Incidental Mortality in Salmon Fisheries
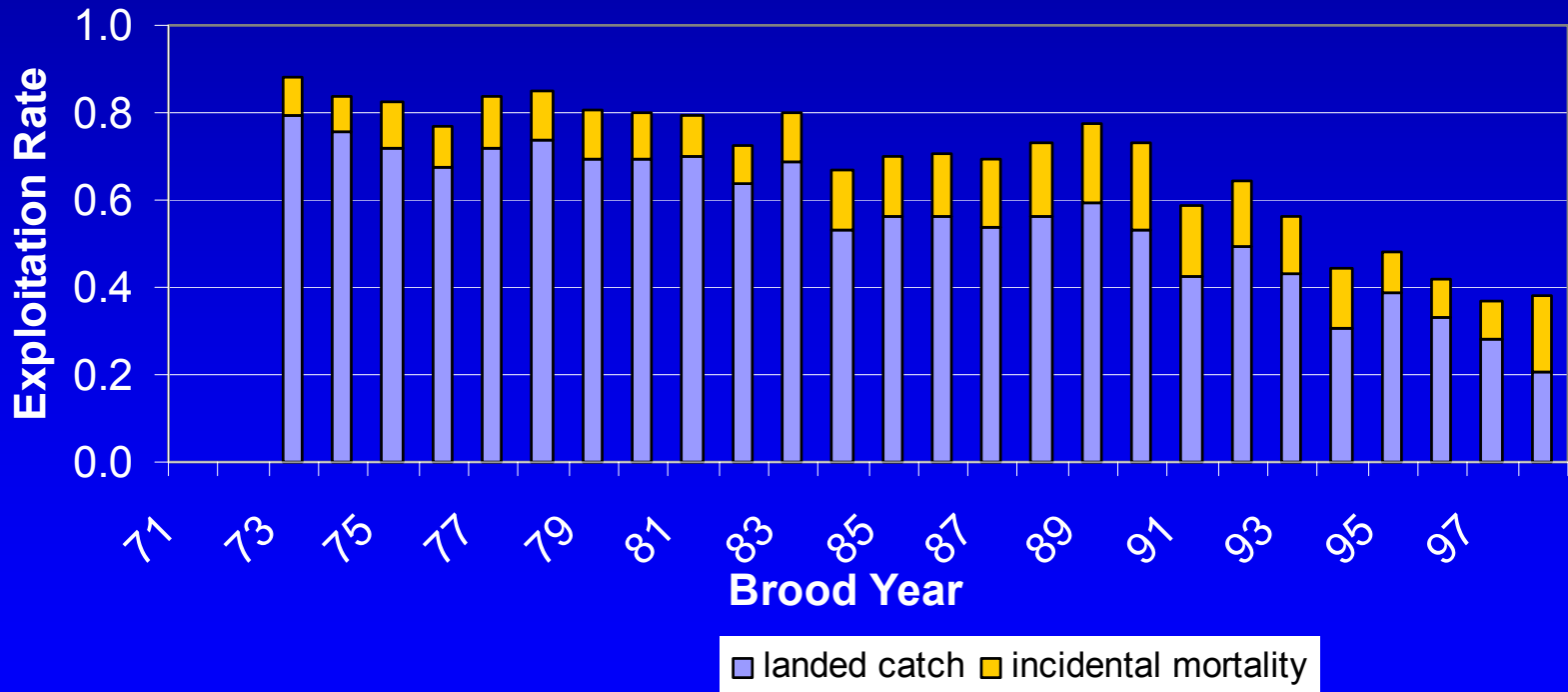
Robert Kope

Peter Lawson

National Marine Fisheries Service

Overview

- Why worry about incidental mortality?
- Components of incidental mortality
- Selective fisheries
- Calculation of incidental mortalities
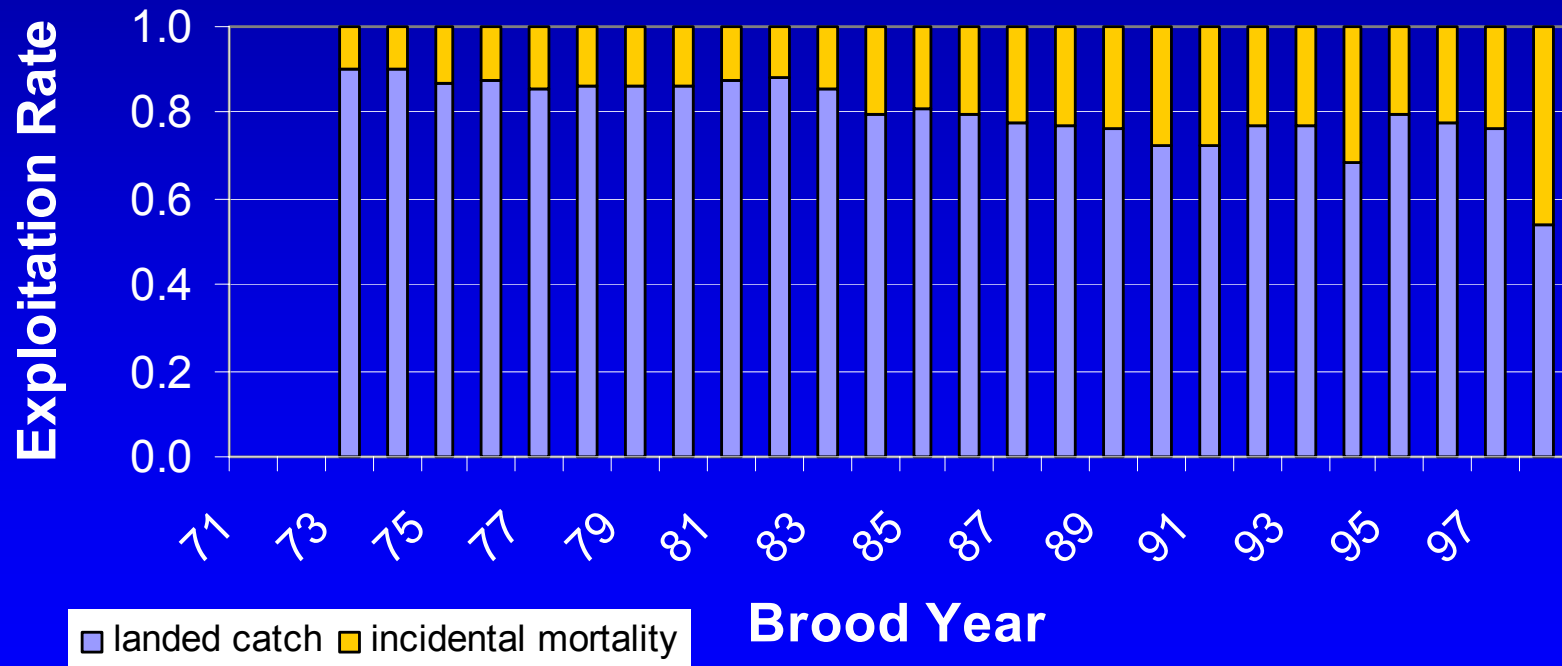- Rates used
- How well does all this work?

Why Worry?

Brood Year Total Exploitation Rate
Big Qualicum

Types of Incidental Mortality

- Release mortality
  - Immediate mortality
  - Delayed mortality
  - Long-term mortality
- Dropoff (dropout) mortality
  - Escaped fish that die
  - Fish removed by predators
- Discards in non-salmon fisheries
- Selective fisheries
  - Illegal retention
  - Mark recognition error

Parameters (what you need to know)

- M - number of marked fish
- U - number of unmarked fish
- α - drop off probability
- β - drop off mortality rate
- δ - hook and release mortality rate
- γ - mark recognition rate

Mortality flow-chart
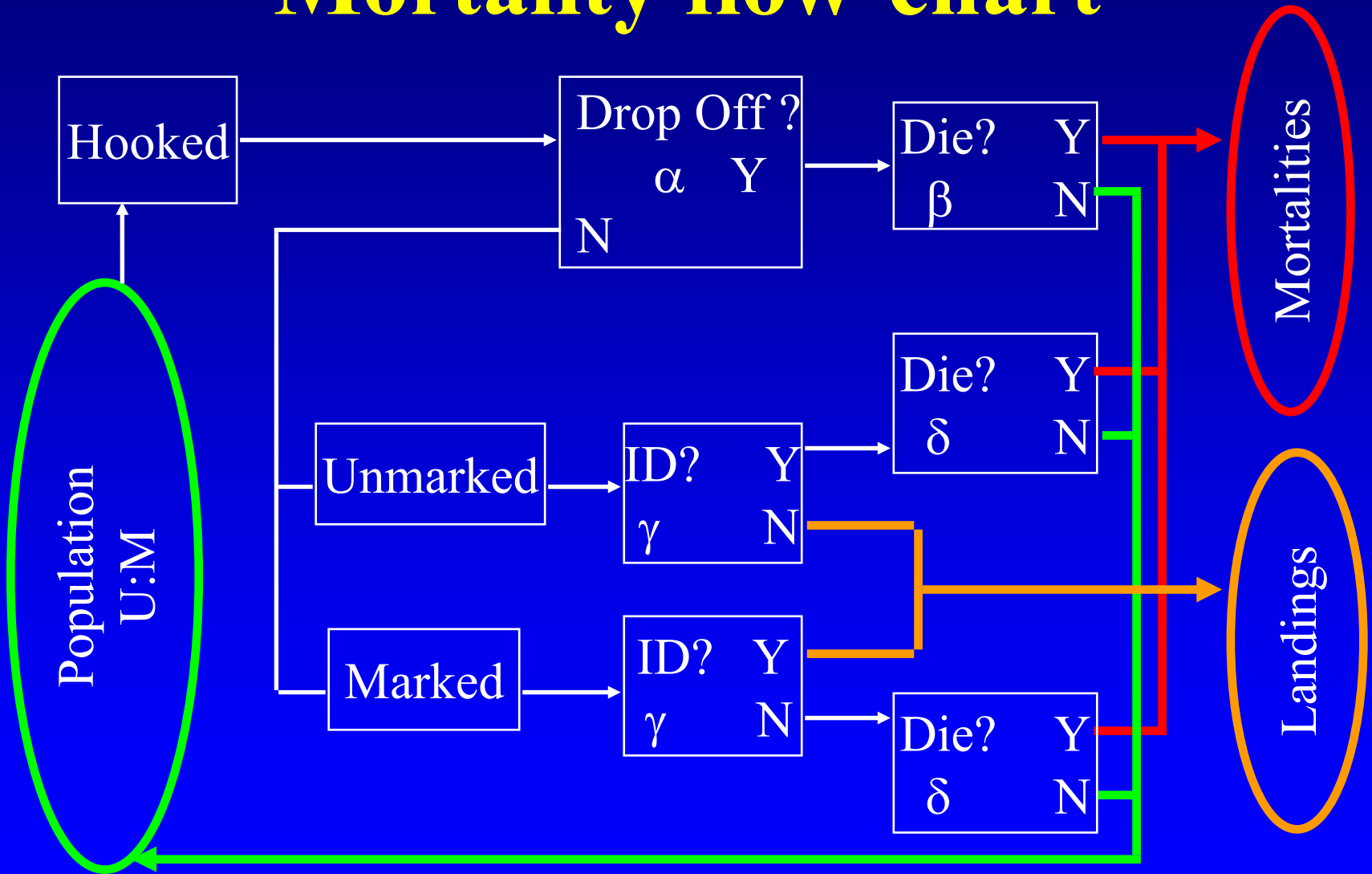
Traditional vs Selective Fisheries

- Traditional mixed-stock fisheries
  - all stocks encounter gear and suffer mortality at equal rates.

- Selective fisheries
  - stock composition and gear encounter rates change throughout the course of the fishery.

Unmarked Mortality Rate (μ) vs. Apparent Harvest Rate (H) at four Hook-and-Release Mortality Rates (δ).
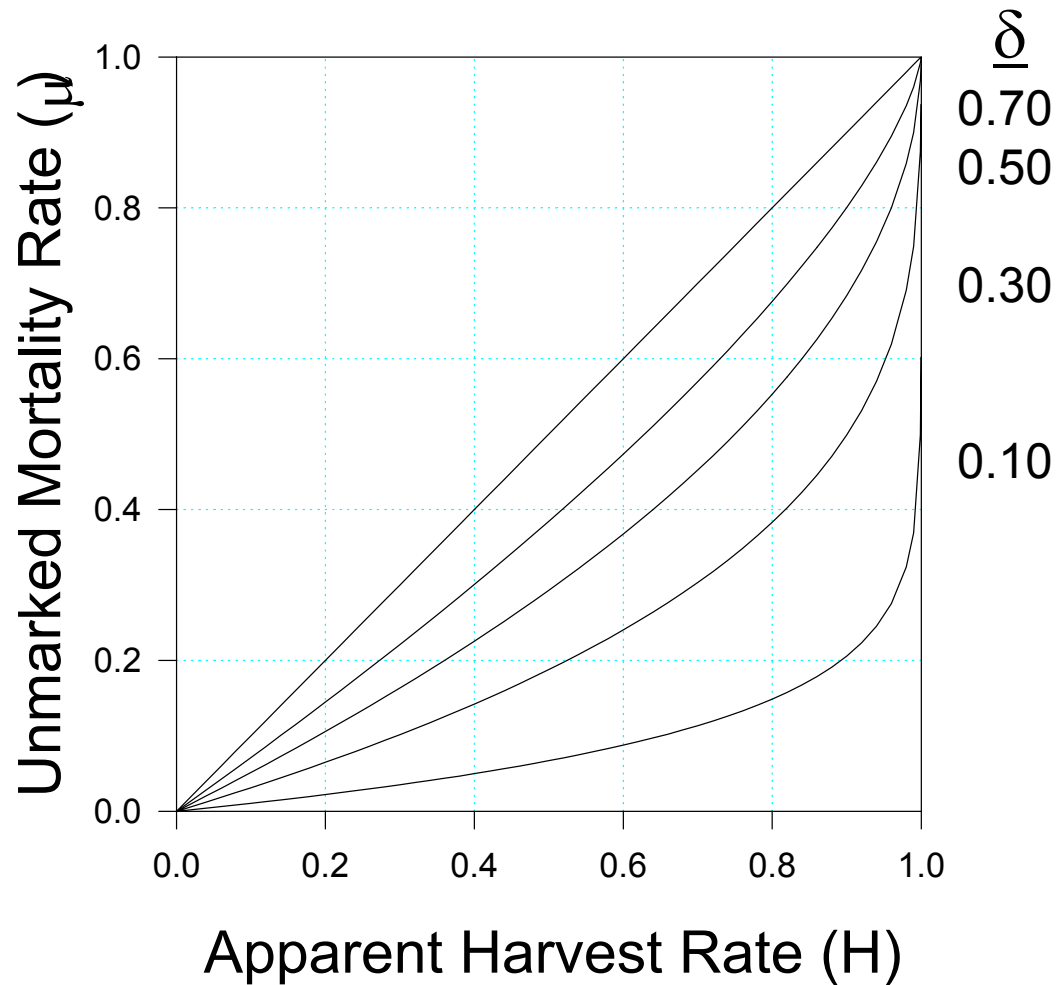
Unmarked Mortality Rate (μ) vs. Apparent Harvest Rate (H) at four Hook-and-Release Mortality Rates (δ).   U:M = 1:9
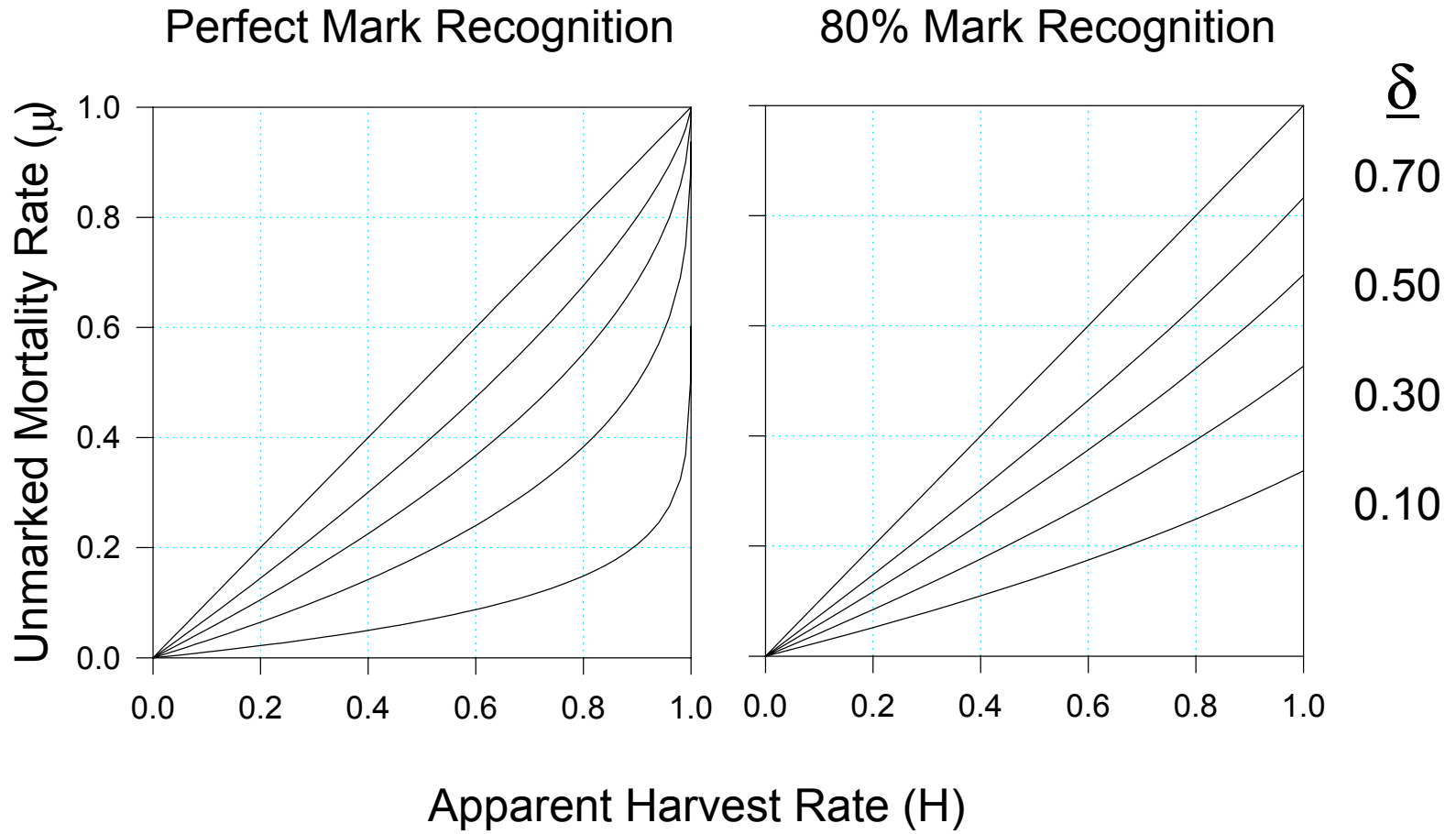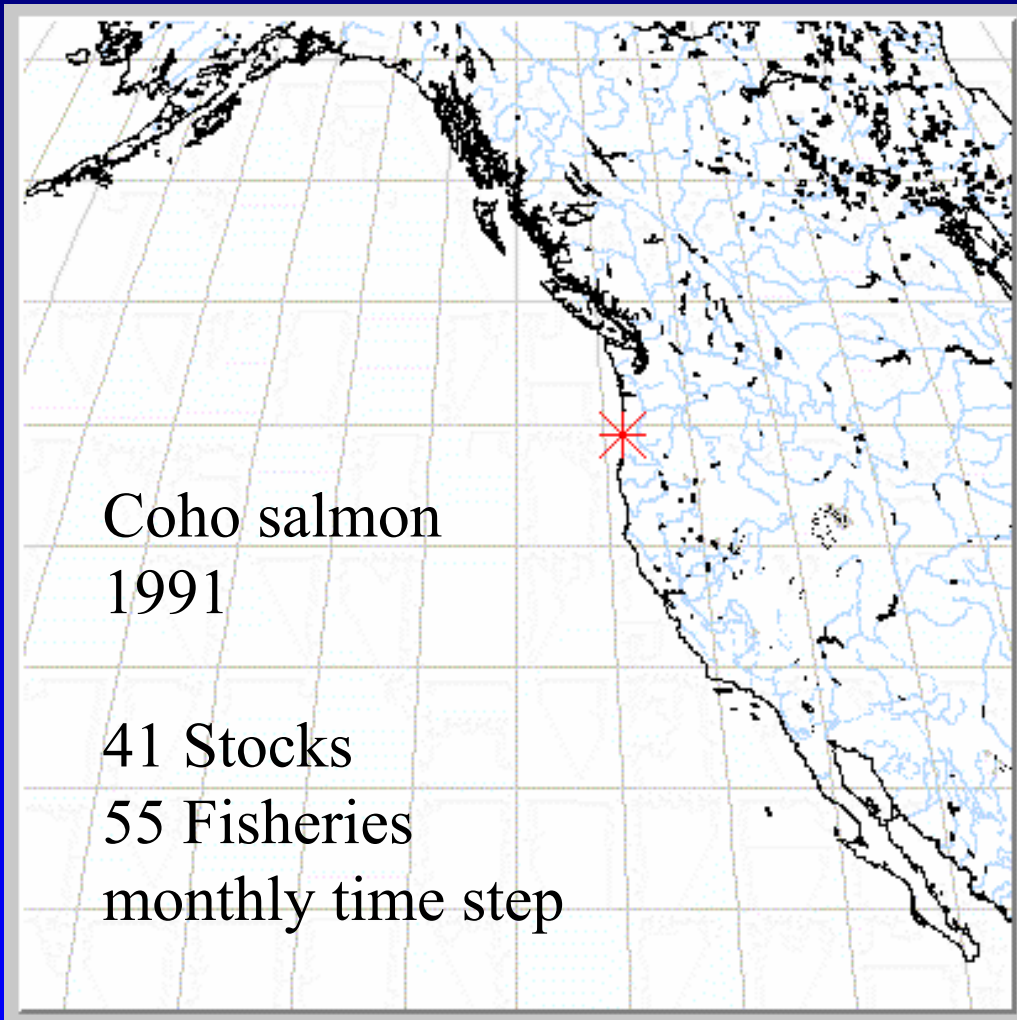
Coho salmon
1991

41 Stocks
55 Fisheries
monthly time step

Modeling Considerations

- Traditional models
  - single pool
  - mortality rates applied to entire stock in each time period
- Selective fisheries
  - use an exponential catch equation
    - Catch = N * e$^{(1-\text{Fishery mortality})}$
    - N = population vulnerable to gear (not single pool)

Data needs
if you're going this route

- Stock composition by fishery and time step
- Migration rates
  - Where in the ocean
  - When
  - By stock
- Mortality rates

Calculation of Incidental Mortalities

- Release mortality
  - Includes sublegal "shaker" and legal-sized non-retention or "CNR"
  - (Number of fish released)(release mortality rate)
- Dropoff mortality
  - (Number of fish encountering gear but not handled)(dropoff mortality rate)

Estimation of Dropoff Mortality

- Escapees
  - ???????

- Predator removals
  - Observation

Calculation of Release Mortality

- Shakers
  - Calculate ratio of sublegal to legal fish
  - Multiply by landed catch
  - Multiply by release mortality rate
  - Allocate based on computed stock/age composition of landed catch
- CNR
  - Compute or input CNR encounters
  - Multiply by release mortality rate
  - Allocate based on computed stock/age composition

Estimation of Release Mortality Rates

- Confinement studies
  - Onboard holding tanks
  - Broodstock tubes
  - Net pens
- Mark-recapture estimates
  - Enumeration
  - Differential recovery

Incidental mortality rates used for commercial chinook fisheries

		sublegal	legal	dropoff
CTC	Troll - AK	0.255	0.211	0.008
	Troll – BC	0.255	0.211	0.017
	Troll – OR,WA	0.220	0.185	0.025
	Net	0.9	0.9	0.0
STT	WA-CA	0.26	0.26	0.05
WDFW	Puget Sound-seine	0.45	0.33	

Incidental mortality rates used for recreational chinook fisheries

		sublegal	Legal	dropoff
CTC	AK-CBC	0.123	0.123	0.036
	SBC-Col R	0.123	0.123	0.069
	Puget Sound	0.123	0.123	0.145
STT	WA-N Cal	0.14	0.14	0.05
	Central CA	0.19	0.19	0.05
WDFW	Puget Sound	0.20	0.10	0.05

Incidental mortality rates used for commercial coho fisheries

		legal	dropoff
STT	WA-CA troll	0.26	0.05
DFO	BC troll	0.15-0.40	-
	BC gillnet	0.40-0.60	-
	BC seine	0.25-0.75	-

Incidental mortality rates used for recreational coho fisheries

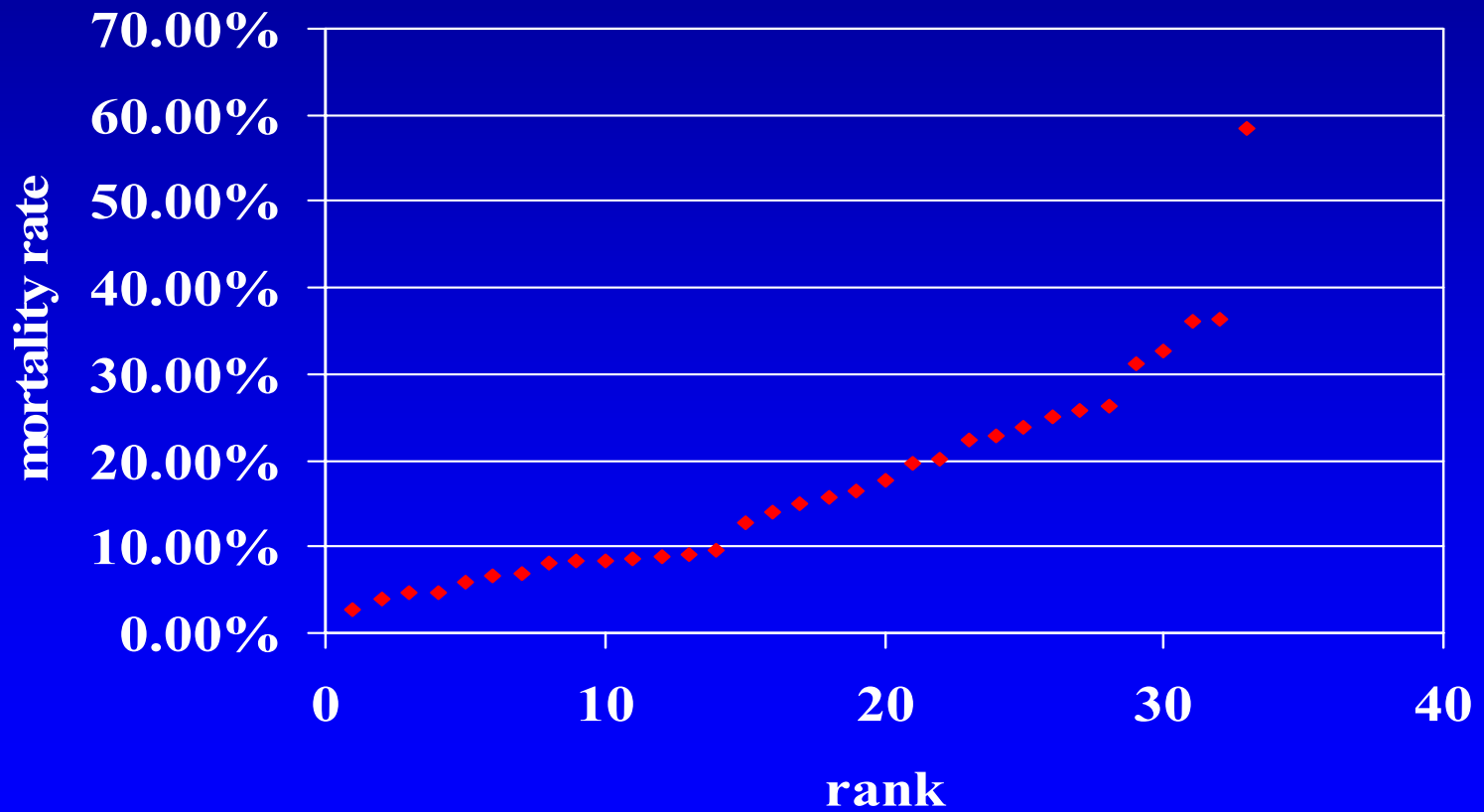|		legal	dropoff
STT	WA-CA	0.14	0.05
	Buoy 10	0.16	-
DFO	BC	0.10	-
WDFW	Puget Sound	0.07	0.05

So…….

How well does all this work?

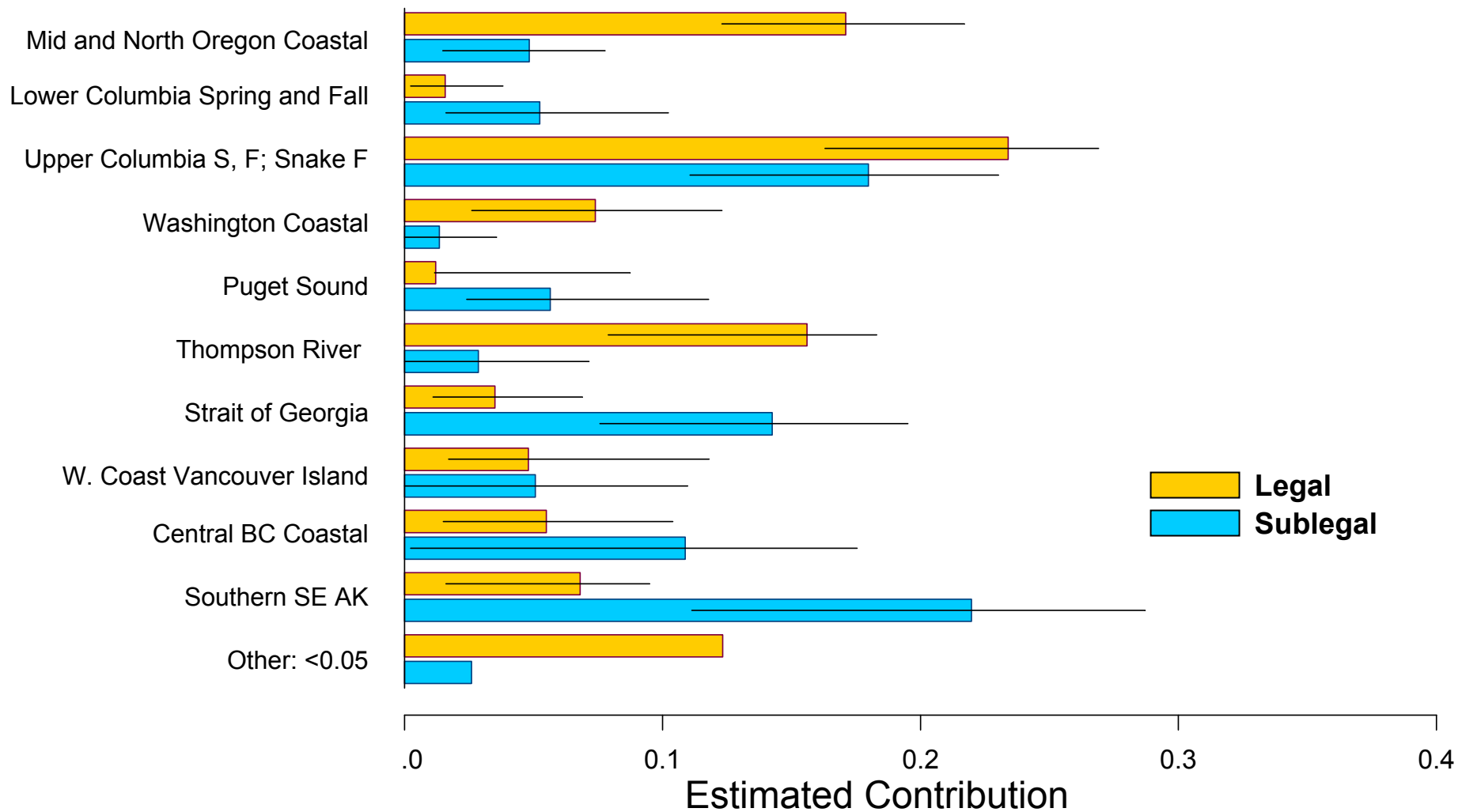# Confinement estimates of chinook marine recreational hooking mortality
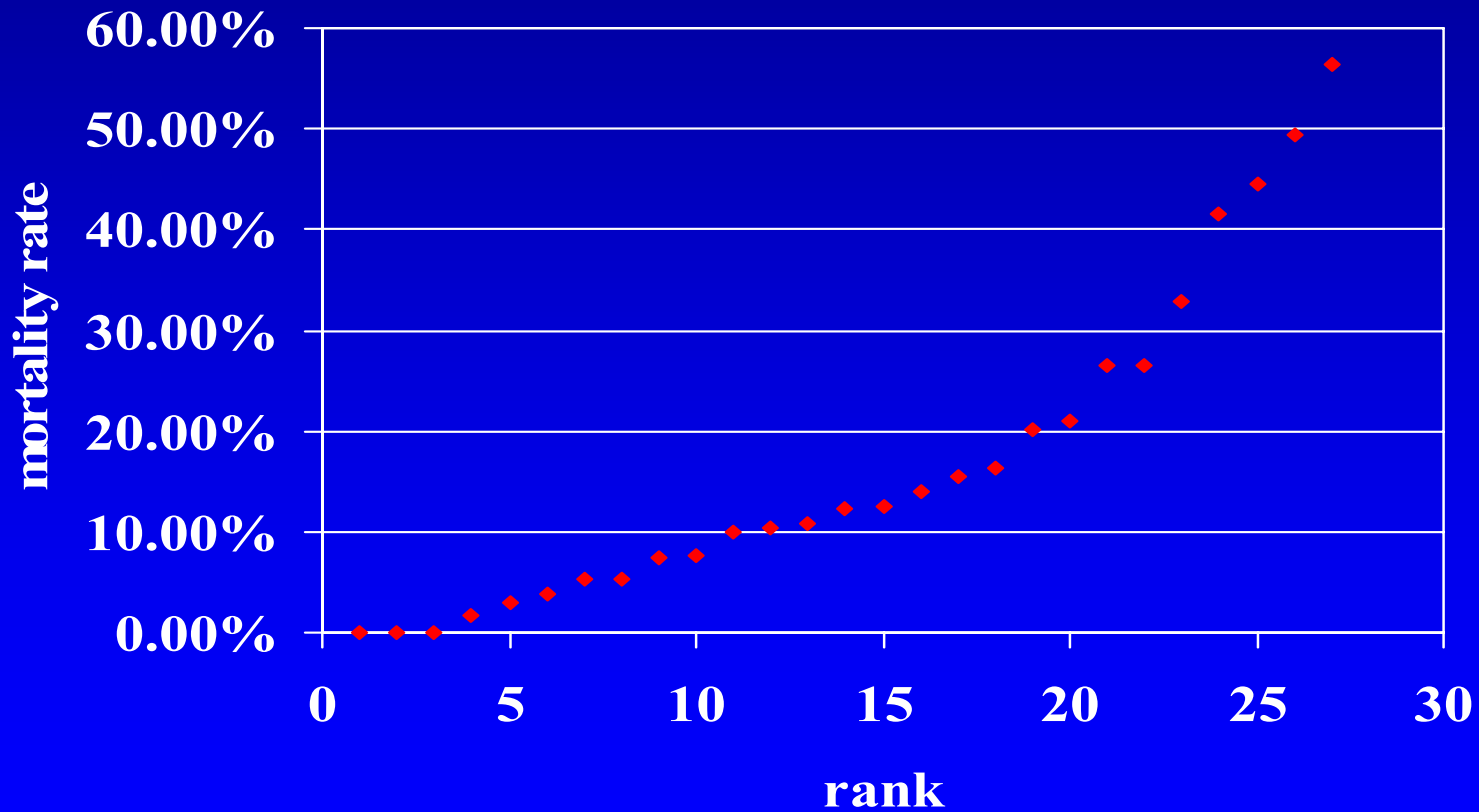
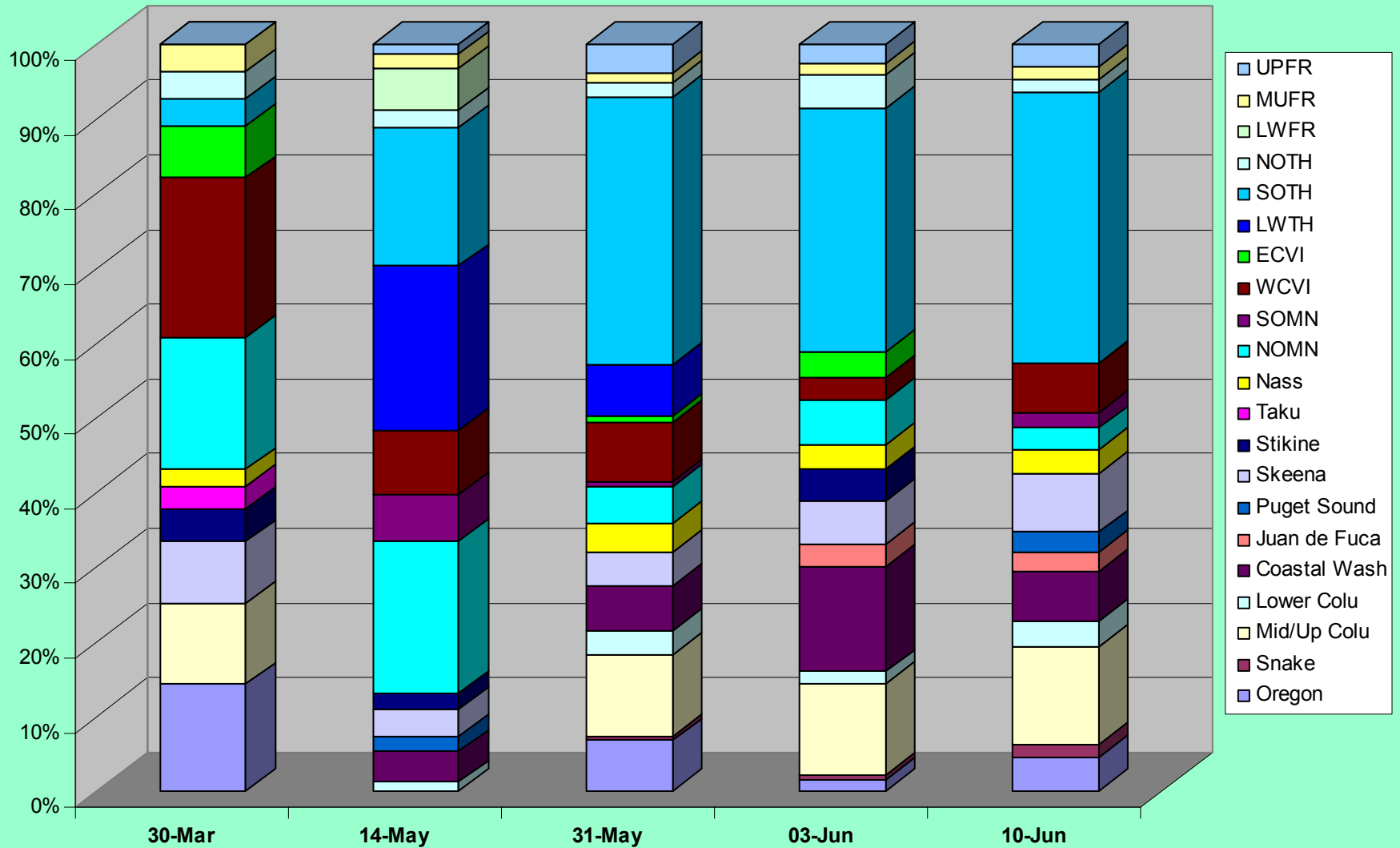# Confinement estimates of coho marine recreational hooking mortality

1999 SEAK Summer Fishery
Legal vs Sublegal

Mid and North Oregon Coastal

Lower Columbia Spring and Fall

Upper Columbia S, F; Snake F

Washington Coastal

Puget Sound

Thompson River

Strait of Georgia

W. Coast Vancouver Island

Central BC Coastal

Southern SE AK

Other: <0.05

Legal
Sublegal

.0   0.1   0.2   0.3   0.4

Estimated Contribution

Area 1 Troll (spring 2002)

Legend:
- UPFR
- MUFR
- LWFR
- NOTH
- SOTH
- LWTH
- ECVI
- WCVI
- SOMN
- NOMN
- Nass
- Taku
- Stikine
- Skeena
- Puget Sound
- Juan de Fuca
- Coastal Wash
- Lower Colu
- Mid/Up Colu
- Snake
- Oregon

X-axis categories: 30-Mar, 14-May, 31-May, 03-Jun, 10-Jun
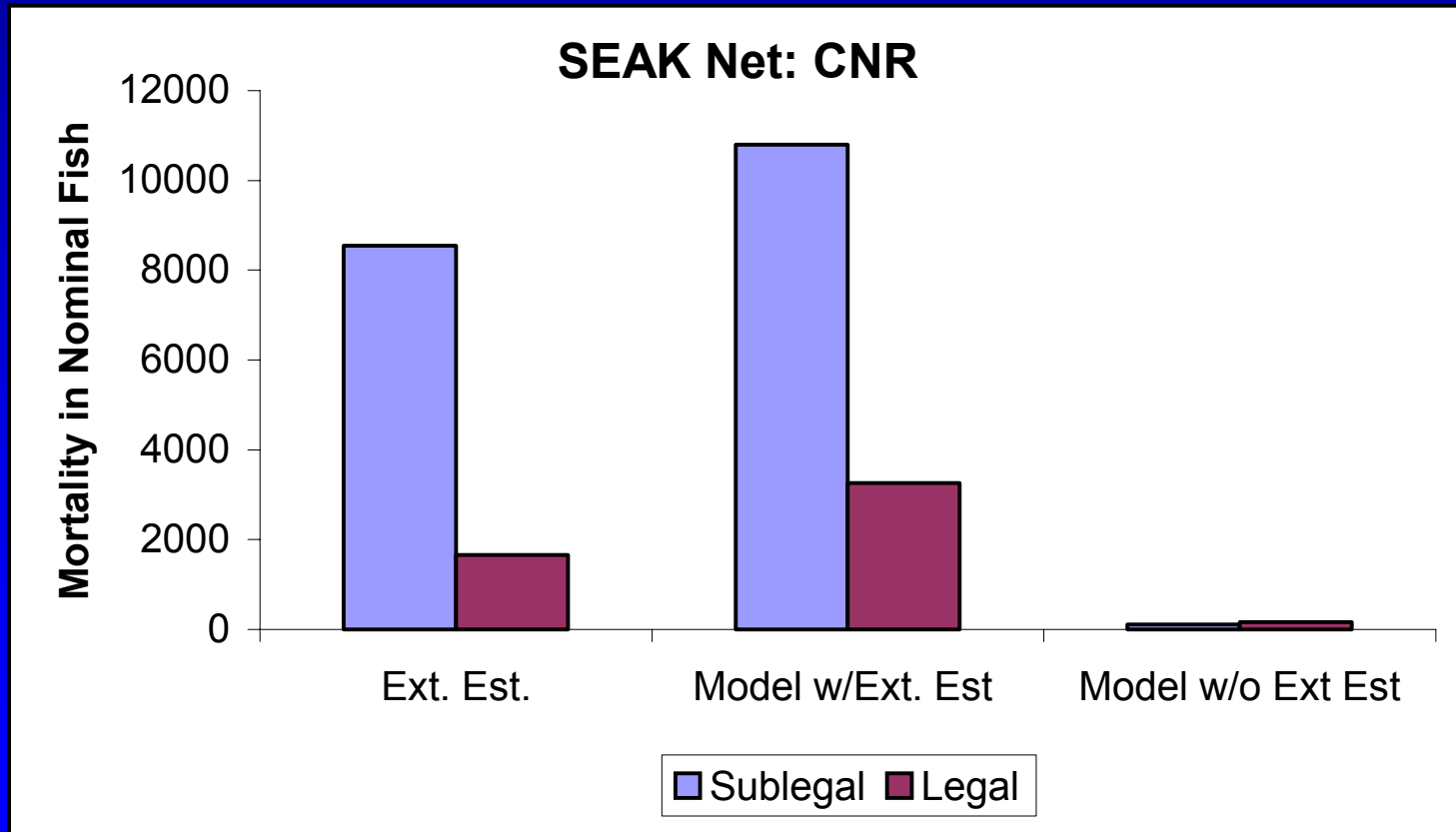
Mortality in the SEAK Troll CNR Fishery in 2001:

External Estimates, CTC Model Estimates Using External Estimates, and CTC Model Estimates Using Effort Data
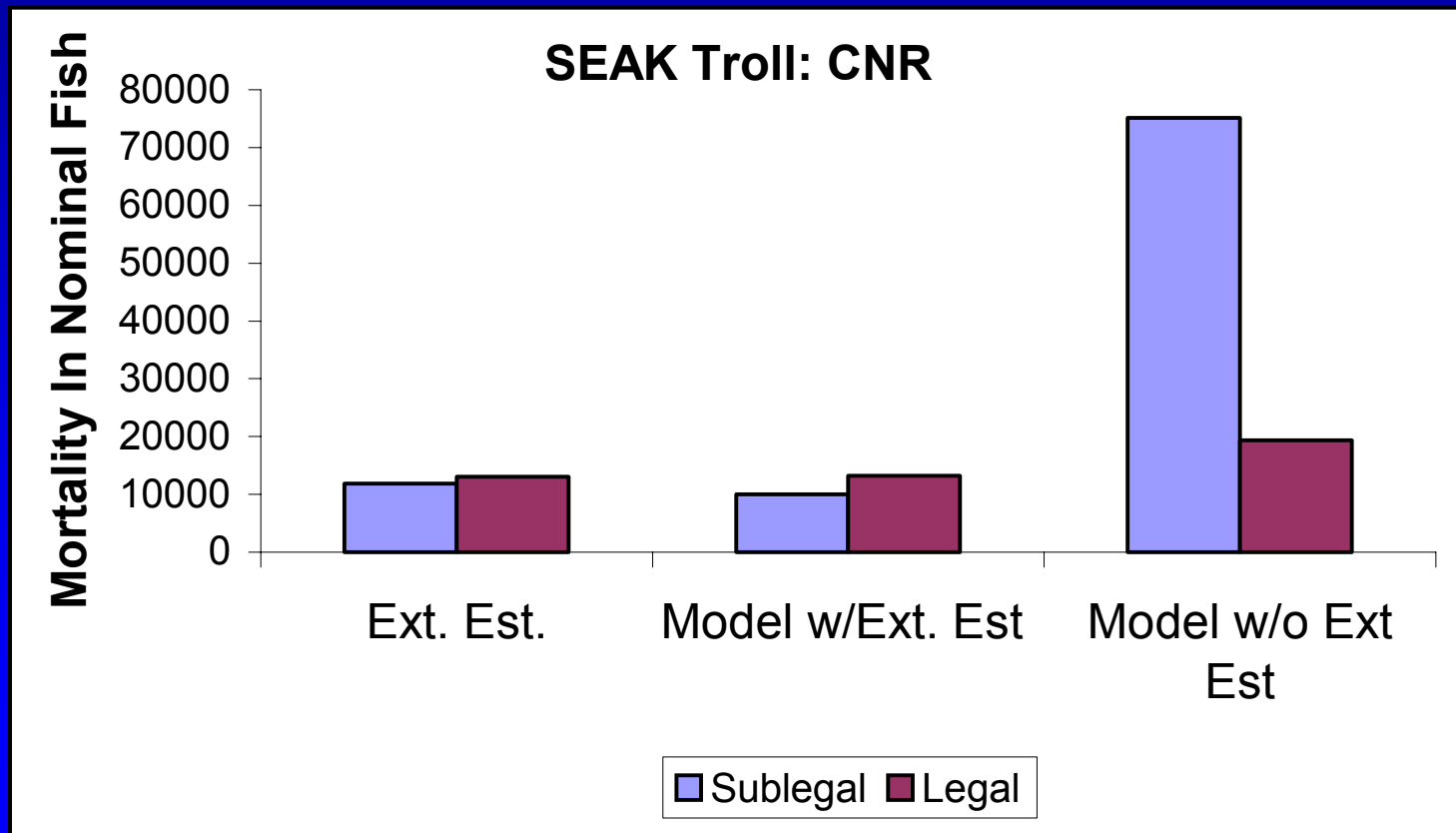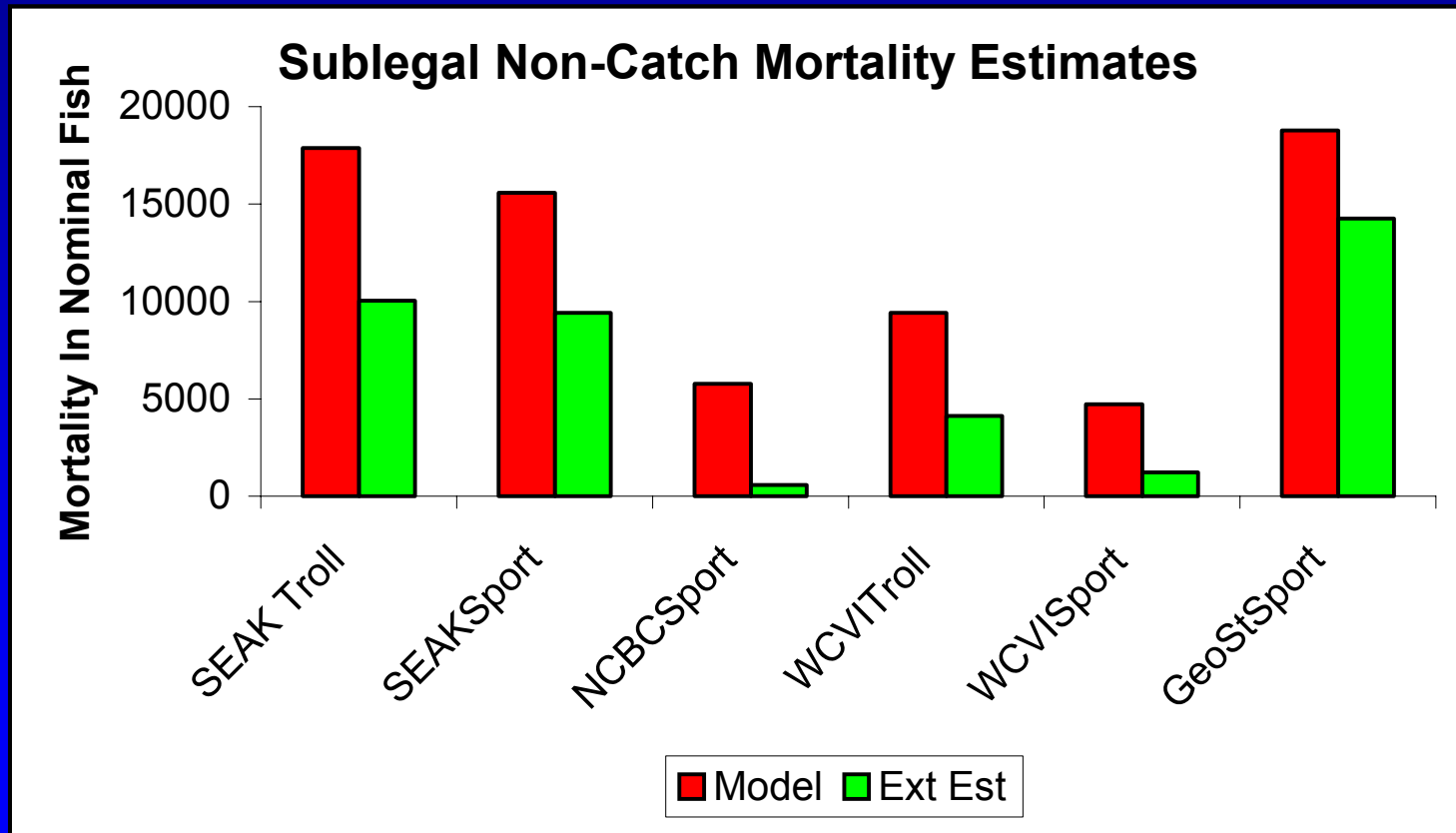
Mortality in the SEAK Net CNR Fishery in 2001:

External Estimates, CTC Model Estimates Using External Estimates, and CTC Model Estimates Using Effort Data
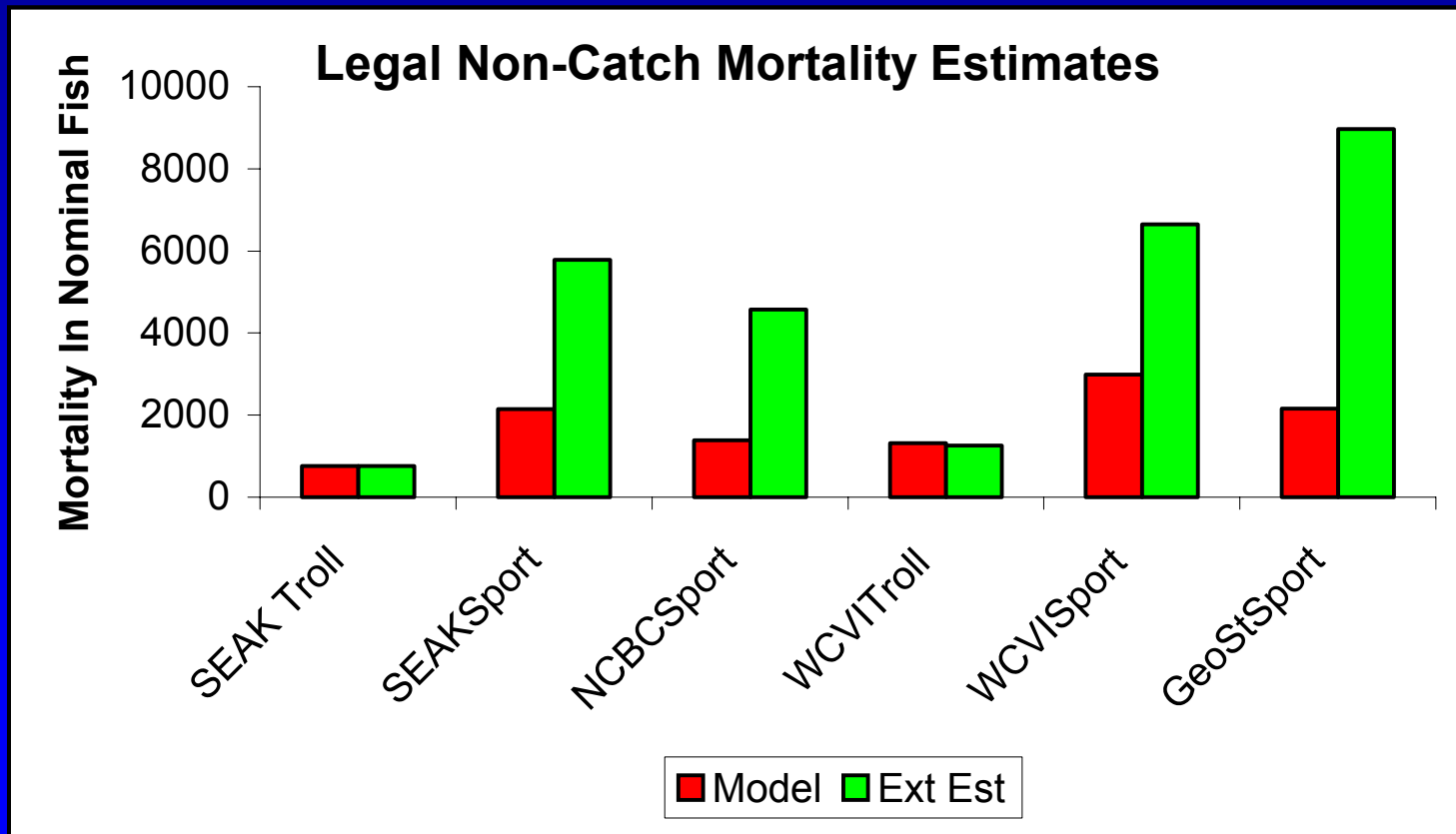
Non-Catch Mortality of Sublegal Chinook In Retention Fisheries in 2001:
Comparison of Model Estimates and External Estimates

Non-Catch Mortality of Legal Chinook In Retention Fisheries in 2001:
Comparison of Model Estimates and External Estimates

Can CWTs provide information on incidental mortality?

	CWT	GSI
Dropoff mortality	no	no
Encounter rates	no	no
Release mortality rates	maybe	no
Stock id of released fish	no	yes