
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 27, 2018



This is where the Indian tribe lived.

An introduction to travel-cost modeling, Edward Morey, Sept 27, 2018



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These swans died agonizing deaths—lead poisoning.

The contamination is also very bad for the fish

At this point you might be wondering why I am lecturing about fish

The simple answer is

To estimate economic values you have to estimate preferences, and to do this one estimates demand functions.

And this lecture will teach you how to estimate demand functions (not just for fishing trips). In addition, it will show you how to extract measures of value from the estimated demand function(s).

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▶ Objective (my job for the government): Estimate Damages to current anglers and potential anglers caused by the mining injuries.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

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

▶ *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 each trip to the site in its injured state than you would have if it had not been uninjured

▶ Travel-Cost Estimates Damage by Observing Behavior

AND

▶ Inferring Value from that Behavior

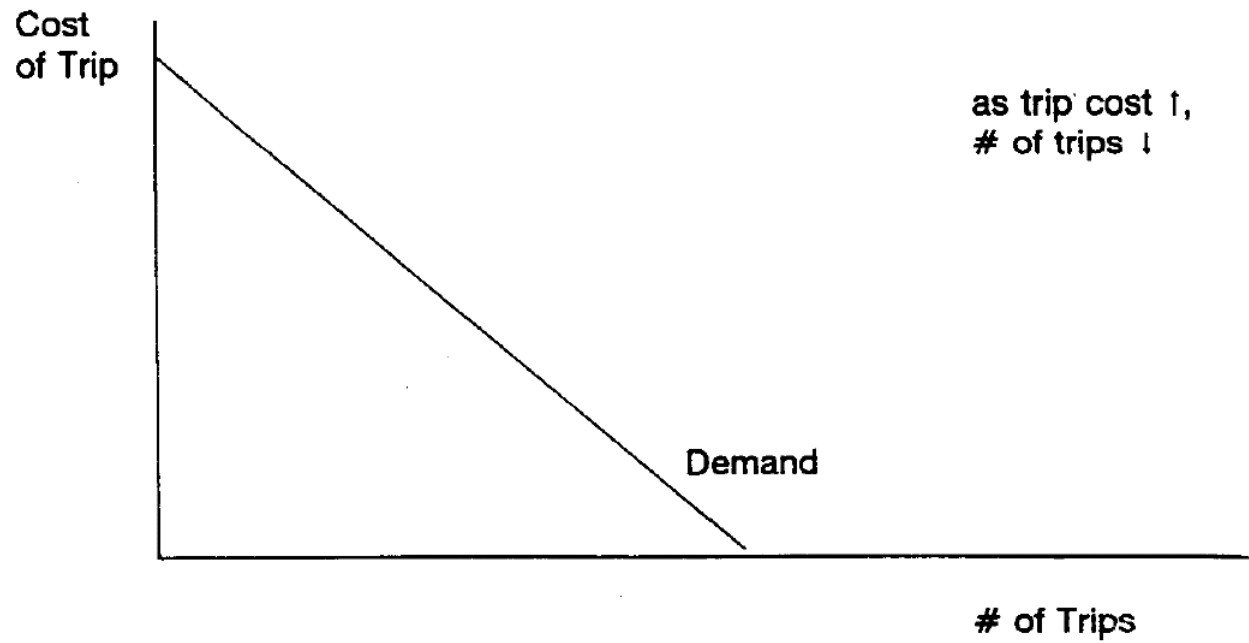
- Travel-cost estimates a demand function for trips to a recreational site or sites

AND

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

For example, the demand curve might look as follows

II



If the quality of the fishing site increases demand shift right. If quality decreases demand shift left.

► 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 the characteristics at site B at least \$50 more than the characteristics at site A

For example, if I could have skied at Eldora (the nearby area) at a cost of \$50, but went instead to Vail which cost me \$200, I valued, on that day, the characteristics of Vail at least \$150 more than I valued the characteristics of Eldora.

My behavior reveals how I value things; your behavior reveals how you value things.

► Demand Estimation and Value: Simple Example

Phil's Estimated Demand for Apples

Assume, initially, that God tells us that for Phil:

Apples demanded = $\alpha - \beta$ (Price Apples) = $8 - 4$ (Price Apples)

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

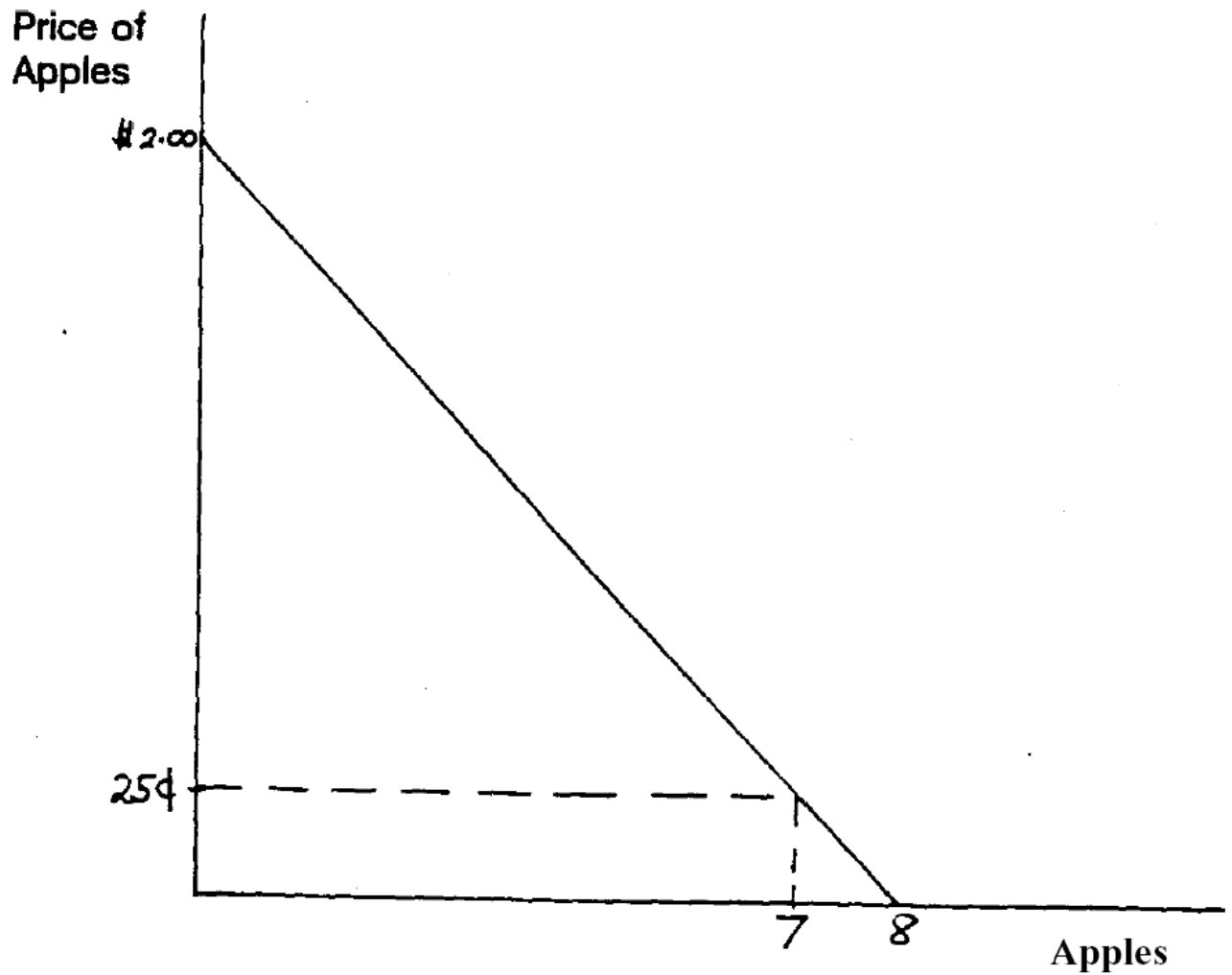
e.g., if Price = \$2.00, Apples = 0

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

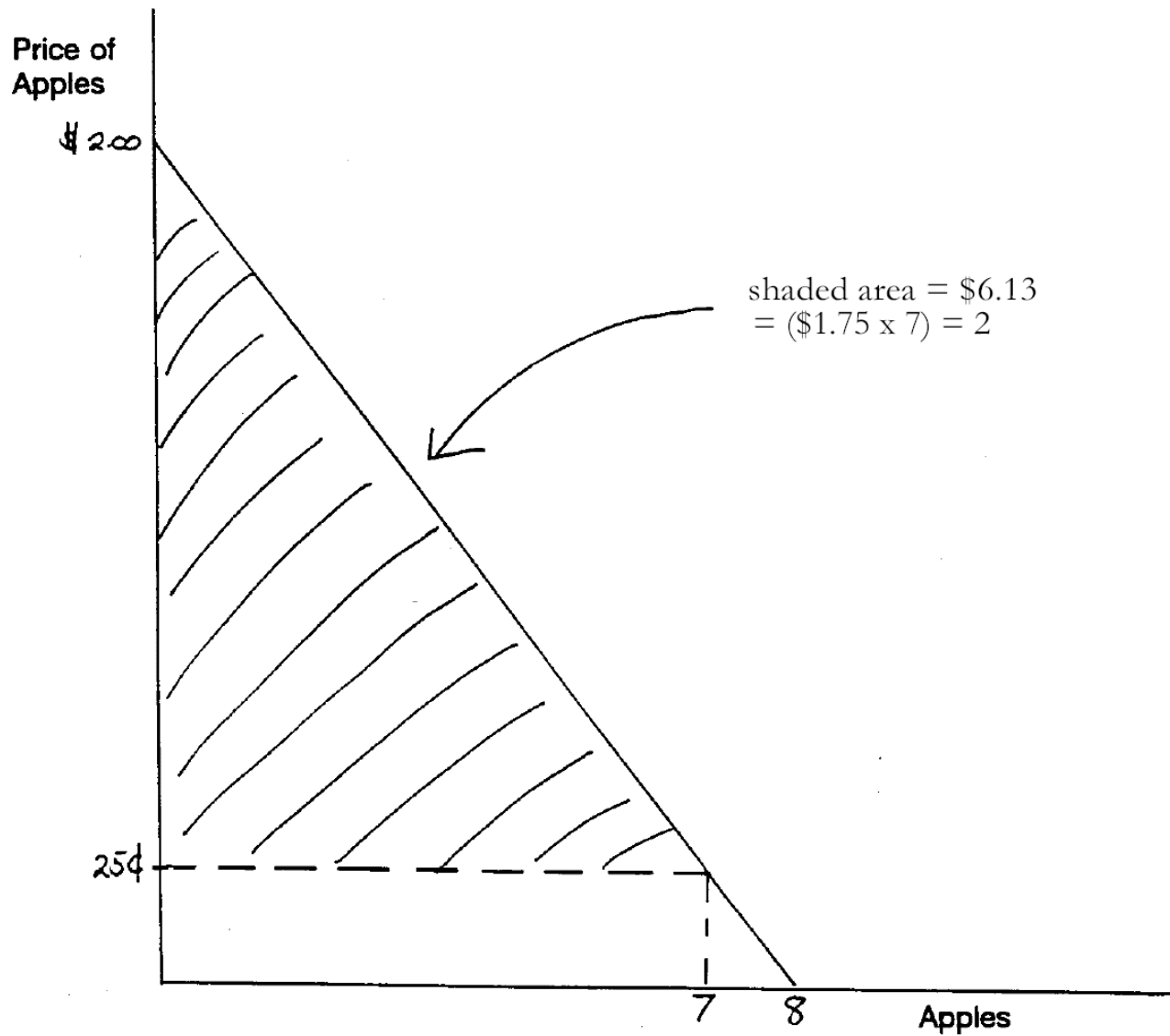
The parameter α is how many apples Phil would consume if they were free.

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

Assume the price is 25 cents an apple.



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



- Shaded area approximates Phil's WTP to have apples available at 25¢

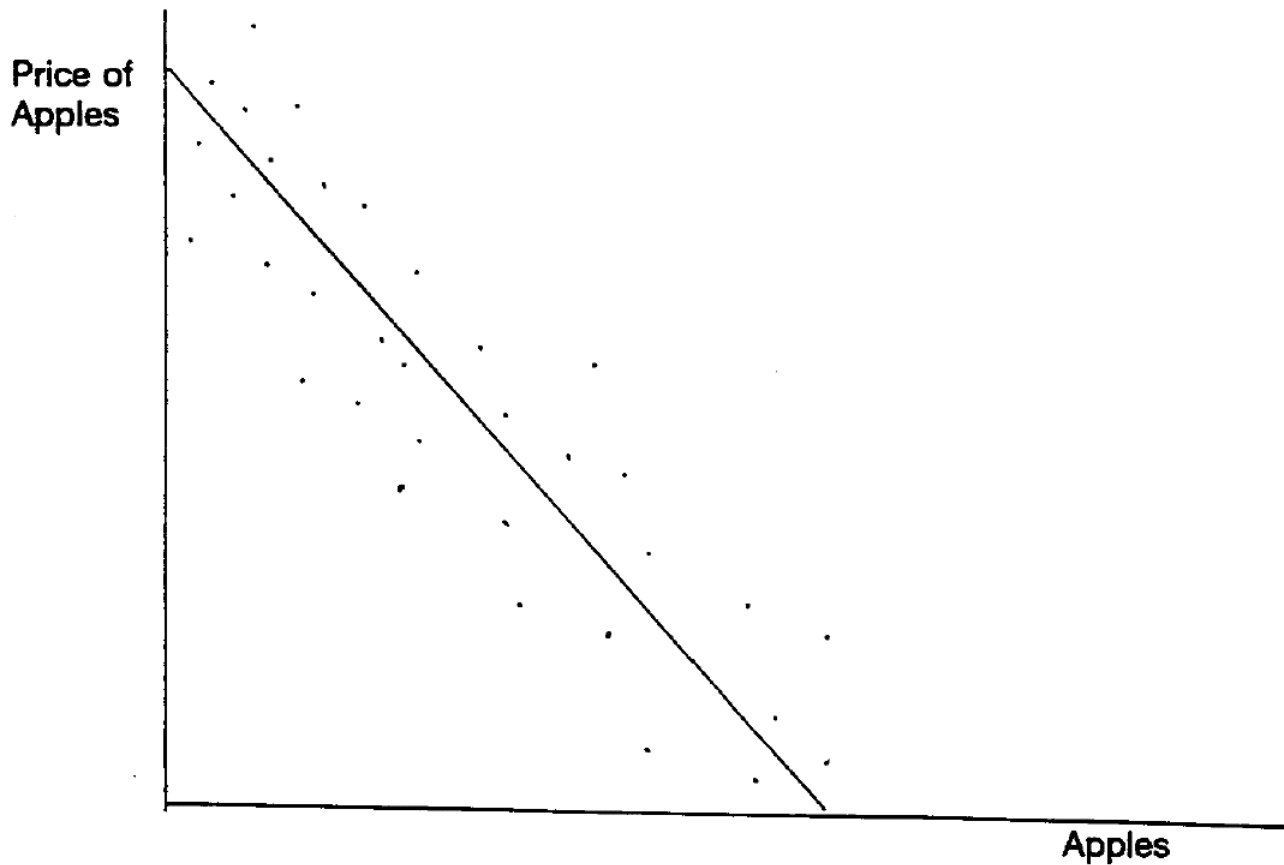
- n This WTP is often called consumer's surplus

Now assume God did not tell us the Phil demand-function for apples, so we have to estimate it.

▶ 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



Each dot is one observation

- 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 a model to predict how many trips an individual will take to each site in his choice set

- ▶ Then uses this estimated demand function to infer value

- ▶ Assume Intent is to Model Recreational Fishing

- ▶ Assume Only Two Sites

- Call the two sites N (North Fork) and S (South Fork)

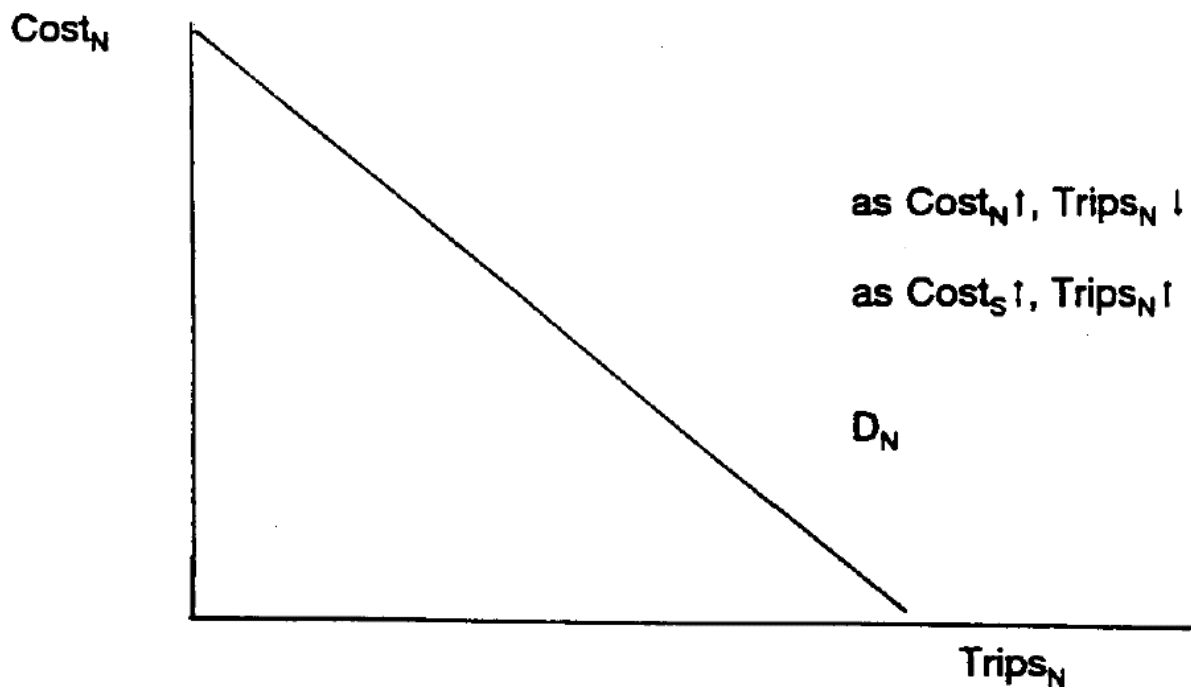
▶ Methodology is Called Travel-Cost

- Travel costs typically a major component of the cost of a 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, and might have different entry fees

► Assume

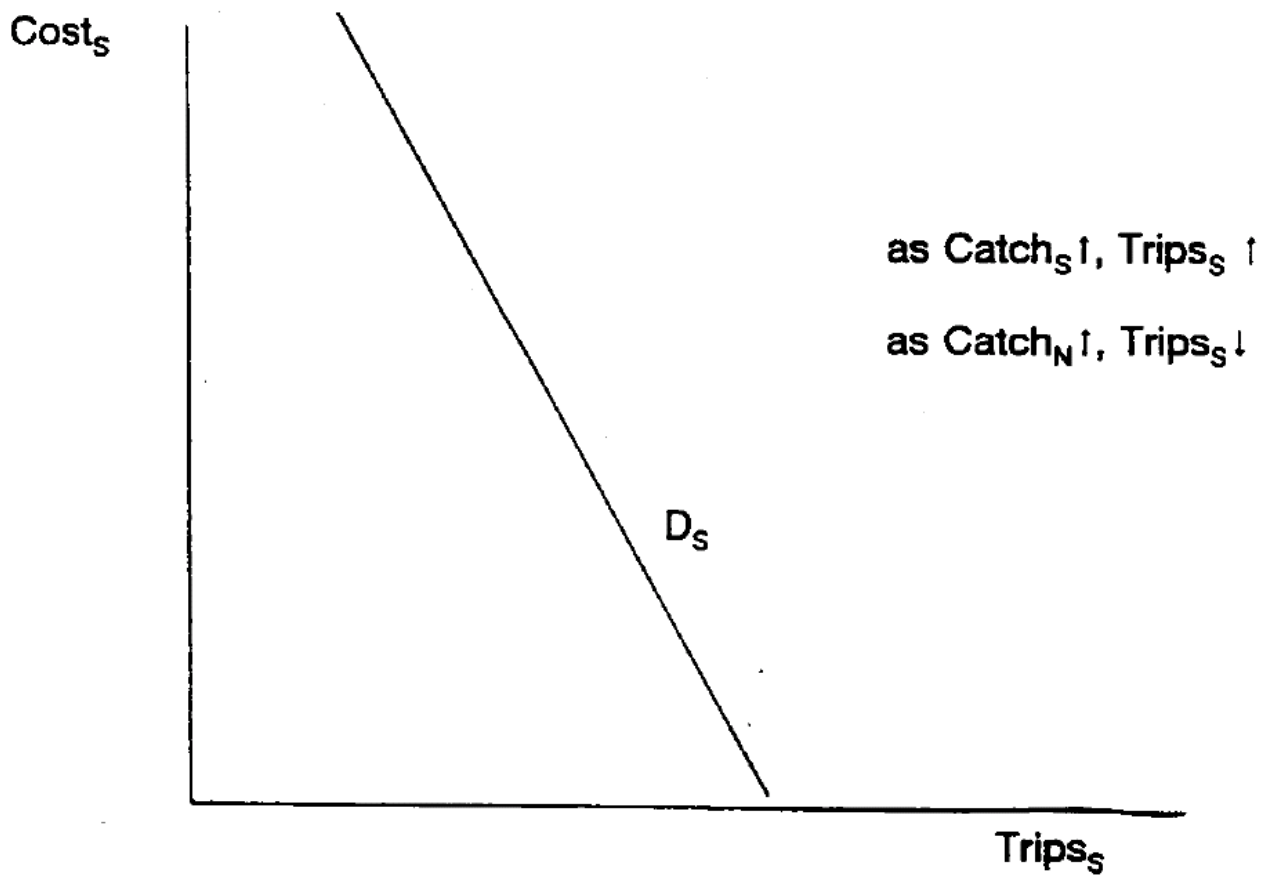
$$Trips_N = \alpha_N + \beta_N * (Cost_N) + \gamma_N * (Catch_N) + \beta_{NS} * (Cost_S) + \gamma_{NS} * (Catch_S)$$

Where $Catch_n$ is the catch rate at the North Fork. So, I draw an example curve next, but we really do not know its specific position and slope until we have estimated the parameter values.



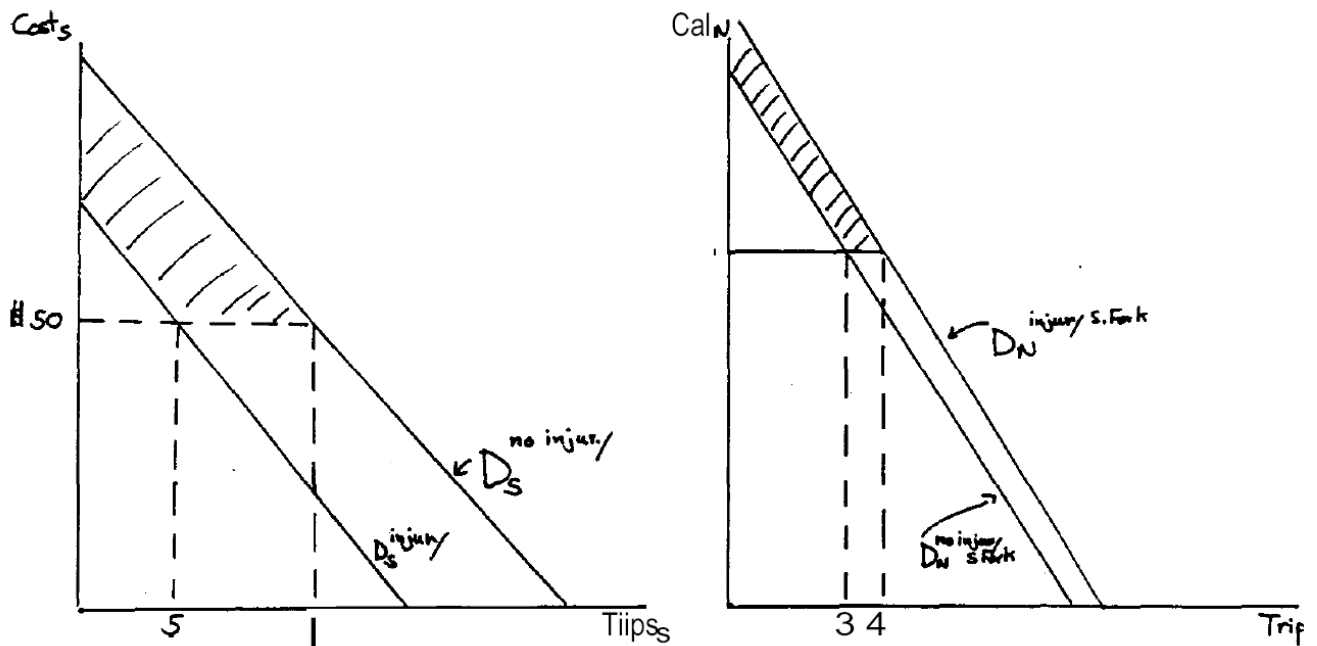
► And assume

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



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

Start with the uninjured state, showing the cs triangles. It costs this individual \$50 to fish the South Fork, more to fish the North Fork (he lives farther from the N. Fork)



Damage due to $Catch_S \downarrow$ is approximated by change in areas under the two curves (specifically the shaded area in the left graph minus the shaded area in the right graph)

- 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 fishing on the North Fork substitutes for fishing on the South Fork, the smaller the damages associated with the decrease in the S Fork catch rate

Relative to the person we are looking at, how much would someone with the same preferences, but who lives far from the site (so faces high costs to both sites) be damaged by the injury? Make it an exam question. The T.A.'s should make it an exam question.

► 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 a fishing season²
- Call these observed trip patterns *Trip Data*
- Don't want sample to only consist of individuals who fish the injured South Fork site³

- 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

²For many, it will be zero trips in the current injured state but remember that they might have taken a trip if the site were not injured.

³ You would not estimate the demand function for cigarettes by only sampling people who smoke at the current prices.

► Need Expected Catch Rates for Each Site, $Catch_S$ and $Catch_N$

- Collect catch data from individuals fishing at the two sites⁴
 - 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

⁴ You could also hire experts to fish the two sites.

► Use data to estimate the demand function for each site (that is, estimate the alphas, betas, and gammas),

Then use the estimated demand functions to estimate the number of trips each individual will take to each site with and without the decrease in the S. Fork catch rate.

- 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 Catches

- For example, damages associated with Catches at the injury level rather than at the 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