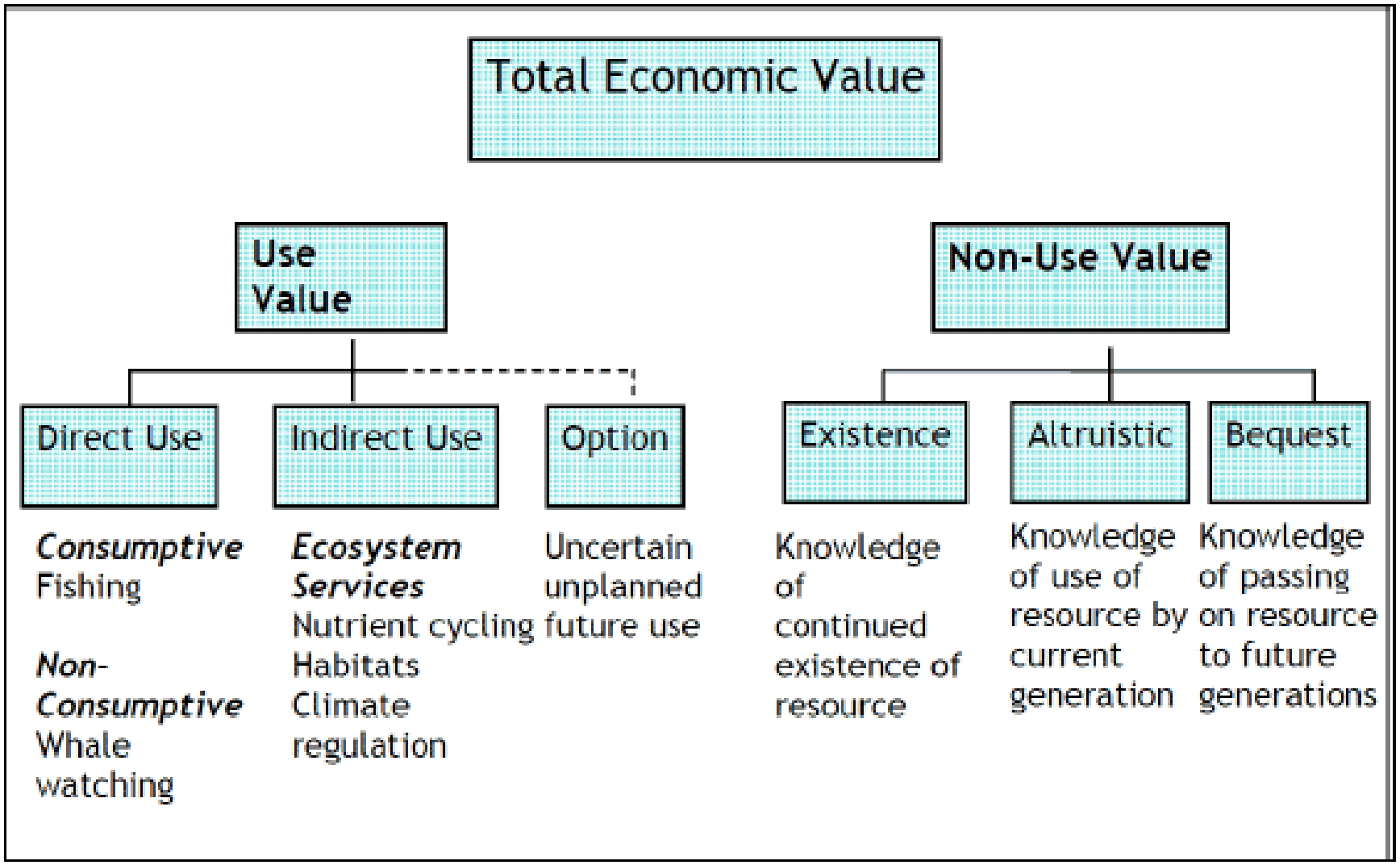

Total Economic Value = Use values + Non-use values

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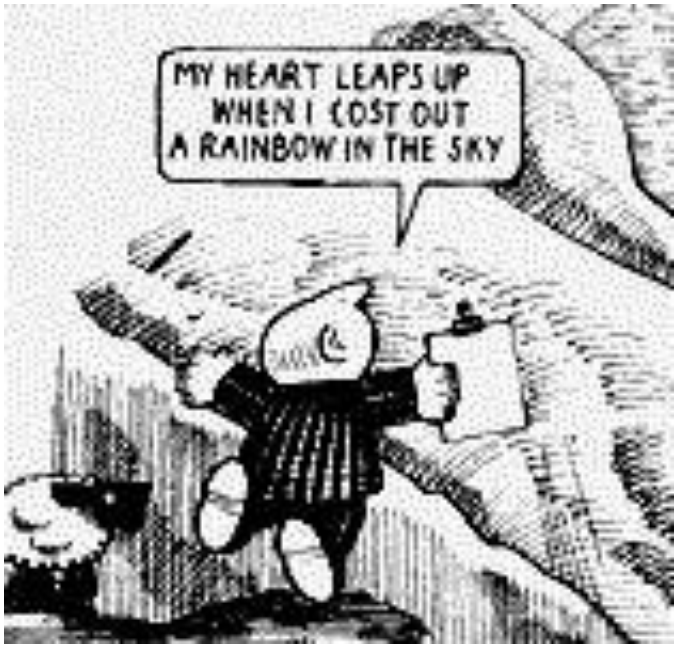

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Total Economic Value (TEV) Uses

- Cost-benefit analysis
  - Spotted owl example
- Setting environmental taxes
- Environmental damage claims
- National accounting

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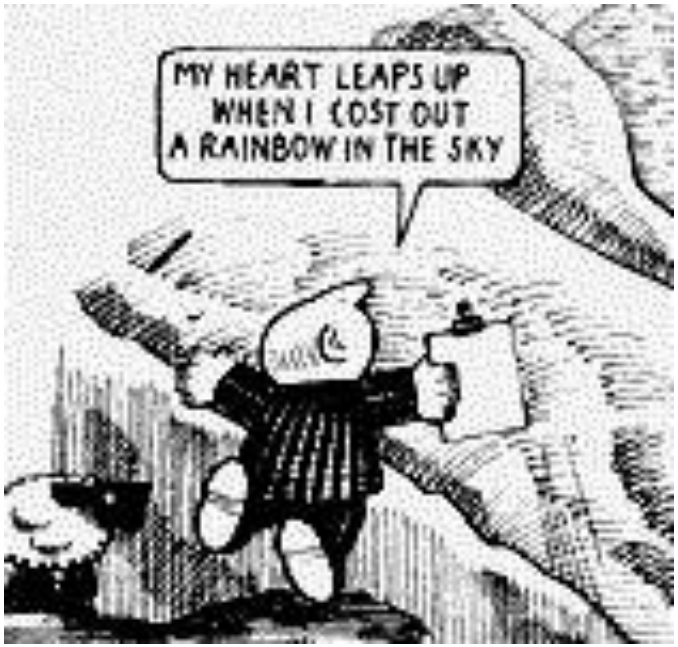

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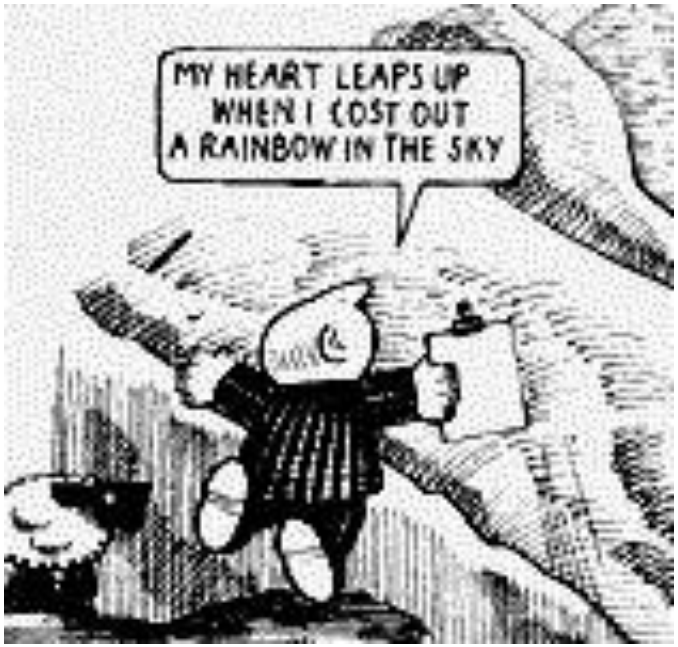

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Stated Preference Approaches

- Contingent valuation method (CVM)
- Choice experiment method

CVM

- Estimates benefits from survey responses about WTP for environmental quality *contingent* upon hypothetical market
- Steps:
  - Construct model of hypothetical market
  - Design survey
  - Assess honesty/reliability of respondents
  - Calculate results

CVM Four Corners Case Study

- Rivers in the Four Corners Region provide 2,465 river miles of critical habitat for nine species of fish that are listed as threatened or endangered. Continued protection of these areas required habitat improvements, such as fish passageways, as well as bypass releases of water from dams to imitate natural water flows needed by fish. A contingent valuation survey was used to estimate the economic value for preserving the critical habitat.

CVM Four Corners Case Study

- *Suppose a proposal to establish a Four Corners region Threatened and Endangered Fish Trust Fund was on the ballot in the next nationwide election. How would you vote on this proposal? Remember, by law, the funds could only be used to improve habitat for fish. If the Four Corners Region Threatened and Endangered Fish Trust Fund was the only issue on the next ballot and it would cost your household $_____ every year, would you vote in favor of it?*

  (Please circle one.) YES / NO

- The dollar amount, blank in the above illustration, was filled in with one of 14 amounts ranging from $1-$3 to $350, which were randomly assigned to survey respondents.

CVM Four Corners Result

- The questionnaire was sent to a random sample of 800 households in the Four Corners states of Arizona, Colorado, New Mexico, and Utah (with the proportions based on the states' relative populations).
- The average willingness to pay was estimated to be $195 per household.
  - When extrapolated to the general population, the value of preserving the habitat areas was determined to be far in excess of the costs.

Additional CVM Case Studies

- How much are Yellowstone Grizzlies worth?

- Invasive species and delaying the inevitable: Valuation evidence from a national survey

CVM Considerations

- Broadly applicable
- Controversy
  - Biases due to survey approach
    - Hypothetical bias
    - ‘scoping’ problem
    - Survey design dilemmas

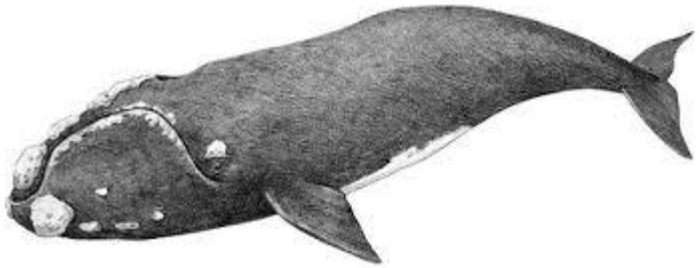
CVM IN-CLASS EXAMPLE

Choice experiment method (CEM)

- The contingent choice method asks the respondent to state a preference between one group of environmental services or characteristics, at a given price or cost to the individual, and another group of environmental characteristics at a different price or cost.
- Steps
  - Construct model of hypothetical market
  - Design choice experiment
    - Contingent ranking
    - Discrete choice
    - Paired rating
  - Calculate results

CEM estimate of the value of recovering or downlisting 8 threatened and endangered marine species in the United States

- Eight species: loggerhead sea turtle, leatherback sea turtle, North Atlantic right whale, North Pacific right whale, upper Willamette River Chinook salmon, Puget Sound Chinook salmon, Hawaiian monk seals, and smalltooth sawfish
- Surveyed a random sample of 8,476 U.S. households



As in the previous question, please compare Options A, B, and C in this table and select the option you most prefer.

Remember that any money you spend on these options is money that could be spent on other things.

Expected result in 50 years for each option

	Option A No additional protection actions	**Option B** Additional protection actions	**Option C** Additional protection actions
Wild Puget Sound Chinook salmon ESA status	Threatened	Recovered	Threatened
Smalltooth sawfish ESA status	Endangered	Endangered	Threatened
Hawaiian monk seal ESA status	Endangered	Threatened	Recovered
Cost per year Added cost to your household each year for 10 years	$0	$50	$30
Which option do you prefer?	●	●	●

CEM Case Study Results

- Willingness-to-pay values ranged from $40/household for recovering Puget Sound Chinook salmon to $73/household for recovering the North Pacific right whale.
- Statistical comparisons among willingness-to-pay values suggest that some taxa are more economically valuable than others
  - Suggests that the U.S. public's willingness to pay for recovery may vary by species.

CEM Considerations

- Benefits
  - Respondents think in terms of tradeoffs
  - May be better at estimating relative values than absolute values.
  - Minimizes many of the biases that can arise in open-ended contingent valuation studies
- Controversy
  - Some tradeoffs difficult to evaluate
  - Respondents' behavior not well understood
  - Translating the answers into dollar values, may lead to greater uncertainty in the actual value that is placed on the good or service of interest.

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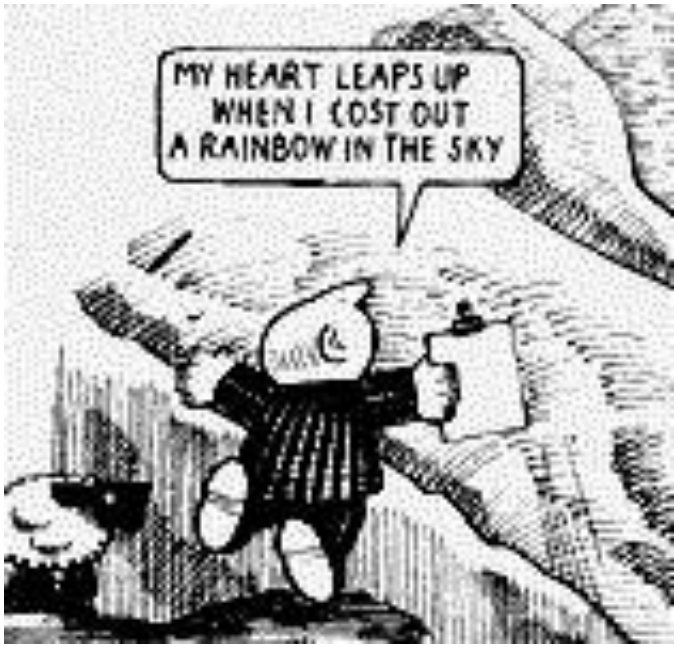

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Revealed Preference Approaches

- Hedonic pricing method
- Travel cost method

Hedonic Price Model (HPM)

- Uses estimated **hedonic,** or implicit, price of an environmental attribute to value a policy-driven improvement
  - e.g., $P_{HOUSE} = f(X_1, X_2, \ldots X_n, E)$, where:
    - each X_i is an attribute of the house, and E is the environmental quality in the area
- Hedonics uses regression analysis, which provides estimates of the prices of the individual attributes, including E
- This price could be used to estimate the D for environmental quality, which in turn could be used to measure the incremental benefit of improving that quality
- Recall that incremental benefit can be measured as an area under the D curve

HPM Continued

- Steps
  - Collect data
  - Run regression
  - Analyze demand curve

HPM Environmental Amenities Southold, Long Island Case Study

- The town of Southold, Long Island, New York is a relatively rural area, with a large amount of farmland.
  - Population and housing density are rapidly increasing in the town, resulting in development pressures on farmland and other types of open space.
- Variables: open space, farm land, major roads, wetlands
- Result: the value of preserving a 10 acre parcel of open space, surrounded by 15 “average” properties, was calculated as $410,907.

HPM Considerations

- Logical, intuitive
- Difficult to employ
  - Requires complex empirical modeling
  - Requires extensive data

Travel Cost Method (TCM)

- Estimates benefits as an increase in consumer surplus (CS) in the market for a ***complement*** to environmental quality (i.e., recreational use), as policy improves that quality
- As policy improves the environment, the D for recreational use of the environment increases, causing an increase in CS
- This CS increase is the benefit estimate

TCM Continued

- Steps
  - Define a set of zones surrounding the site
  - Collect information about visitors
  - Calculate the average round-trip travel distance and travel time to the site for each zone
  - Construct the demand function for visits to the site (regression analysis)
  - Estimate economic benefit (area under demand or CS)

TCM Example

- Collect data run regression on time and cost to get to different sites.

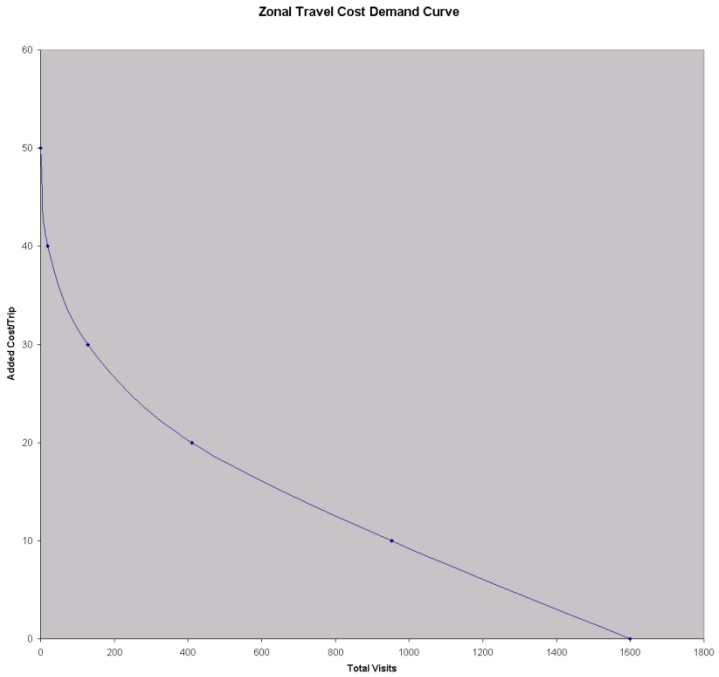
Zone	Round Trip Travel Distance	Round Trip Travel Time	Distance times Cost/Mile ($.30)	Travel Time times Cost/Minute ($.15)	Total Travel Cost/Trip
0	0	0	0	0	0
1	20	30	$6	$4.50	$10.50
2	40	60	$12	$9.00	$21.00
3	80	120	$24	$18.00	$42.00

TCM Example Continued

- Do regression analysis
  - Visits/1000 = 330 – 7.755*(Travel Cost).
- Derive Demand

Entry Fee	Total Visits
$0	1600
$10	954
$20	409
$30	129
$40	20
$50	0

TCM Example Continued



- Calculate area under demand or consumer surplus
- Total economic benefits from recreational uses of the site of around $23,000 per year, or around $14.38 per visit ($23,000/1,600).

TCM Great Barrier Reef Case Study

- The best estimates of the annual recreational benefits of the Great Barrier Reef range between $ 700 million to 1.6 billion.
- The domestic value to Australia is about $ 400 million, but the estimated value to more distant countries depends on the definition of travel cost and the functional form.
- The study conclusively demonstrates that there are very high benefits associated with protecting high quality coral reefs.

TCM Considerations

- Benefits
  - Method is based on actual behavior
  - Relatively inexpensive
  - Results are relatively easy to interpret and explain
- Controversy
  - Availability of substitute sites will affect values
  - Estimates are biased downward if access to site is congested
  - Requires user participation
  - Opportunity costs of travel

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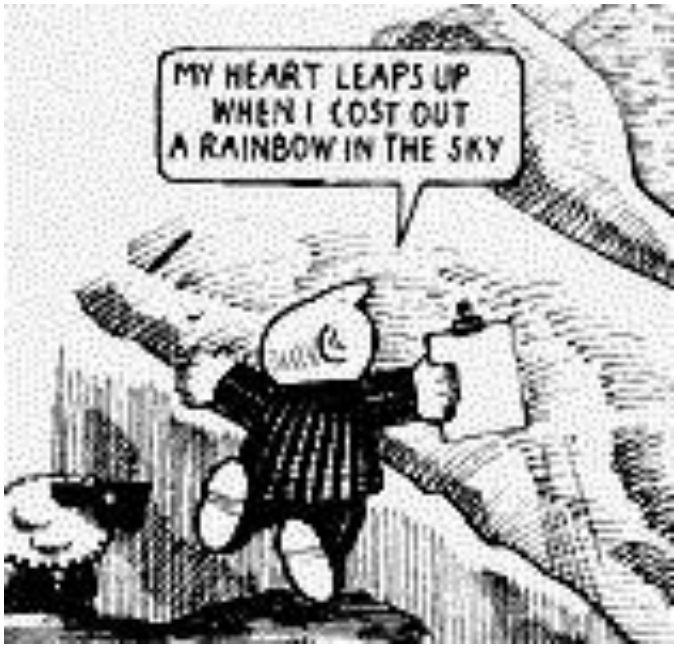

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Production Function Approach (PFA)

- Physical link approach
  - Applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good.
  - Example: water quality
- Steps
  - Specify the production function for purified drinking water
  - Estimate how the cost of purification changes when reservoir water quality changes, using the production function estimated in the first step
  - Estimate the economic benefits of protecting the reservoir from runoff, in terms of reduced purification costs

PFA Values of Wetlands in the Peconic Estuary, Long Island

- The Peconic Estuary includes many productive wetlands of different types, including eelgrass, saltmarsh, and intertidal mudflats. Development and resulting water quality degradation have reduced the quantity of these wetlands, and may continue to do so in the future.
- Results
  - an acre of eelgrass is worth $1065 per year
  - an acre of saltmarsh is worth $338 per year
  - an acre of intertidal mudflat is worth $68 per year, in terms of increased productivity of crabs, scallops, clams, birds, and waterfowl

PFA Considerations

- Good estimate
  - If the resource in question is a perfect substitute for other inputs
  - In cases where only producers of the final good benefit from changes in quantity or quality of the resource
- Controversy
  - Other environmental benefits missing
  - Information is needed on the scientific relationships between actions to improve quality or quantity of the resource and the actual outcomes of those actions

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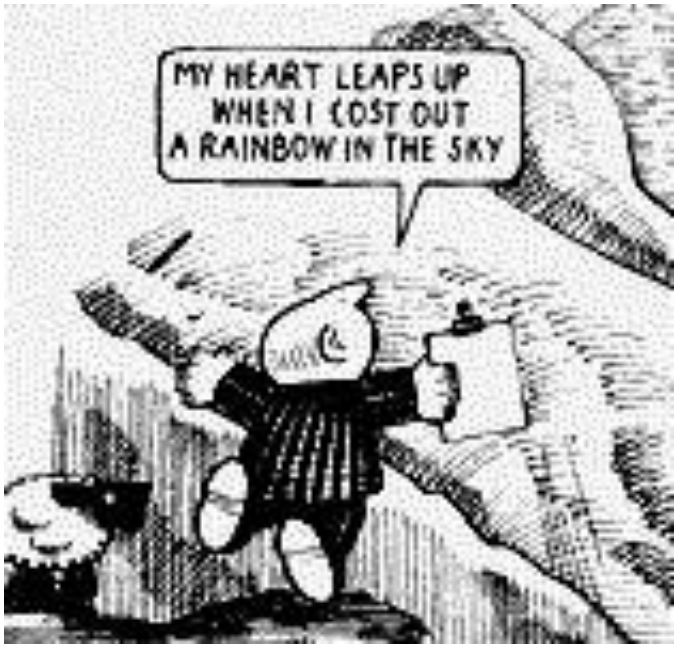

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Benefits Transfer (BT)

- Estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.
  - Used when it is too expensive and/or there is too little time available to conduct an original valuation study, but some measure of benefits is needed.
- Steps
  - Identify existing studies or values that can be used for the transfer
  - Decide whether the existing values are transferable/quality of transfer
    - Value comparable?
    - Characteristics comparable?
  - Adjust the existing values to better reflect the values for the site under consideration

Protecting California's Coastal Wetlands

- Use the values of wetlands in the Peconic Estuary, Long Island
  - an acre of eelgrass is worth $1065 per year
  - an acre of saltmarsh is worth $338 per year
  - an acre of intertidal mudflat is worth $68 per year, in terms of increased productivity of crabs, scallops, clams, birds, and waterfowl
  - Total = $1,471 per acre

BT Consideration

- May not be accurate, except for making gross estimates of recreational values, unless the sites share all of the site, location, and user specific characteristics.
- Good studies for the policy or issue in question may not be available.
- Extrapolation beyond the range of characteristics of the initial study is not recommended.
- Quickly dated.

Summary of TEV Concepts and Methods