# An Introduction to the travel-cost method for estimating use damages: mining injuries in the Coeur d'Alene Basin

Edward Morey: Tc-intro-coeurdalene.doc revised September 19, 2011

This is where the Indian tribe lived.


HEALTH WARNING
The Lower Coeur d'Alene River and lateral lakes are contaminated with lead and other metals from mine tailings. Small children are at greatest risk. To protect your health:
Avoid breathing dust and touching the soil and mud.
Wash hands before eating and serving foods.
Do not eat large amounts of fish, waterfowl or aquatic plants.
Do not drink water from the river or lakes.

These swans died an agonizing deaths—lead poisoning.

► Objective (my job): Estimate Damages from Injuries to current anglers and potential anglers.[1]

► Damage: Willingness to Pay (WTP) for Uninjured State

- □ Damage to individual angler is how much he or she would pay for a world with no mining injuries in the Coeur d'Alene Basin

► *Travel-Cost Method* Estimates *Use* Damages

- □ Use values only experienced by visiting site
  - – If you take fewer trips to site in the injured state than you would in uninjured state, you experience use damages
  - – In addition, you receive less benefits from trips to site in its injured state than you would in its uninjured state

[1] Other people were charged with estimating other components of the damages.

- Travel-Cost Estimates Damage by Observing Behavior

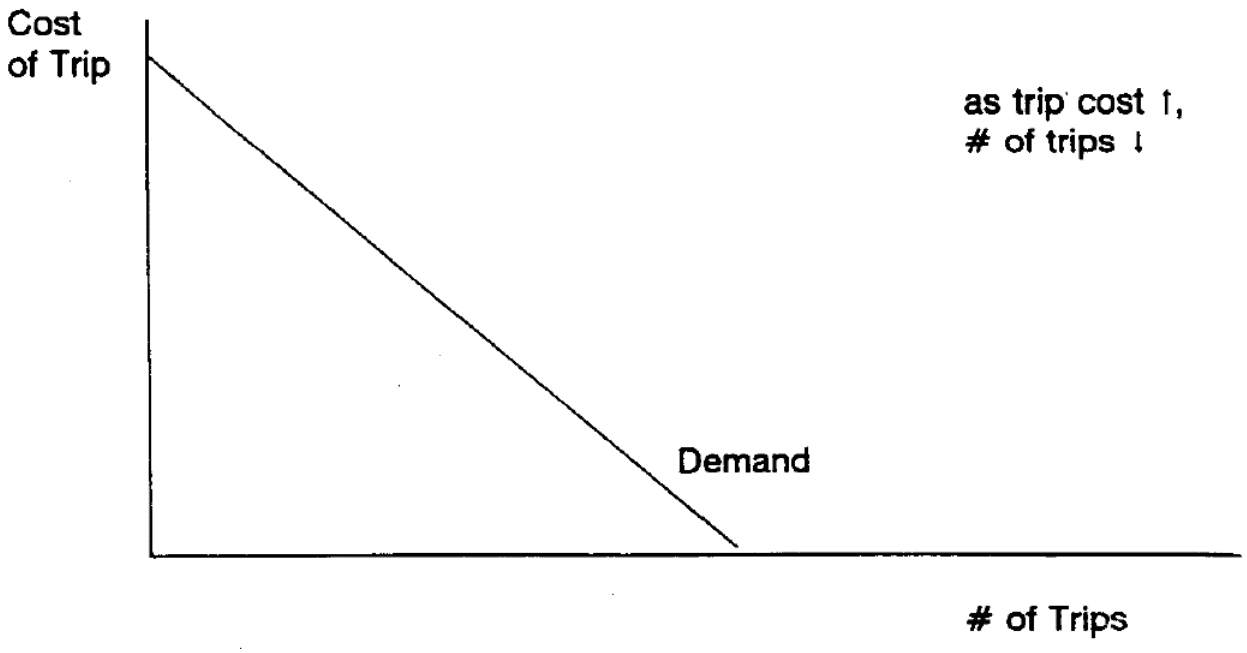
AND

- Inferring Value from that Behavior
  - Travel-cost estimates a demand function for trips to a recreational site or sites

  AND

  - Uses that estimated demand function to derive estimates of benefits from the site

    For example, the demand curve might looks as follows



## ► How Behavior Infers Value

- If trip costs $50, and an individual takes an additional trip, we can infer that the individual expects at least $50 worth of benefits from the trip

- If an individual could have taken trip to site A for $50 but instead went to site B at cost of $100, the individual must value characteristics at site B at least $50 more than characteristics at site A

For example if I could have skied at Eldora at a cost of $50, but went instead to Vail which cost me $150, I valued, on that day, the characteristics of Vail at least $100 more than I valued the characteristics of Eldora.

My behavior reveals how I value things.

## ► Demand Estimation and Value: Simple Example

Phil's Estimated Demand for Apples

Assume for Phil:

Apples = α – β (Price Apples) = 8 – 4 (Price Apples)

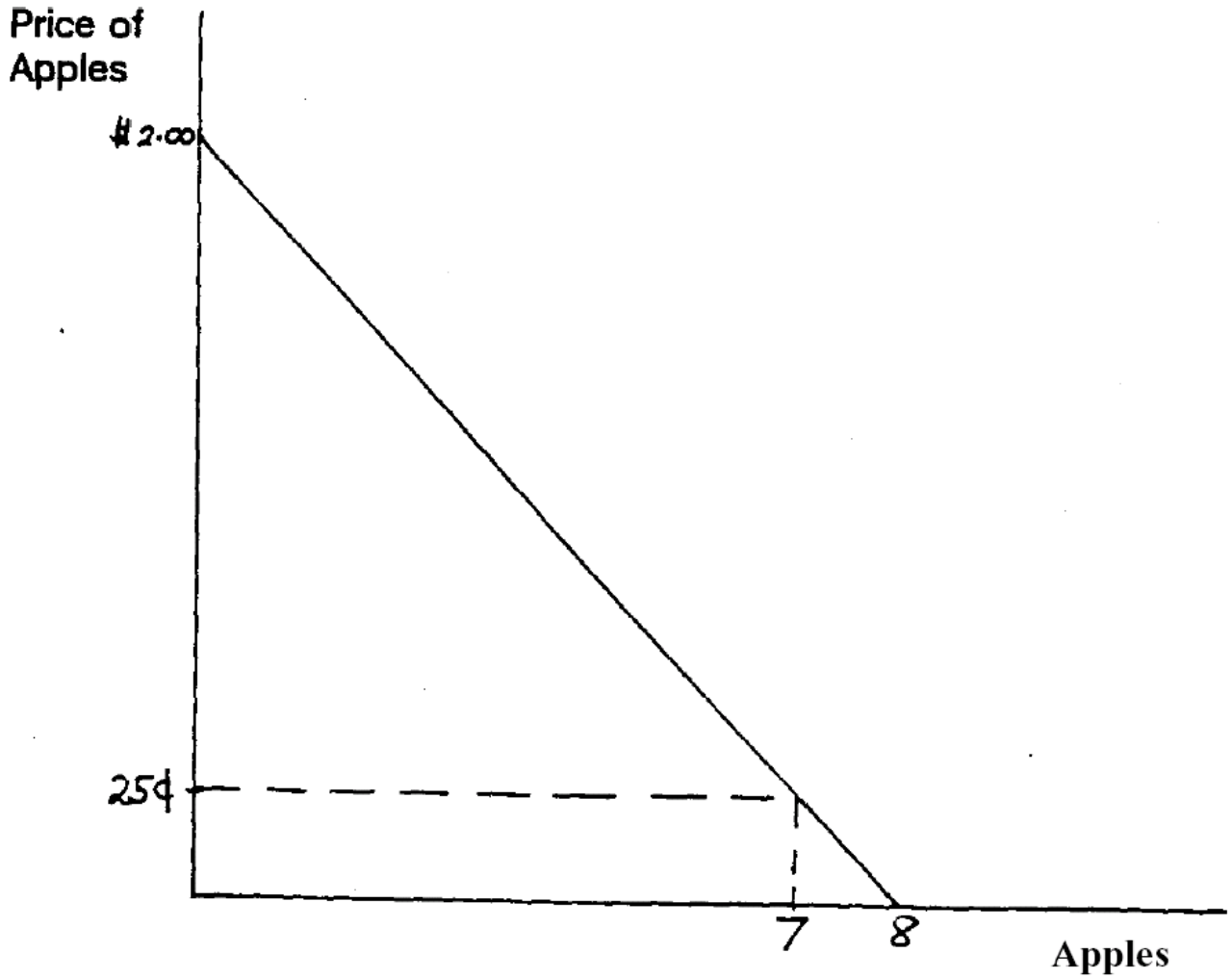
e.g., if Price = $0.25, Apples = 7

e.g., if Price = $2.00, Apples = 0

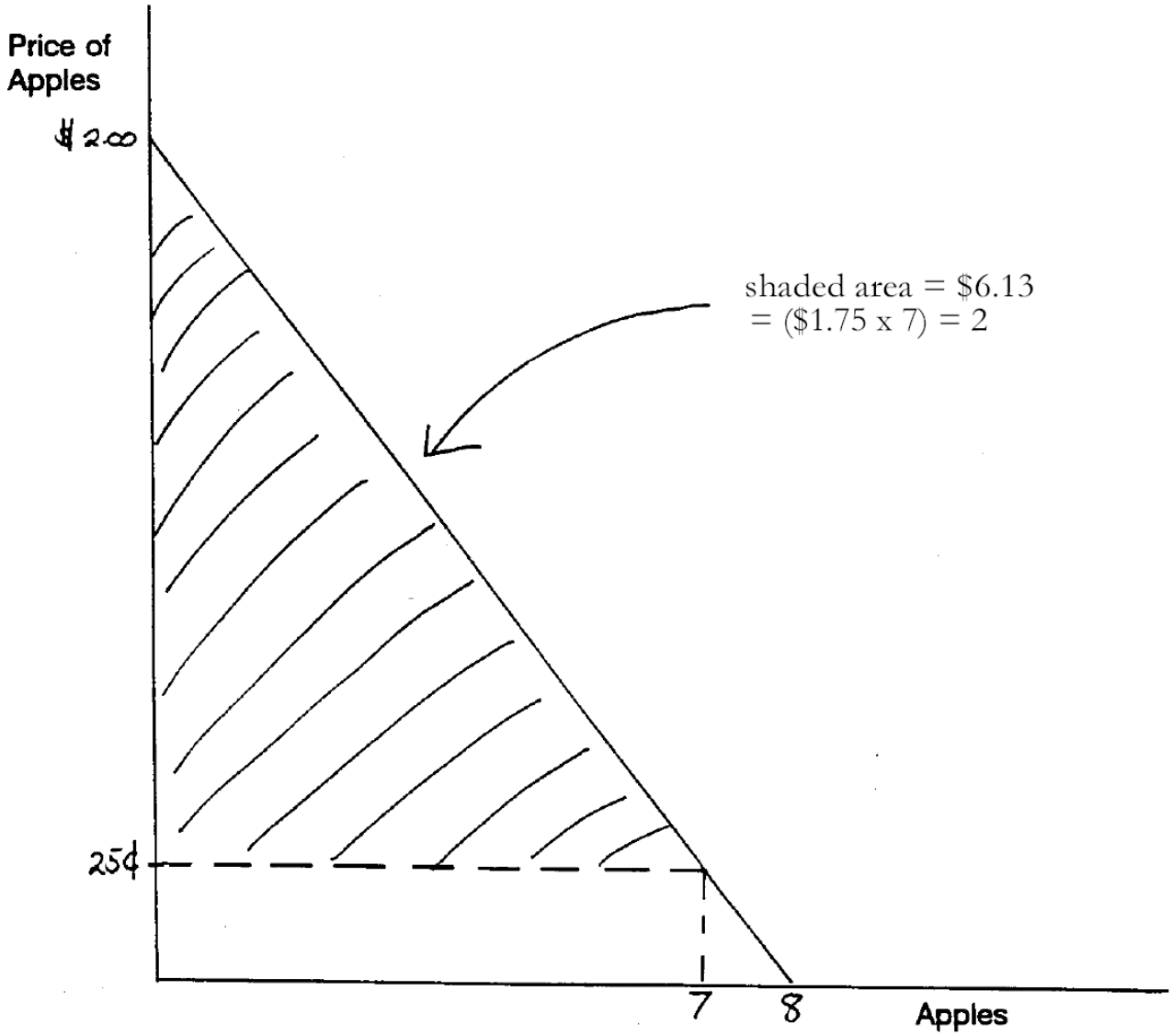
e.g., if Price = $0.00, Apples = 8

The parameter α is how many apples Phil would consume if they were free.

The parameter β is how many fewer apples Phil will consume if the price increases by $1

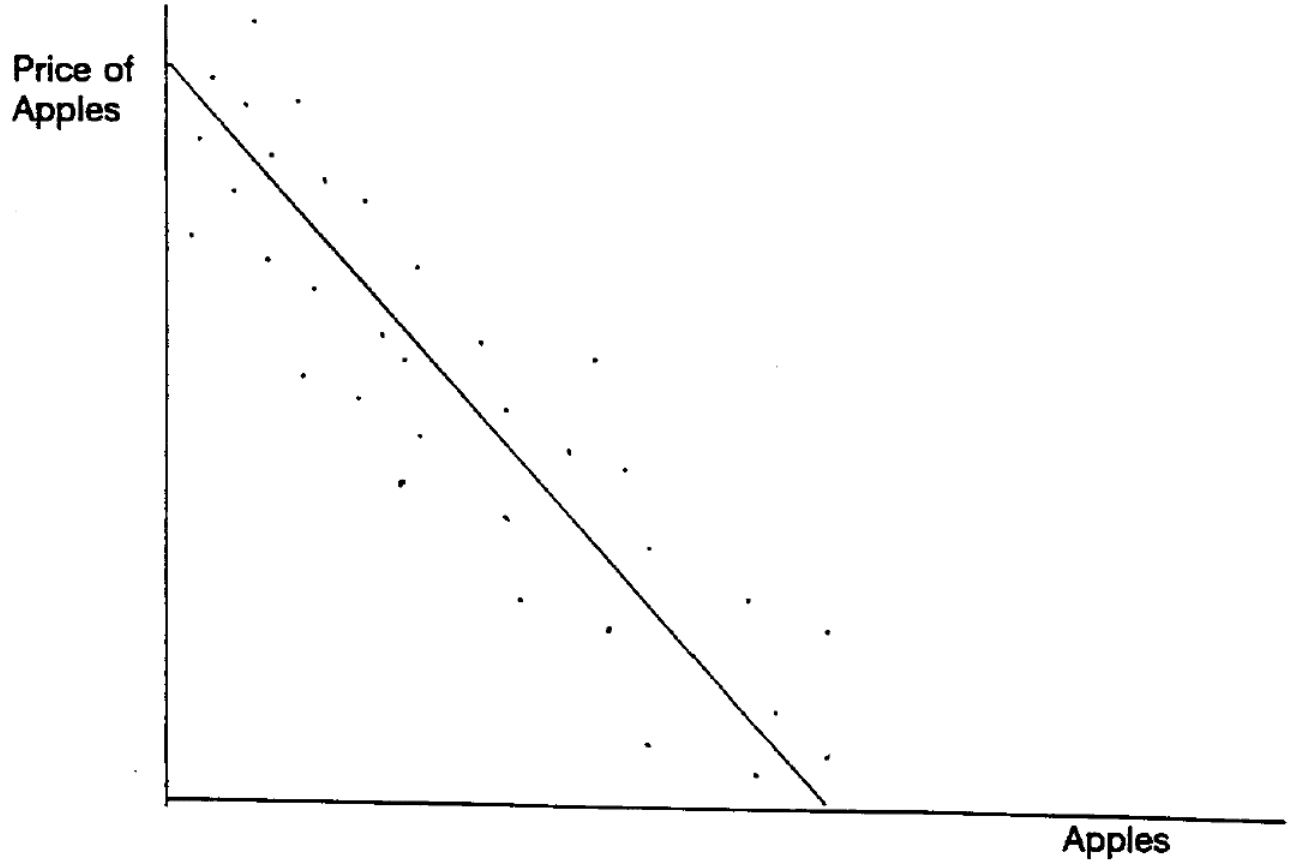

Price of Apples
$2.00
25¢
7
8
Apples

► What is Phil's WTP to Have Apples Available at 25¢?




- Shaded area approximates Phil's WTP to have apples available at 25¢
- This WTP is often called consumer's surplus

- How to Estimate Demand Curve for Apples
  - Collect from a number of Phils the price each faced for apples, and how many apples each Phil purchased
  - Use this data to estimate demand curve for apples




  - Choose values of α and β that best fit data
  - Note: Need variation in price of apples across individuals; otherwise, cannot estimate

influence of price on demand (show ex.)

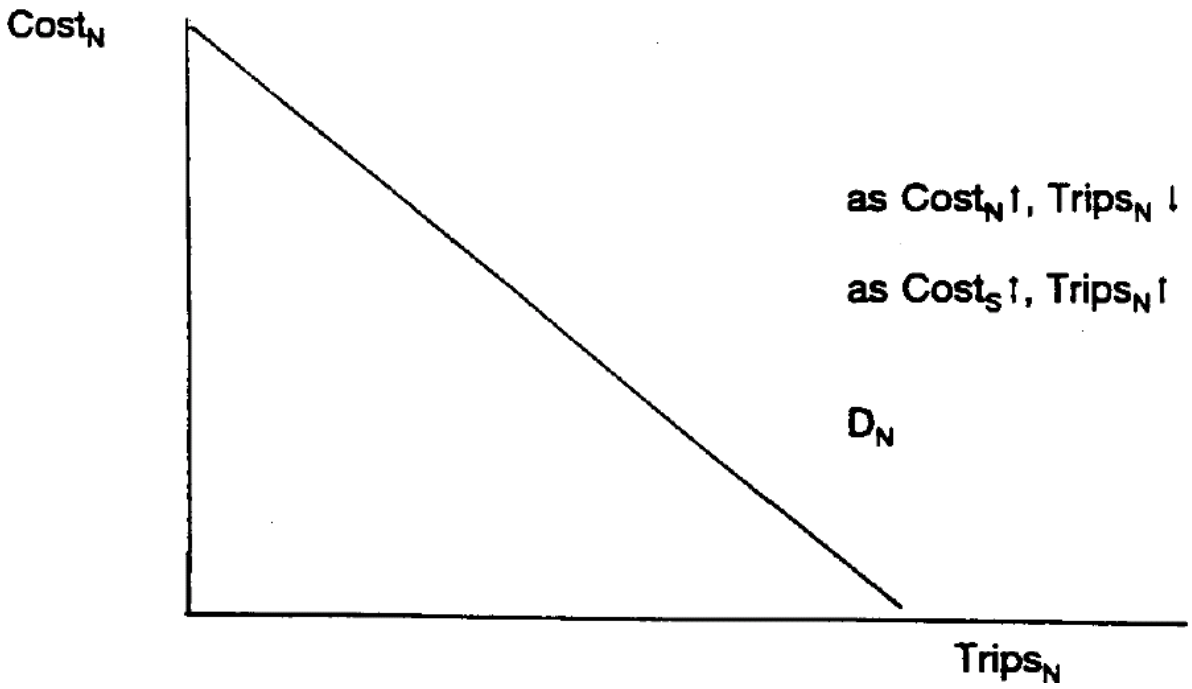
# RECREATION

- Travel-Cost Estimates the Demand Function for a Recreational Site or Sites
  - Travel-cost methodology builds and estimates model to predict how many trips individual will take to each site in his choice set
- Then Uses these Estimated Demand Functions to Infer Values
- Assume Intent is to Model Recreational Fishing
- Assume Only Two Sites
  - Call the two sites N (North Fork) and S (South Fork)

- Methodology is Called Travel-Cost
  - Travel costs typically a major component of cost of trip
  - Trip costs include transportation costs, The value of the individual's time, entrance fees, equipment costs, etc.
  - For a given site, trip costs vary across Individuals as a function of where each lives and how each values their time
  - For a given individual, trip costs vary across sites because different sites are different distances from individual's residence

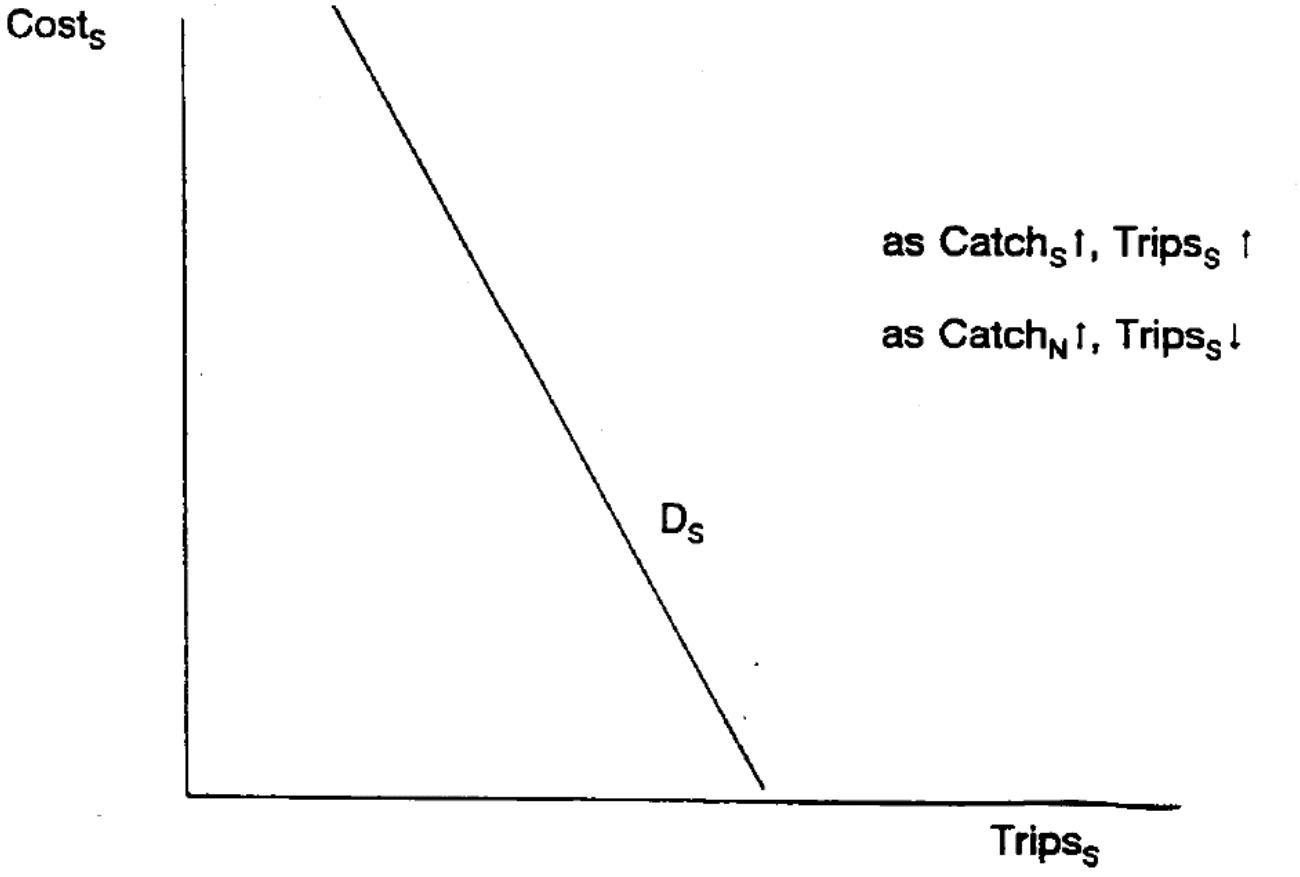
- Assume

$$Trips_N = \alpha_N + \beta_N(Cost_N) + \gamma_N(Catch_N) + \beta_{NS}(Cost_S) + \gamma_{NS}(Catch_S)$$

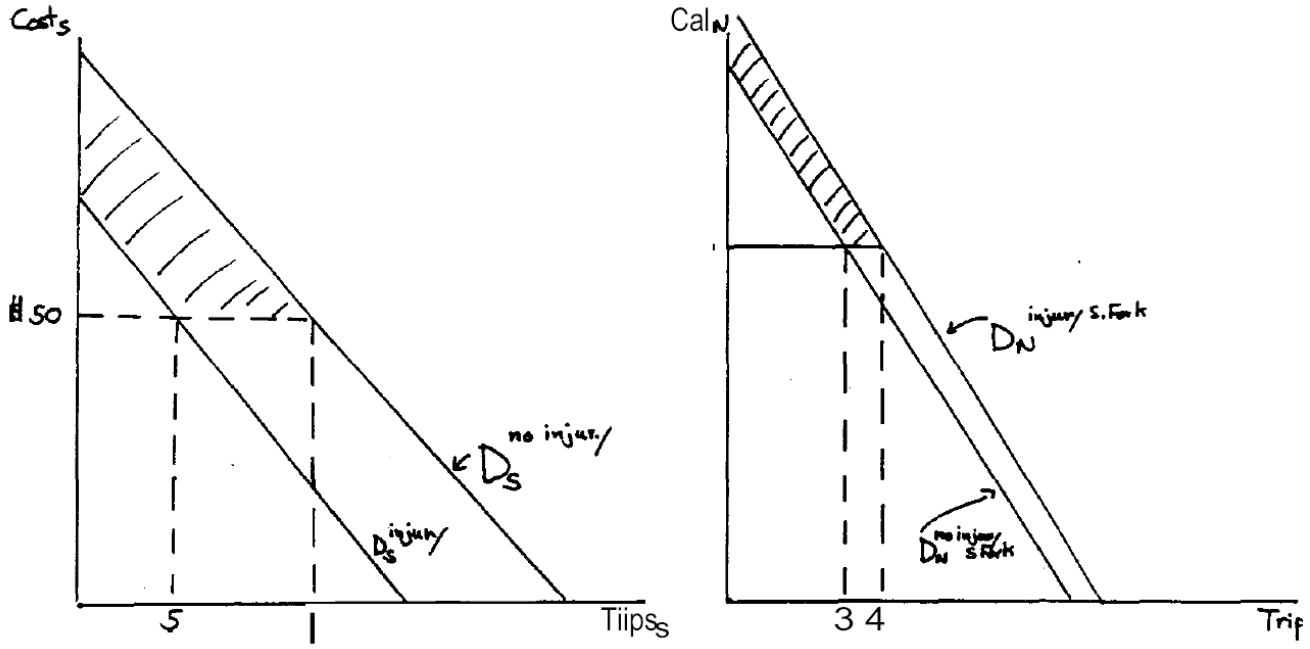


- And assume

$$Trips_S = \alpha_S + \beta_S(Cost_S) + \gamma_S(Catch_S) + \beta_{SN}(Cost_N) + \gamma_{SN}(Catch_N)$$



- Consider how demand functions shift if $Catch_S \downarrow$




- Damage Due to $Catch_S \downarrow$ Approximated by Change in Areas Under the Two Curves
  - WTP for trips to the South Fork are lower than they would have been in absence of injury
  - But, WTP for trips to the North Fork are higher than would have been in absence of injury to the South Fork
  - The more easily fishing on the North Fork substitutes for fishing on the South Fork, the smaller the damages

- Need Random Sample of Users and Potential Users to Estimate the Demand Function for each site
  - Need to know how many trips each individual took to each site during fishing season
    - Call these observed trip patterns *Trip* Data
    - Don't want sample to only consist of individuals who fish the injured South Fork site
  - For each individual, need enough information to calculate individual's trip costs to each site
    - Distance to each site
    - Vehicle operating costs
    - Value of individual's time
  - Use this information to calculate $Cost_N$ and $Cost_S$ for each individual

- Need Expected Catch Rates for Each Site, $Catch_S$ and $Catch_N$
  - Collect catch data from individuals fishing at the two sites
  - Note: Need variation in expected catch rates across sites to estimate influence of expected catch on trip patterns
- Might Want to Supplement Observed Trip Data with Responses to Hypothetical Questions
  - Ask individuals to choose between pairs of hypothetical sites, where the two sites in each pair have different costs and catch rates

- Use Data to Estimate Number of Trips Each Individual Will Take to Each Site
  - Estimate how trip patterns would change if costs or expected catch rates change
- From the Estimated Travel-Cost Model, We Can Estimate Damages Associated with Any Change in $Catch_S$
  - For example, damages associated with $Catch_S$ at injury level rather than at no injury level

- To Link Expected Catch Rate at the South Fork to Mining Related Injuries
  - Contamination → ↓ fish stock in South Fork → ↓ expected catch rate
  - Must estimate the relationship between expected catch and stock size
  - And must estimate size of injured stock and what stock size would have been in absence of injuries
- Example has been Simplified