

# Angler Heterogeneity and Species-Specific Demand for Recreational Fishing in the Southeast United States

Tim Haab, Ohio State University

Rob Hicks, College of William and Mary

Kurt Schnier, University of Rhode Island

John Whitehead, Appalachian State University

# Sector Allocation



Table 45. Dolphin harvest (pounds) on the Atlantic Coast from 1994-1999 (Data Source: NMFS, 2000 and Goodyear, 1999).

|              | Recreational | Commercial | Total      | Recreational | Commercial |
|--------------|--------------|------------|------------|--------------|------------|
| 1994         | 9,500,580    | 1,252,553  | 10,753,133 | 88%          | 12%        |
| 1995         | 13,092,212   | 2,231,787  | 15,323,999 | 85%          | 15%        |
| 1996         | 8,002,144    | 1,216,682  | 9,218,826  | 87%          | 13%        |
| 1997         | 10,640,713   | 1,594,920  | 12,235,633 | 87%          | 13%        |
| 1998         | 7,693,144    | 826,640    | 8,519,784  | 90%          | 10%        |
| 1999         | 10,127,970   | 1,050,090  | 11,178,060 | 91%          | 9%         |
| 2000         | 12,574,950   | 970,781    | 13,545,731 | 93%          | 7%         |
| Avg. 94-97   | 10,308,912   | 1,573,986  | 11,882,898 | 87%          | 13%        |
| Avg. 97-99   | 9,487,276    | 1,157,217  | 10,644,492 | 89%          | 11%        |
| Avg. 97-2000 | 10,259,194   | 1,110,608  | 11,369,802 | 90%          | 10%        |

# Plan leaves snapper anglers empty handed

BY JIM WAYMER • FLORIDA TODAY • NOVEMBER 5, 2009

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Red snapper fight like mad. And if they're made off limits, so will fishermen such as Billy Golding.

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"Who wants to go fishing and throw back everything they catch?" said Golding, captain of the Miss Cape Canaveral, a 100-passenger "party" boat at Port Canaveral.

Under a ban on fishing for red snapper, Miss Cape Canaveral and other such boats would have to rely on top-water fish, such as kingfish, dolphin and cobia, which can be tougher to catch and less tasty.

Federal regulators want the total yearly red snapper kill cut by up to 88 percent to end overfishing -- a limit of 79,000 pounds by next year. And that's only the fish killed inadvertently as "bycatch."

The South Atlantic Fisheries Management Council proposes year-round closures from Florida to South Carolina of sport and commercial fishing for red snapper and other bottom fish, including many other popular grouper and snapper. The council would ban fishing for the other species as a way to prevent



Purchase this Photo

Travis Wright of Orlando shows a red snapper he caught from the Miss Cape Canaveral of Port Canaveral. If snapper fishing is banned, the boat would rely on less popular species. (Craig Rubadoux, FLORIDA TODAY)

## WHAT'S NEXT

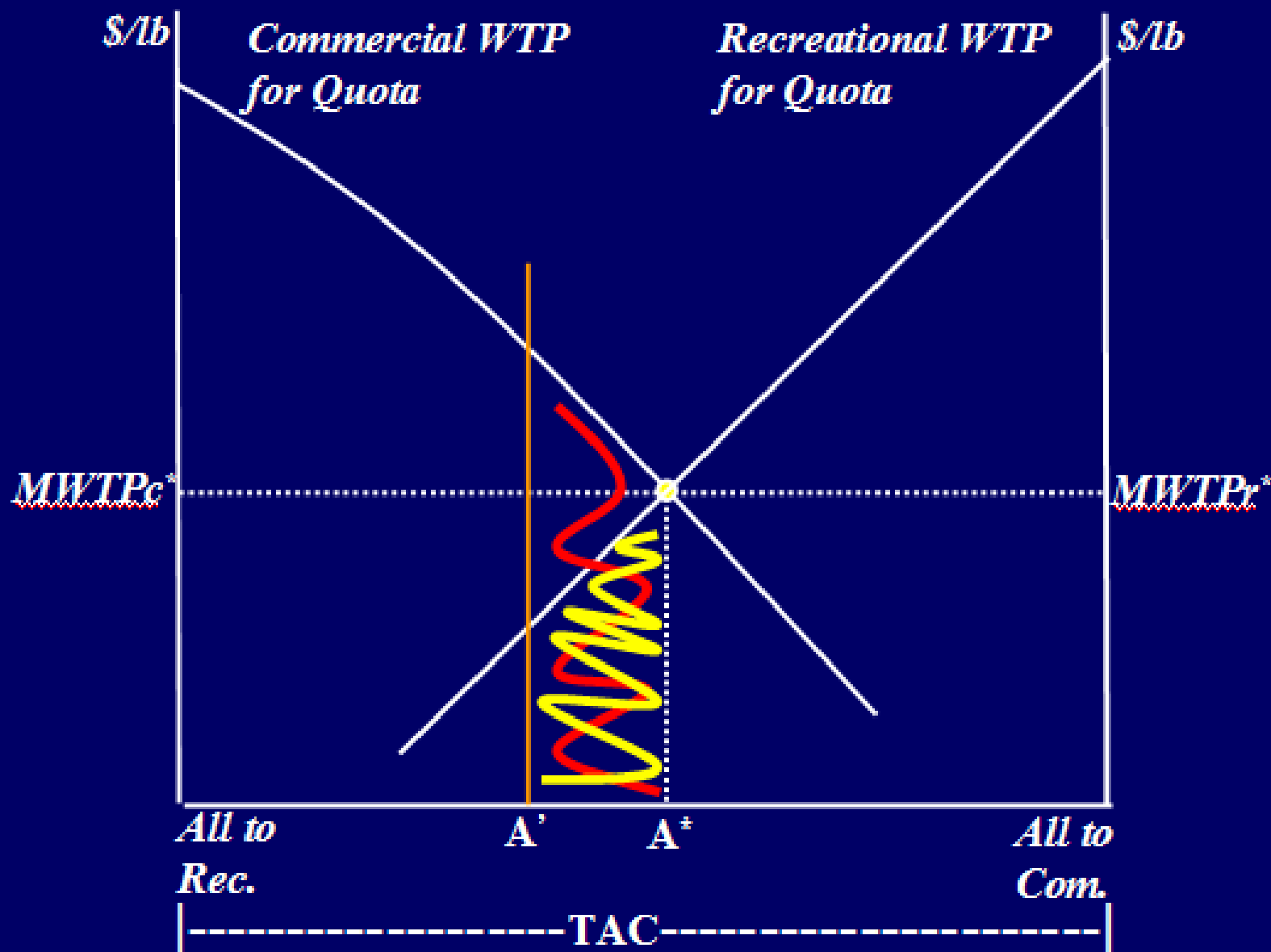
A public hearing for the ban on fishing for red snapper will be from 3 to 7 p.m. Wednesday at the Radisson Resort at the Port, 8701 Astronaut Blvd., Cape Canaveral.

## Possible red snapper ban

The South Atlantic Fishery Management Council is considering a year-round ban of red snapper and grouper within a portion of its jurisdictional boundaries, to prevent red snapper from being caught and killed as "bycatch." The proposal would close 8,500 to 26,000 square miles of water. Another proposal would close waters from 240 feet deep seaward for deepwater snapper and grouper.



Commercial Marginal WTP



Recreational Marginal WTP

# **Allocation Analysis of the Gulf of Mexico Gag and Red Grouper Fisheries**

Prepared for:  
Coastal Conservation Association

By:  
Brad Gentner  
Principal  
Gentner Consulting Group



# Most previous research ignores differences among anglers

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## ■ Journal literature

- Schuhmann 1998
- Whitehead and Haab 1999
- Whitehead 2006
- Gentner 2007

## ■ Gray literature

- McConnell and Strand 1994
- Hicks, Steinbeck, Gautam, Thunberg 1999
- Haab, Whitehead, and Ted McConnell 2000

# Most previous research employs species aggregates

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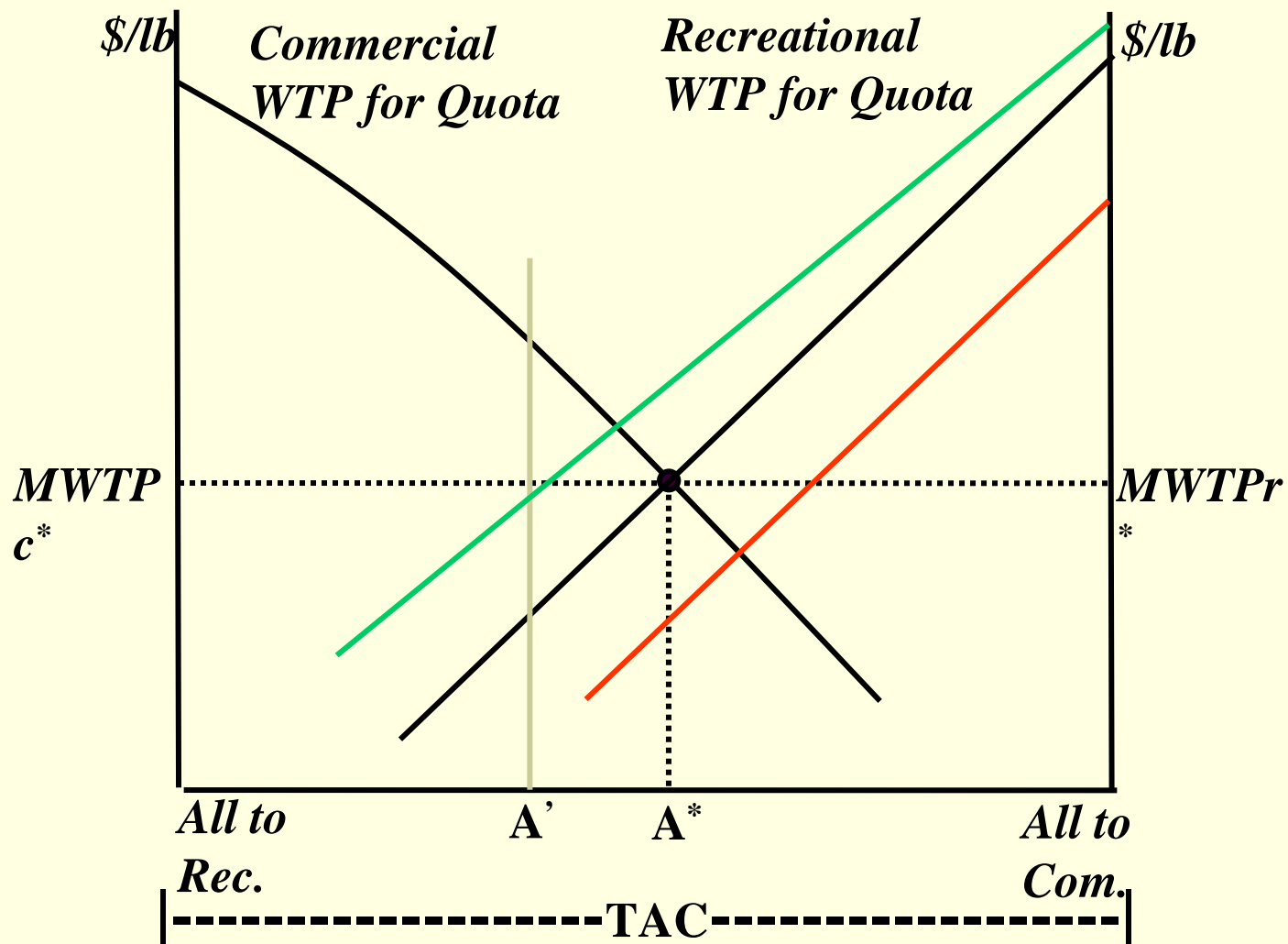
## ■ Journal literature

- Bockstael, McConnell and Strand 1999
- Green, Moss and Spreen 1997
- Schuhmann 1998
- Whitehead and Haab 1999
- Whitehead 2006
- Gentner 2007

## ■ Gray literature

- McConnell and Strand 1994
- Hicks, Steinbeck, Gautam, Thunberg 1999
- Haab, Whitehead, and Ted McConnell 2000

# Better Estimates for Allocation

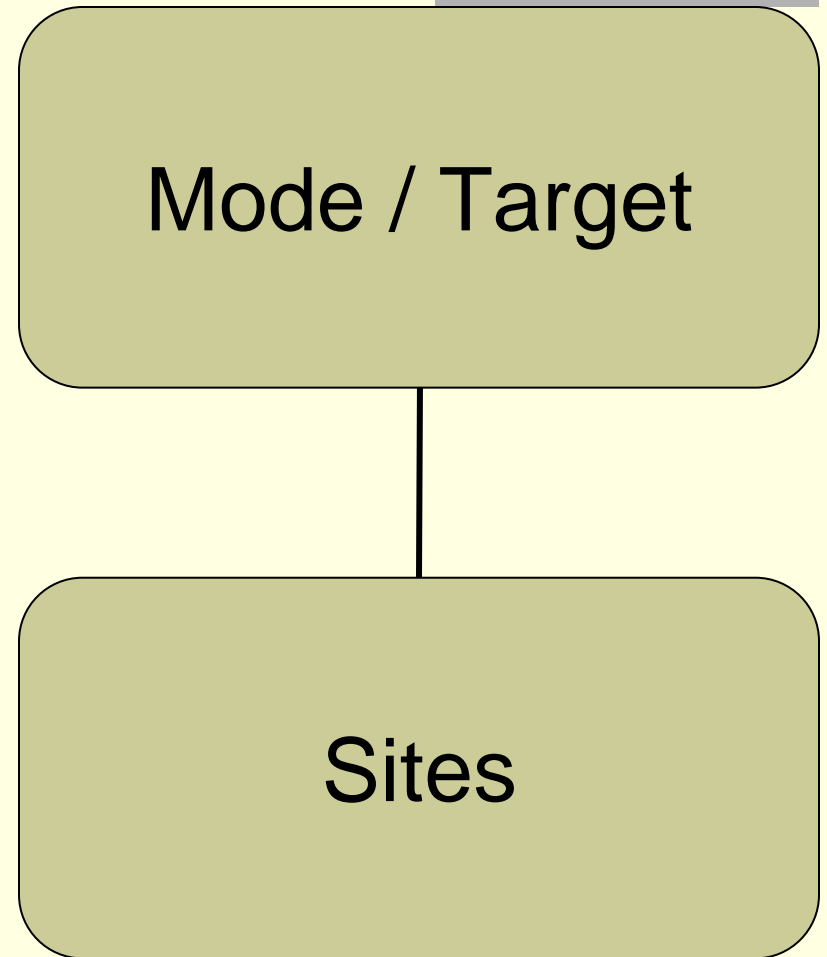




# NMFS SE Nested Logit Model

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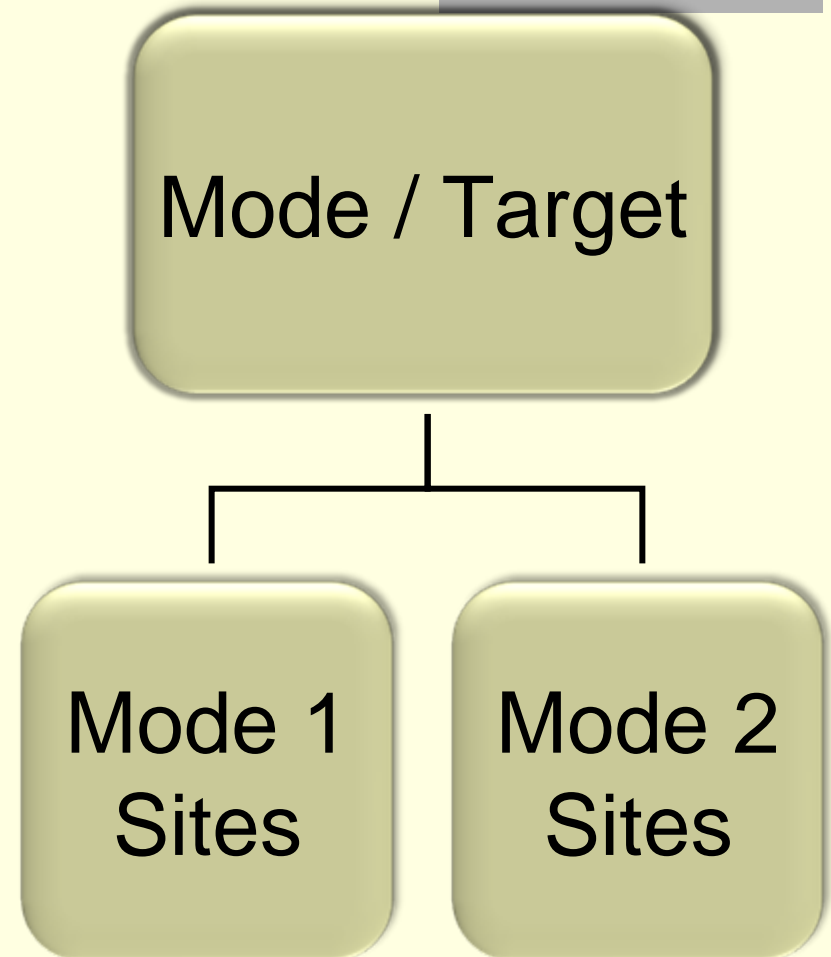
- 3 Modes
- 4 Aggregate targets species
- 70 County level sites
- 1000+ alternatives
- Sequential estimation



# This project

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- Single species
- Preference heterogeneity
- 70+ alternatives
- Full information maximum likelihood estimation



# Random Utility Model

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$$(1) \quad u_i = v_i(y - c_i, q_i) + \varepsilon_i$$

$$(2) \quad \pi_i = \Pr(v_i + \varepsilon_i > v_s + \varepsilon_s \quad \forall s \neq i)$$

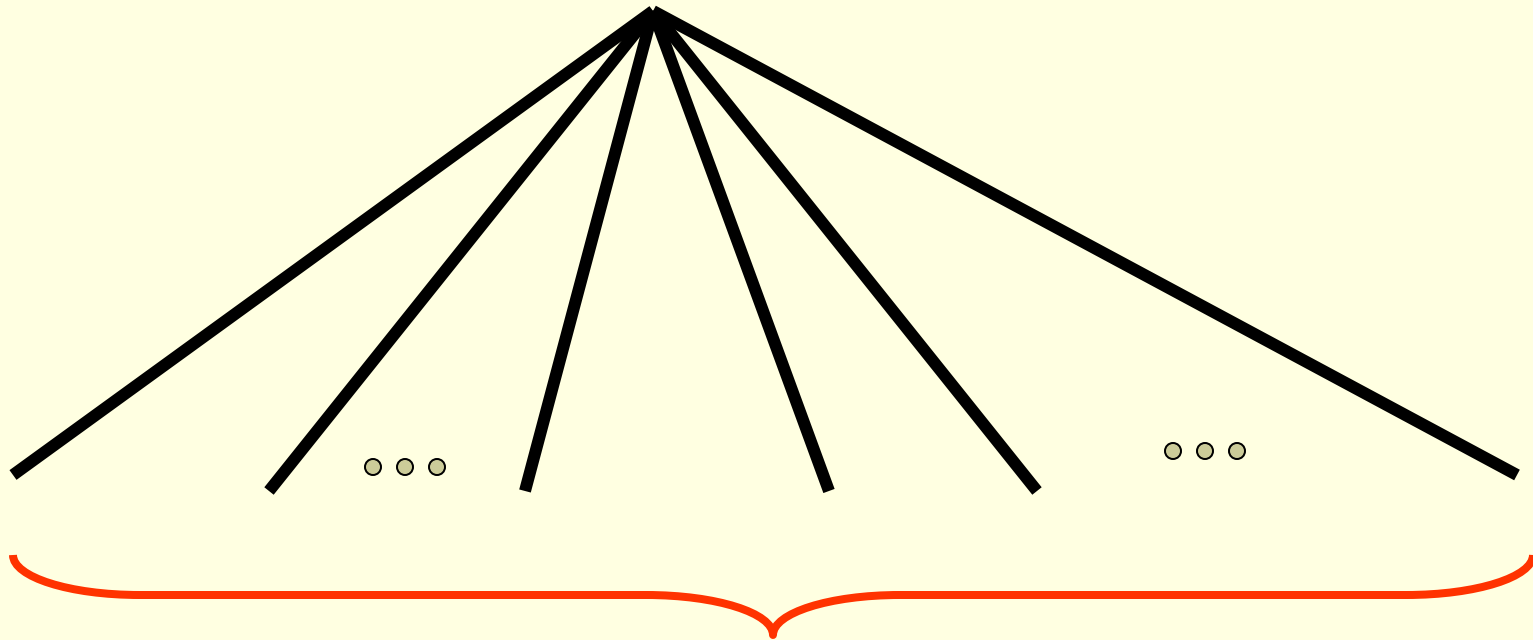
# Conditional Logit

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$$(3) \quad \pi_i = \frac{e^{v_i}}{\sum_{s=1}^J e^{v_s}}$$

# Conditional Logit: Choice Framework

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Party/charter boat, Private/rental boat  
County sites

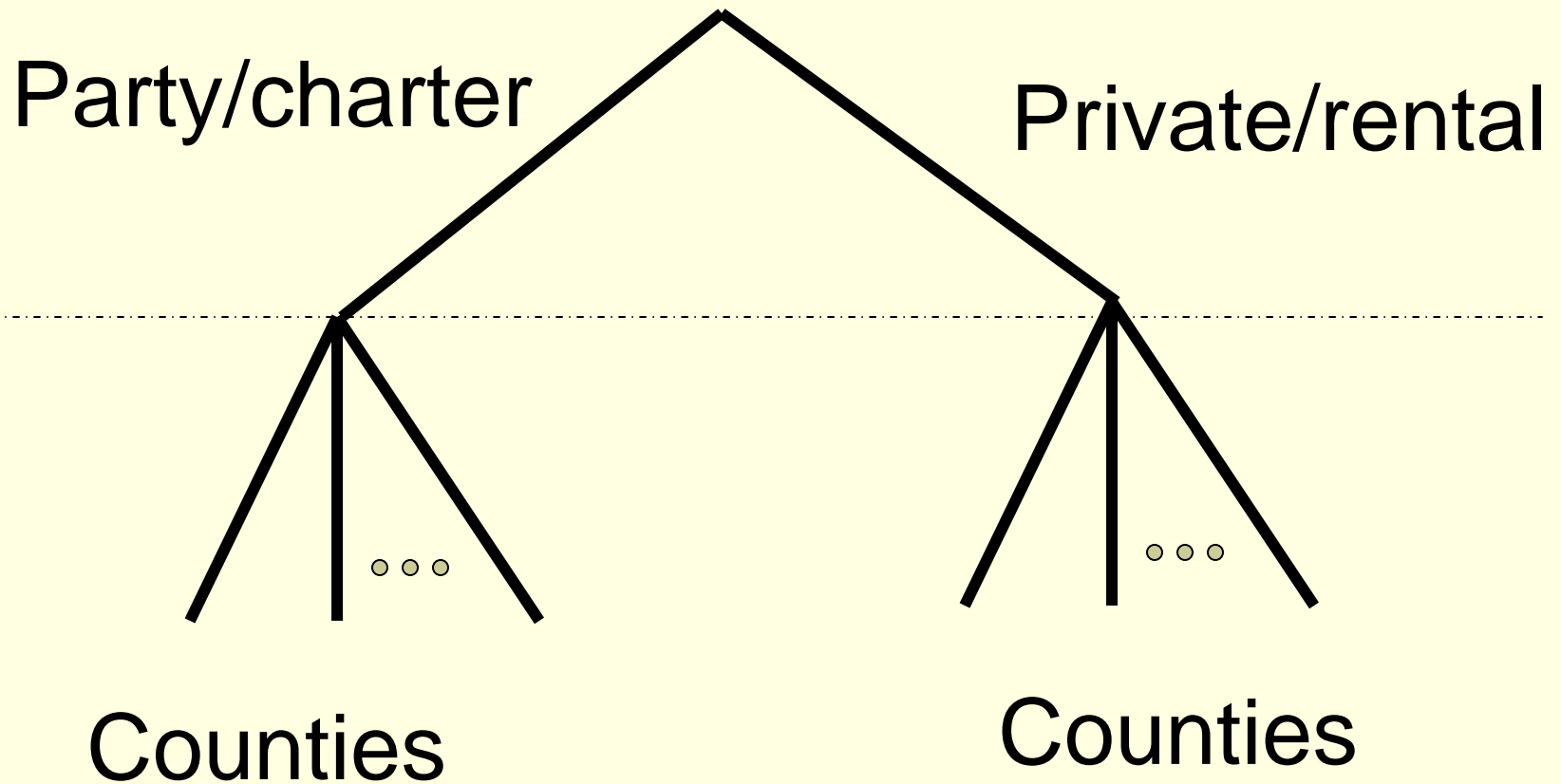
# Nested Logit

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$$(4) \quad \pi_{ni} = \frac{e^{v_{ni}/\theta} \left[ \sum_{j=1}^{J_n} e^{v_{nj}/\theta} \right]^{\theta-1}}{\sum_{m=1}^M \left[ \sum_{j=1}^{J_m} e^{v_{mj}/\theta} \right]^{\theta}}$$

# Nested Logit: Choice Framework

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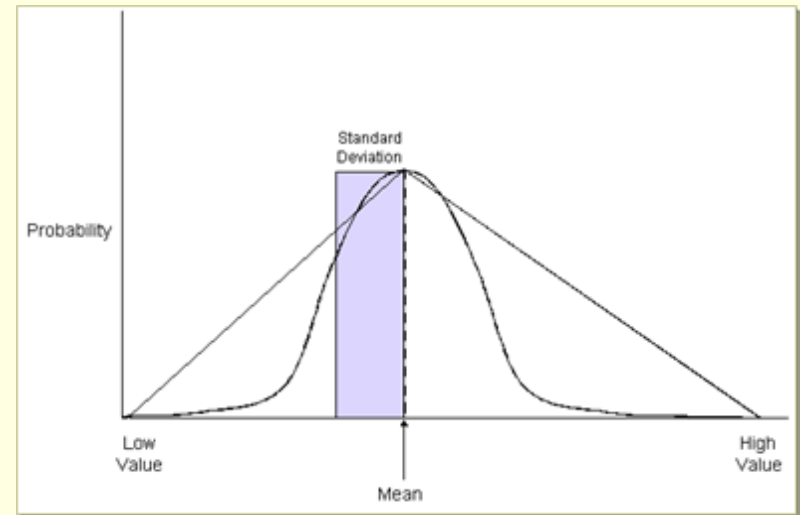
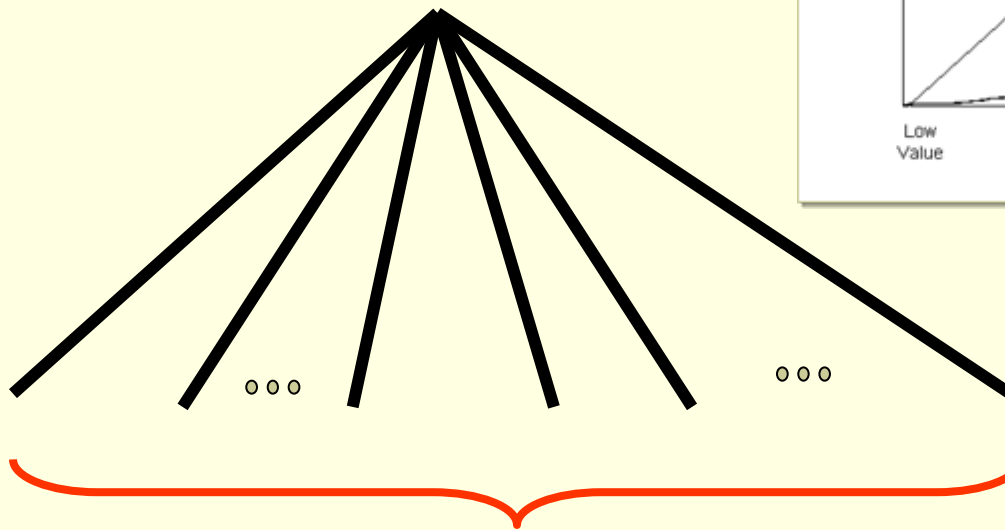
# Preference Heterogeneity: Mixed Logit

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$$(7) \quad \pi_{ih} | \eta_{ik} = \frac{e^{\tilde{\beta} + \eta_{ih}}}{\sum_{s=1}^J e^{\tilde{\beta} + \eta_{jh}}}$$



# Mixed Logit: Choice Framework



Party/charter boat, Private/rental boat County sites

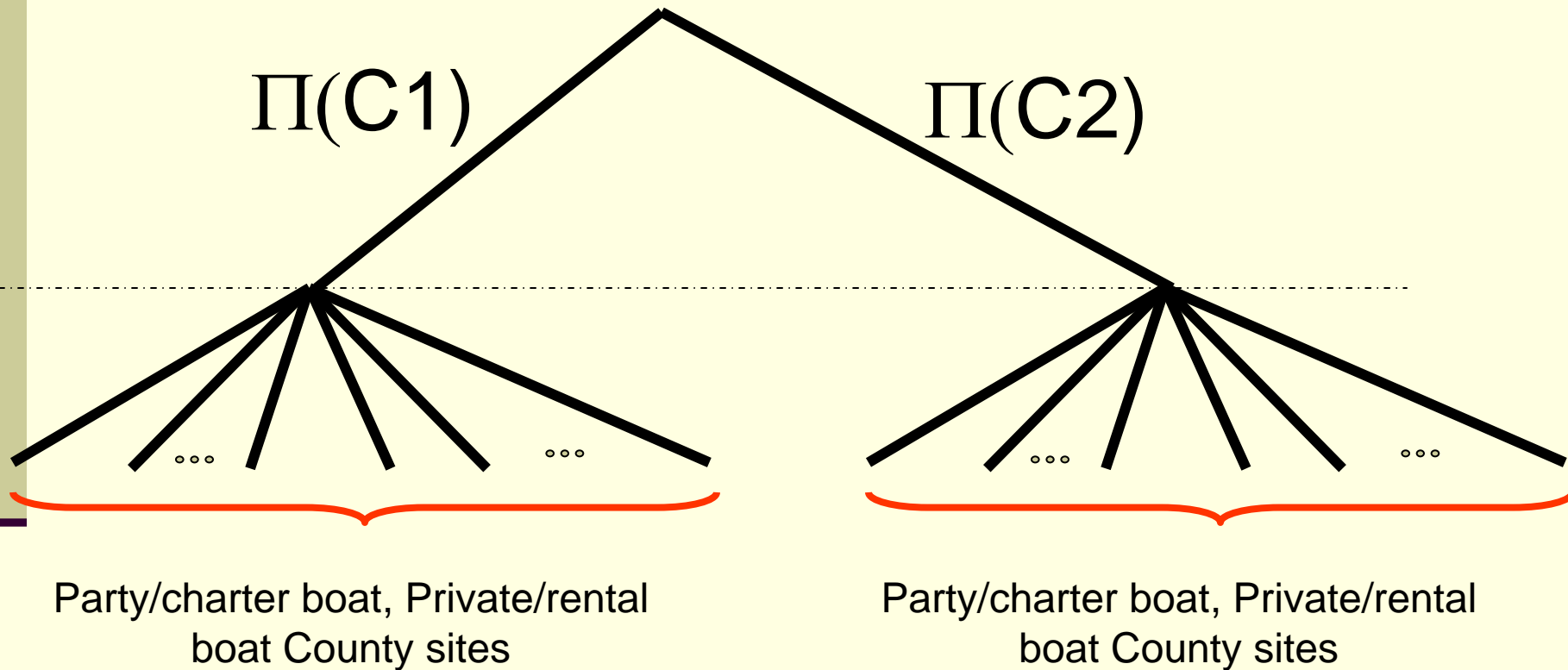
# Preference Heterogeneity: Finite Mixture Model

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$$(9) \quad P(j \mid X_{ij}, \beta^t, i \in t) = \frac{e^{X_{ij}\beta^t}}{\sum_{k \in K} e^{X_{ik}\beta^t}}$$

$$(10) \quad P(i \in s \mid Z_i, \delta^s) = \frac{e^{Z_i\delta^s}}{\sum_{t \in T} e^{Z_i\delta^t}}$$

# FM Logit: Choice Framework

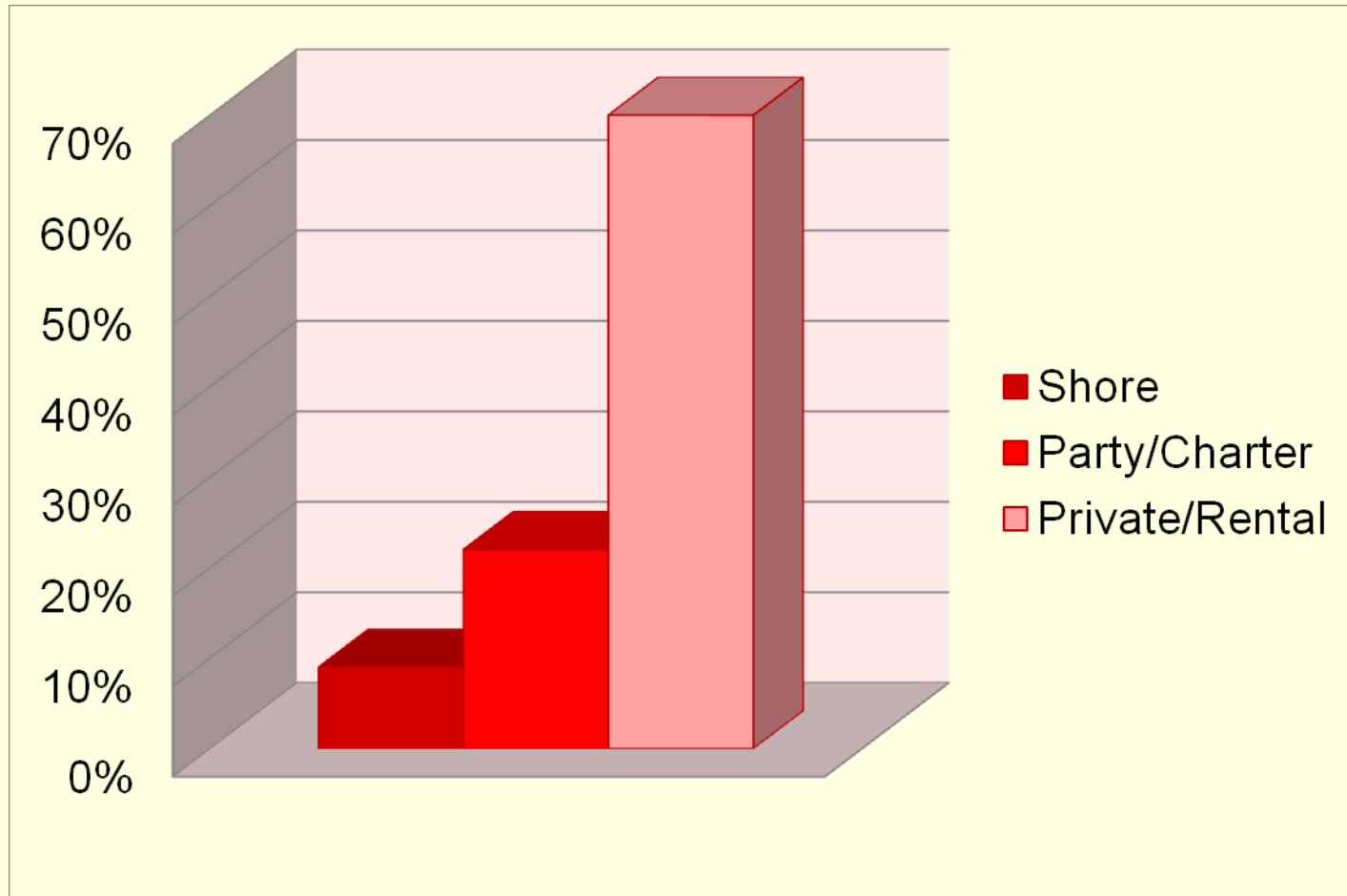


# MRFSS 2000 Add-on

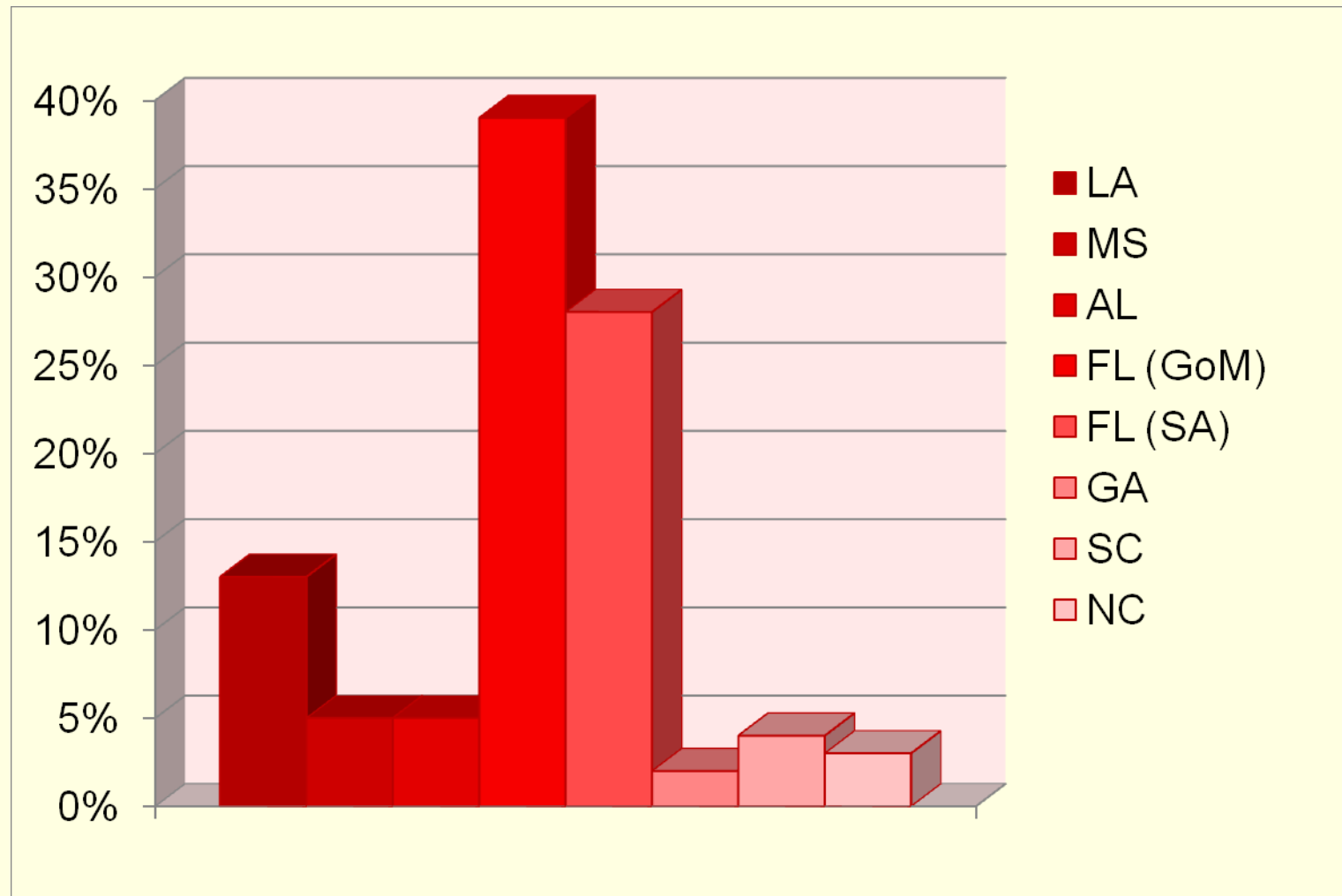
- LA to NC
  - n = 70,781
- Southeast 2000 (Limited Valuation Round)
  - n = 42,079
- Hook and line trips only (99%), day trips only (67%) [self-reported and < 200 miles one-way distance], delete missing values on key variables (28% PRIM1 is missing)
  - n = 18,709
- Targets a species
  - n=11,257



# Fishing mode



# State of intercept



# Species

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- 425 unique species caught by recreational anglers sampled by the MRFSS
- 15 species account for 82% of the targeting activity and 38% of the (type 1) catch

# Four sets of demand models

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- Gulf of Mexico Reef Fish ( $n = 1086$ )
  - “Snappers”
  - Shallow water groupers
  - Red snapper
- Florida Atlantic Big Game: Dolphin, big game ( $n = 823$ )
- Inshore small game: Red drum, spotted seatrout, small game ( $n=4353$ )
- Offshore small game: King mackerel, spanish mackerel, small game ( $n = 1531$ )

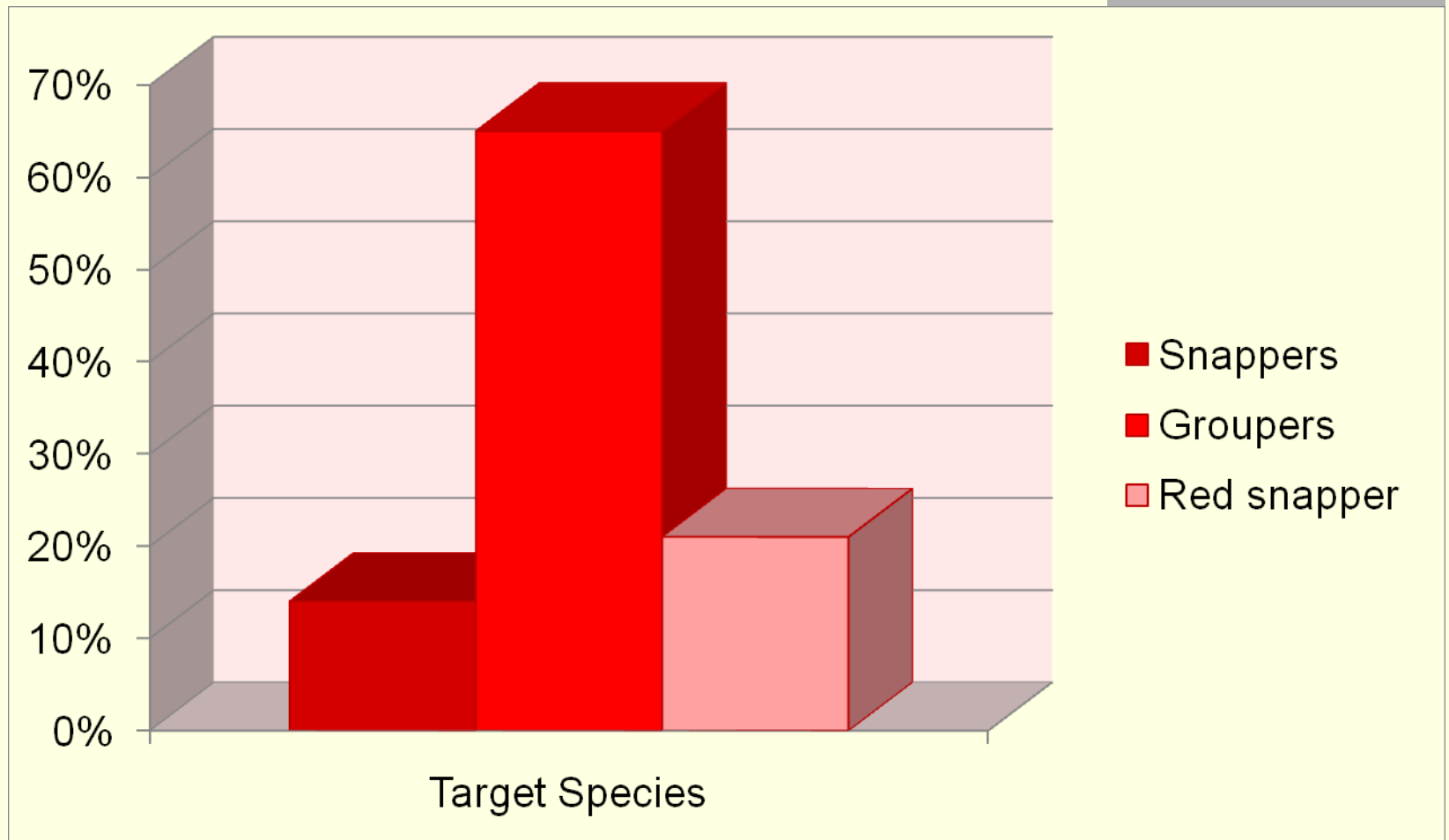


# Red Snapper Model

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# Target Species



# Target species (groups)

## Snappers (n=122)

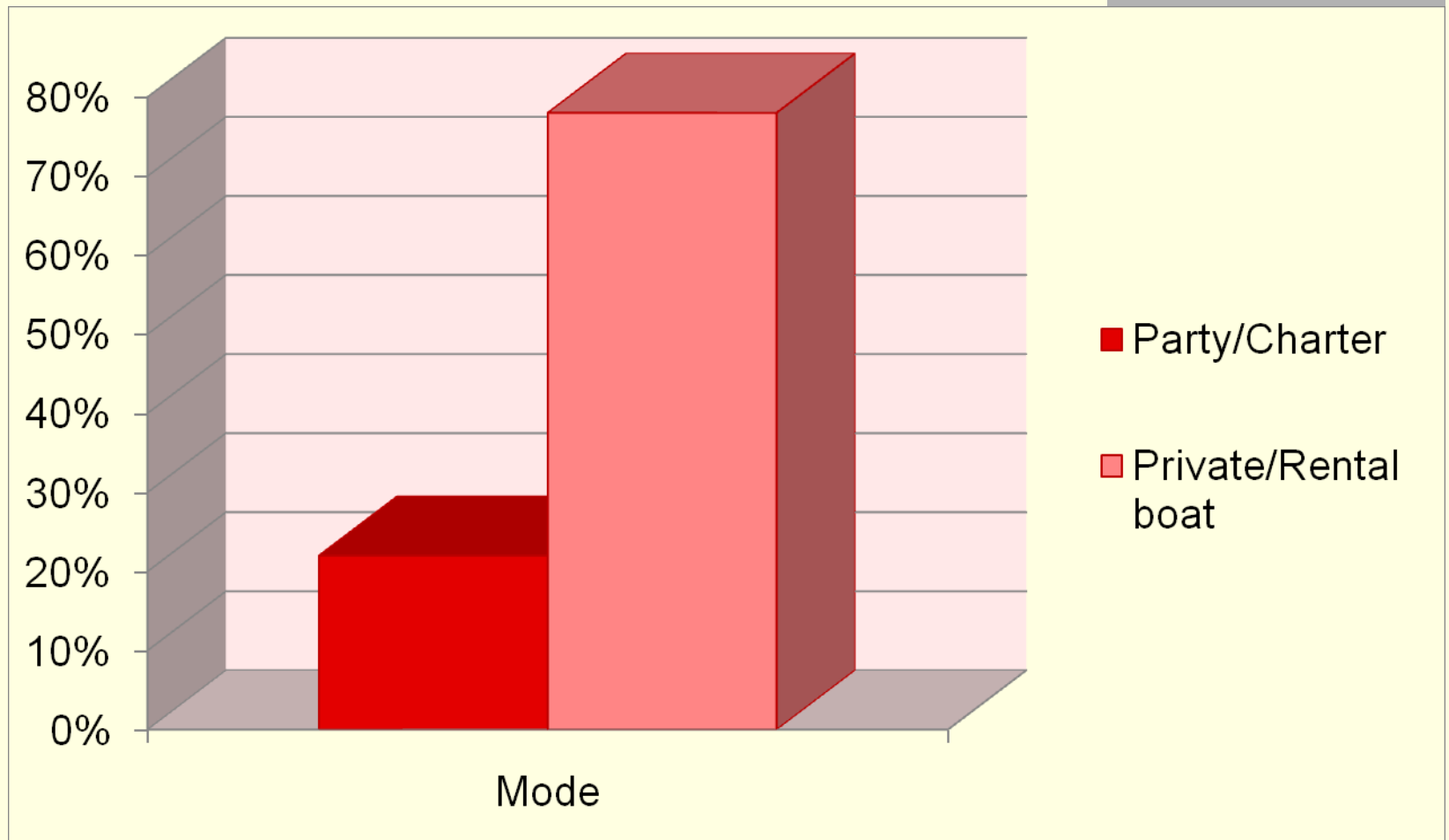
|                    |        |
|--------------------|--------|
| gray snapper       | 48.13% |
| sheepshead         | 23.75% |
| white grunt        | 11.88% |
| black sea bass     | 3.75%  |
| crevalle jack      | 3.75%  |
| amberjack genus    | 1.88%  |
| gray triggerfish   | 1.88%  |
| snapper family     | 1.25%  |
| yellowtail snapper | 1.25%  |
| atlantic spadefish | 0.63%  |
| blackfin snapper   | 0.63%  |
| blue runner        | 0.63%  |
| vermillion snapper | 0.63%  |

## Groupers (n=725)

|                               |        |
|-------------------------------|--------|
| unidentified grouper          | 73.38% |
| gag                           | 17.38% |
| red grouper                   | 6.07%  |
| grouper genus<br>Mycteroperca | 2.9%   |
| black grouper                 | 0.28%  |

## Red Snapper (n=239)

# Mode



# Mode-Species Choice Frequencies

| Mode           | Target      | Frequency |
|----------------|-------------|-----------|
| Party/charter  | Snappers    | 14        |
| Party/charter  | Groupers    | 150       |
| Party/charter  | Red snapper | 84        |
| Private/rental | Snappers    | 108       |
| Private/rental | Groupers    | 575       |
| Private/rental | Red snapper | 155       |

# Variables

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- 71 Species/Mode/Site choices
- Travel cost
  - [party/charter] TC = charter fee + driving costs + time costs
  - [private/rental] TC = driving costs + time costs
- Quality
  - 5-year historic (type 1) targeted catch rate
- Number of MRFSS interview sites in the county

# Model Performance

$$RMSE = \frac{\sqrt{\sum_{i=1}^K (S_i^p - S_i^a)^2}}{K}$$

Table 6. Root Mean Square Error

|                                   | Conditional<br>Logit | Nested<br>Logit | Mixed<br>Logit <sup>a</sup> | Finite Mixture<br>Model |
|-----------------------------------|----------------------|-----------------|-----------------------------|-------------------------|
| Dolphin and Big Game <sup>d</sup> | 0.0537               | 0.0508          | 0.0233                      | 0.0188                  |
| Mackerel and Small Game           | 0.0106               | 0.0106          | 0.0105                      | 0.0098                  |
| Red Drum and Seatrout             | 0.0088               | 0.0088          | 0.0087                      | 0.0088                  |
| Snapper-Grouper                   | 0.0187               | 0.0160          | 0.0176                      | 0.0134                  |

<sup>a</sup>Normal Distribution

Table 5. Snapper-Grouper Logit Models

|                  | Conditional<br>Logit | Nested<br>Logit | Mixed Logit |         | Finite Mixture<br>Model |        |
|------------------|----------------------|-----------------|-------------|---------|-------------------------|--------|
|                  |                      |                 | Normal      | Uniform | Tier 1                  | Tier 2 |
| Travel cost      | -0.04                | -0.1            | -0.04       | -0.08   | -0.02                   | -0.34  |
|                  | -29.91               | -26.91          | -40.00      | -20.25  | -15.57                  | -11.33 |
| SD (Travel cost) |                      |                 | -0.01       | 0.08    |                         |        |
|                  |                      |                 | -5.00       | 11.00   |                         |        |
| Snappers         | 0.89                 | 0.83            | 0.88        | 0.88    | 0.22                    | 0.95   |
|                  | 10.21                | 8.71            | 6.62        | 6.03    | 4.41                    | 5.93   |
| Grouper          | 3.27                 | 3.11            | 3.02        | 2.22    | 2.25                    | 13.90  |
|                  | 27.41                | 15.83           | 21.40       | 12.12   | 18.78                   | 13.05  |
| Red snapper      | 4.43                 | 3.82            | 4.59        | 4.85    | 2.71                    | 3.71   |
|                  | 21.76                | 13.93           | 23.09       | 24.39   | 14.64                   | 7.57   |
| Ln(Sites)        | 0.98                 | 0.72            | 0.914       | 0.924   | 1.65                    | -0.25  |
|                  | 17.02                | 11.76           | 17.92       | 17.43   | 14.96                   | -1.70  |
| Inclusive value  |                      | 0.14            |             |         |                         |        |
|                  |                      | 14.79           |             |         |                         |        |

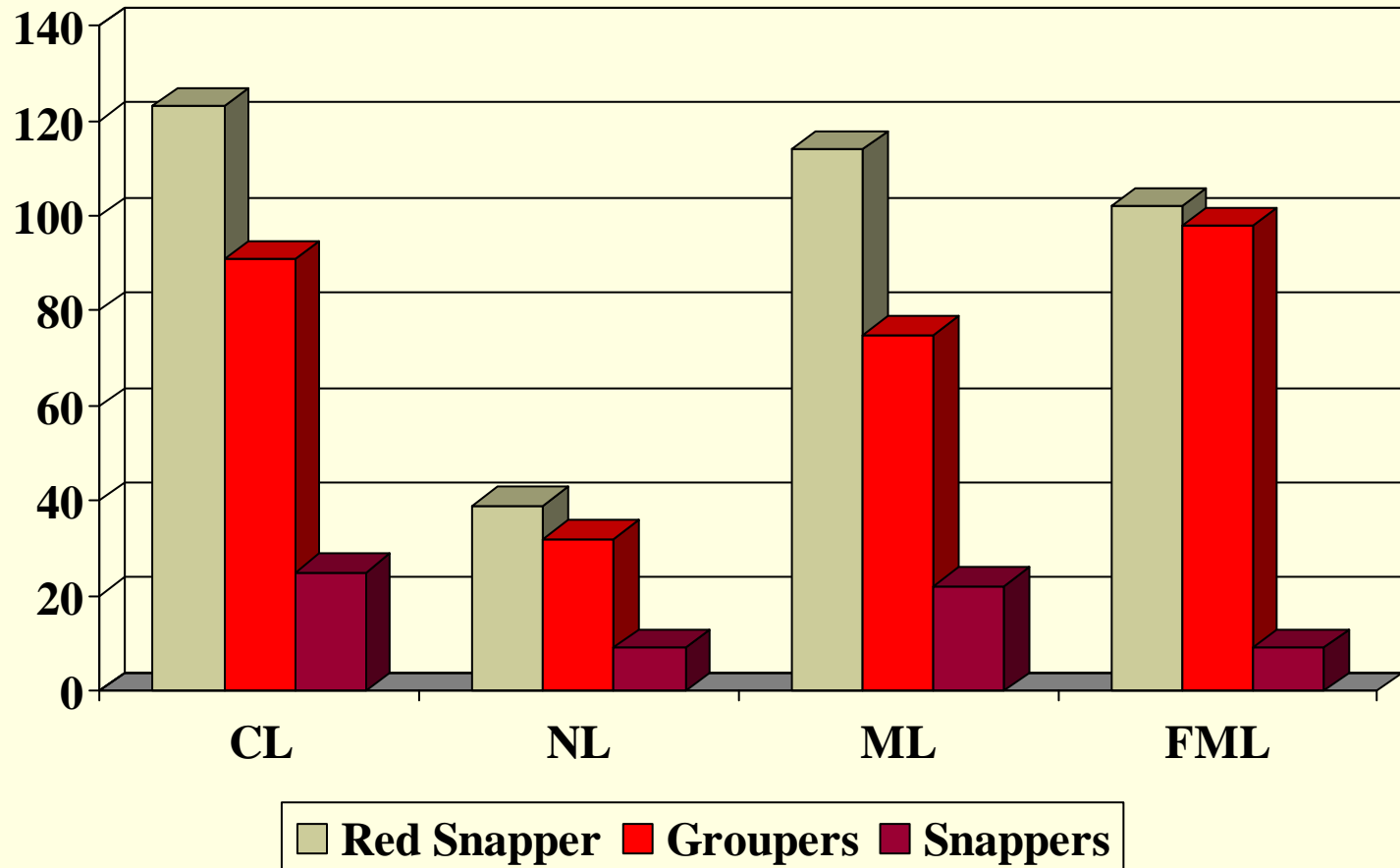


# Willingness-to-pay

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$$WTP(\Delta q \mid ni) = \frac{\beta_q \Delta q}{\alpha}$$

# Snapper-Grouper WTP



# Mixed Logit: Distribution of WTP

**Table 4-8. Willingness-to-Pay for one additional fish caught and kept: Snapper-Grouper**  
Mixed Logit (Travel Cost Parameter Randomly Distributed)

|             | 5 <sup>th</sup> Percentile | Normal<br>Mean         | 95 <sup>th</sup><br>Percentile | 5 <sup>th</sup><br>Percentile | Uniform<br>Mean     | 95 <sup>th</sup><br>Percentile |
|-------------|----------------------------|------------------------|--------------------------------|-------------------------------|---------------------|--------------------------------|
|             | 5th                        | 50th                   | 95th                           | 5th                           | 50th                | 95th                           |
| Snapper     | \$14.61                    | \$21.96<br>(15, 29)    | \$43.37                        | \$5.79                        | \$10.82<br>(7, 15)  | \$74.51                        |
| Grouper     | \$50.05                    | \$74.95<br>(66, 85)    | \$148.58                       | \$14.68                       | \$27.36<br>(22, 33) | \$188.94                       |
| Red Snapper | \$76.20                    | \$114.28<br>(103, 127) | \$226.23                       | \$32.13                       | \$56.51<br>(50, 64) | \$413.46                       |

(95% Krinsky-Robb Confidence Intervals)

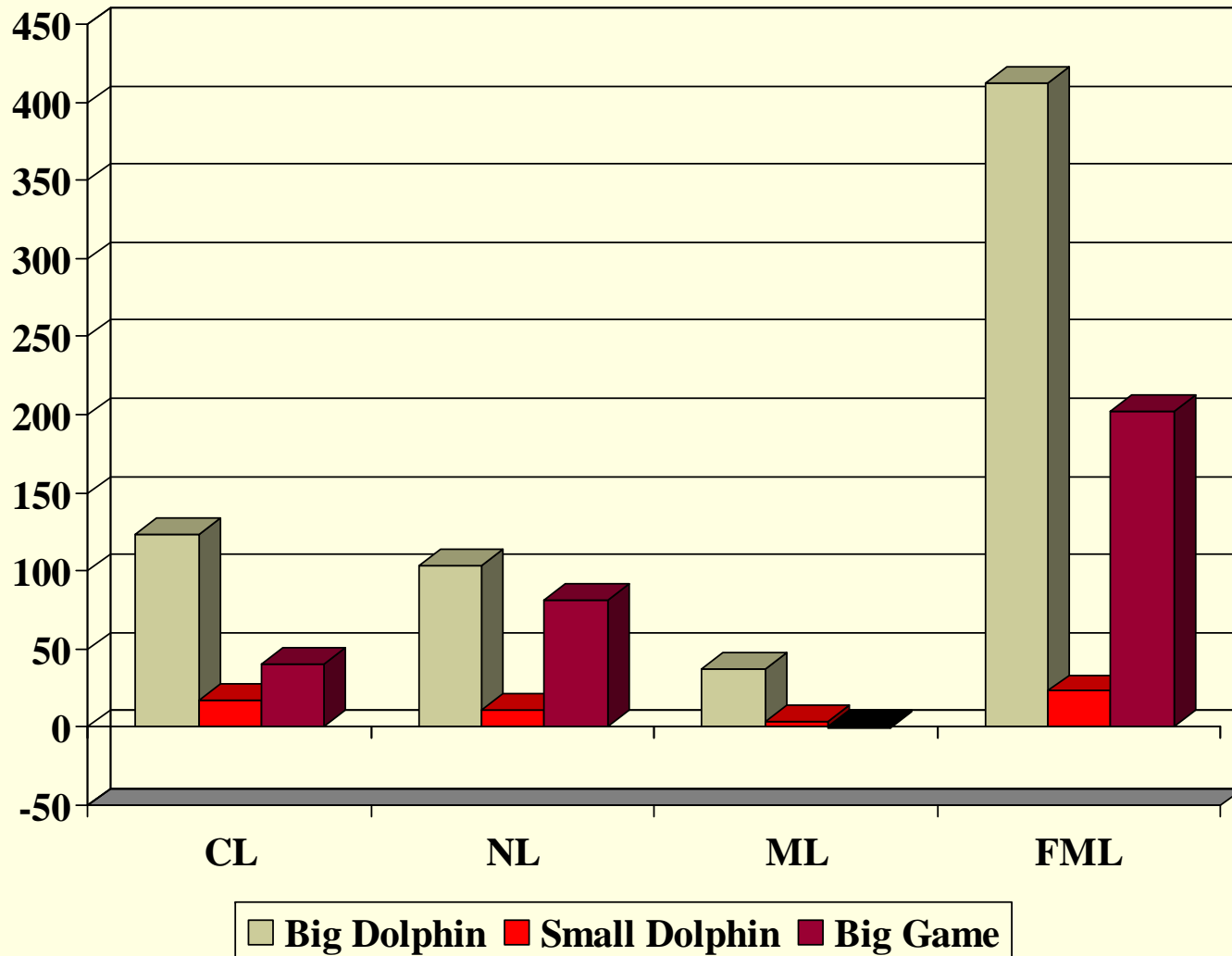
# FM Logit: Tier WTP

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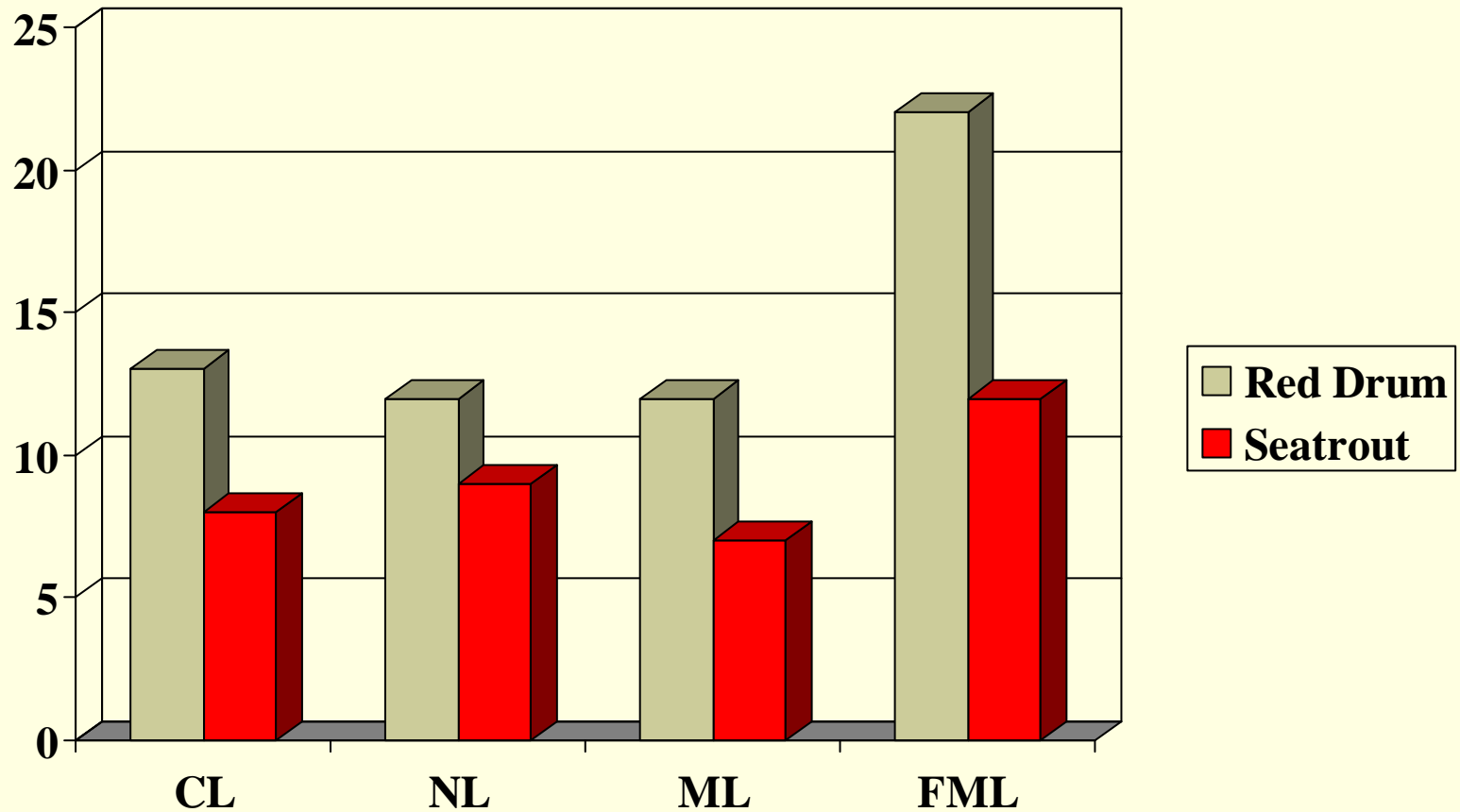
**Table 5-12. Tier-Specific Willingness-to-Pay for one additional fish caught and kept: Snapper-Grouper**

|             | Tier 1 | Tier 2 |
|-------------|--------|--------|
| Grouper     | 136.15 | 40.65  |
| Snapper     | 13.55  | 2.79   |
| Red Snapper | 164.14 | 10.85  |
| Probability | 0.5996 | 0.4004 |

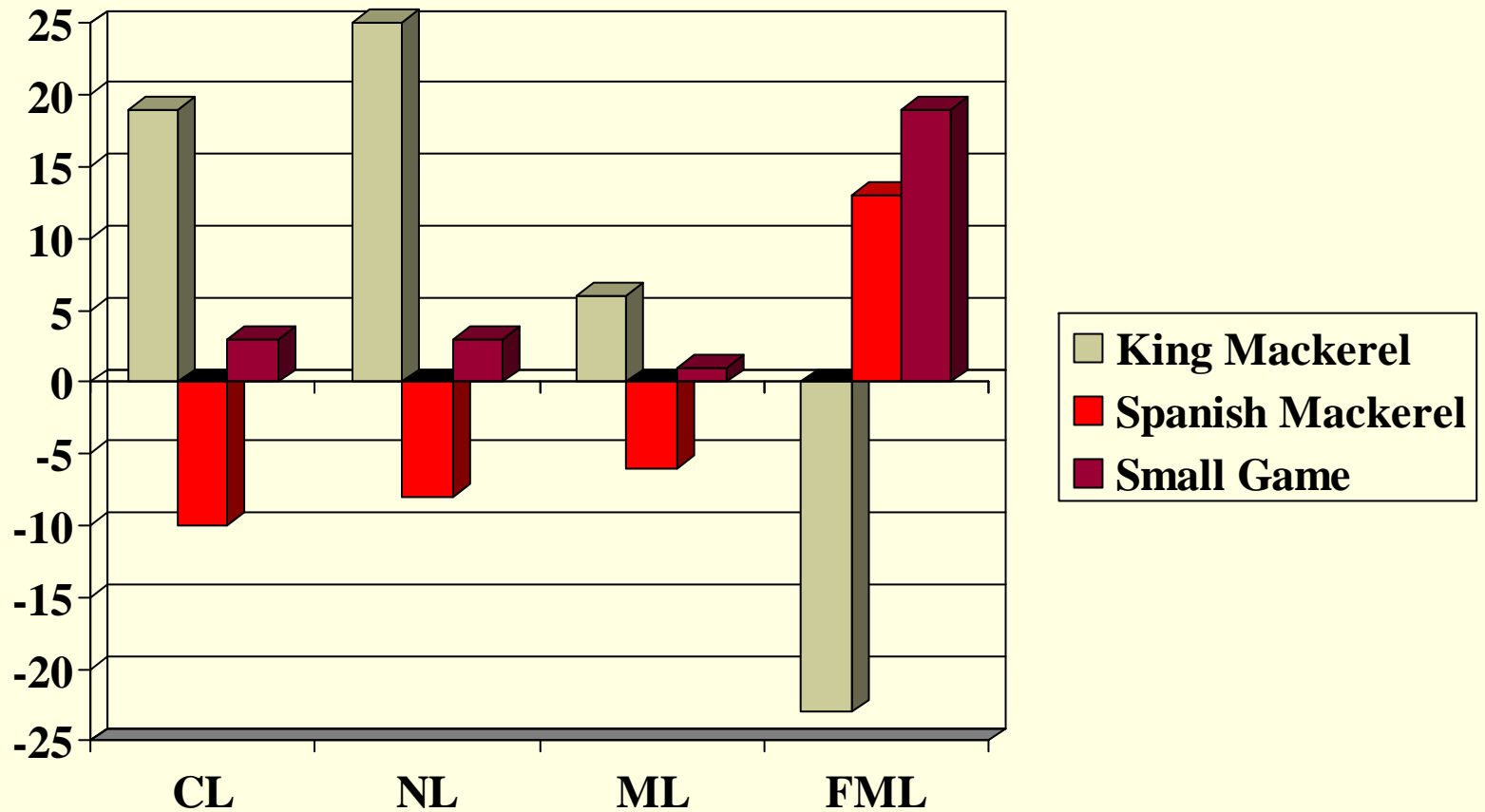
# Dolphin Model Willingness-to-pay



# Red Drum Model WTP



# Mackerel Model WTP



# Conclusions

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- MRFSS supports only a few single species
- Models with preference heterogeneity statistically outperform baseline models
- Preference heterogeneity tends to raise WTP
- Preference heterogeneity models outperform standard models statistically based on a single criterion



# Policy?

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- The recreational value per catch should be conducted with the best estimate available, in the \$102-\$123 range.
- If the results indicate that more catch should be allocated to the recreational sector then the lower nested logit value, \$39, could be used in sensitivity analysis.

# Future Research

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- MRFSS 1997
- MRFSS 2006