

**The Feather River: A case history
illustrating the challenges of
monitoring salmonids on a large river**

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Feather River Study Elements

- Juvenile Salmonid Distribution and Abundance
 - Snorkel surveys
 - Electrofishing
 - Rotary screw traps
- Juvenile Steelhead Survival/Growth/Behavior
 - Mark-recapture (elastomer, PIT tags)
- Adult Salmonid Distribution and Abundance
 - Steelhead redd survey, creel survey
 - Hatchery counts
 - Salmon spawning carcass survey



Salmon Spawning Escapement Surveys

Two major activities...

1. Estimate spawning population by carcass mark-recapture
2. Sample for and recover Coded Wire Tags (CWTs)



Brief Overview:

Salmon Spawning Population Estimates Using Mark-Recapture Techniques

- River searched for salmon carcasses
- “Fresh” carcasses are given external tag
- Other carcasses are counted, checked for tags (from previous weeks’ surveys) and are then chopped in half.
 - Chopping ensures carcasses are not counted more than once.
- Total population estimate (N) is based on weekly data



Brief Overview: Salmon Spawning Population Estimates Using Mark-Recapture Techniques

A simplified example...

$N = \text{Carcasses Sampled} / \text{Recovery Rate}$

If 1000 carcasses are counted and we have a 50% recovery rate of tagged carcasses, then $N = 2000$

Recovery rate *should* be a measure of the proportion of the population sampled



Comparison of Carcass Mark-Recapture to Typical Mark Recapture Study



Normal Mark Recapture Study

Animals alive

Mixing: Yes

Animal encounters:
Somewhat random

Potential observer
bias: Moderate



Carcass Mark Recapture Study

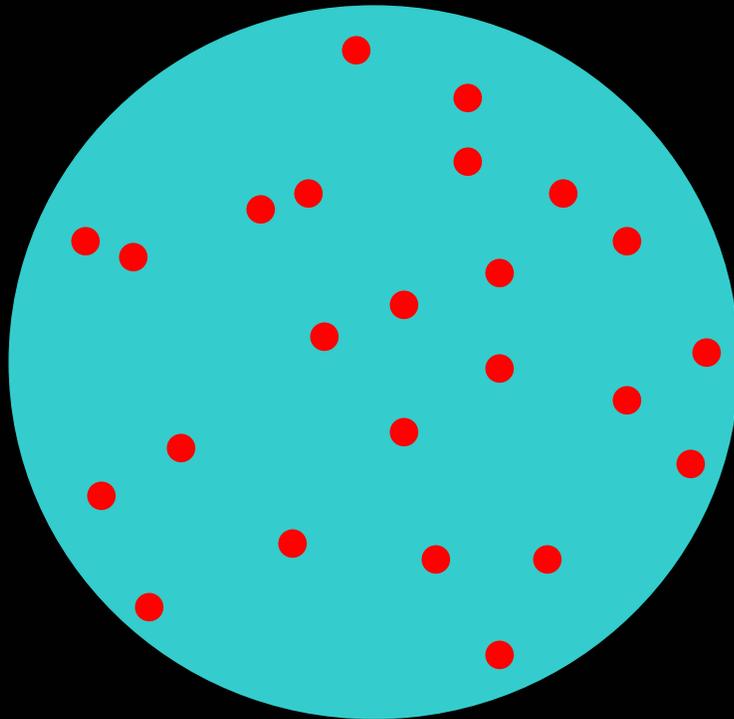
Animals dead

Mixing: Not really

Animal encounters:
Haphazard, Selective

Potential observer
bias: Very High

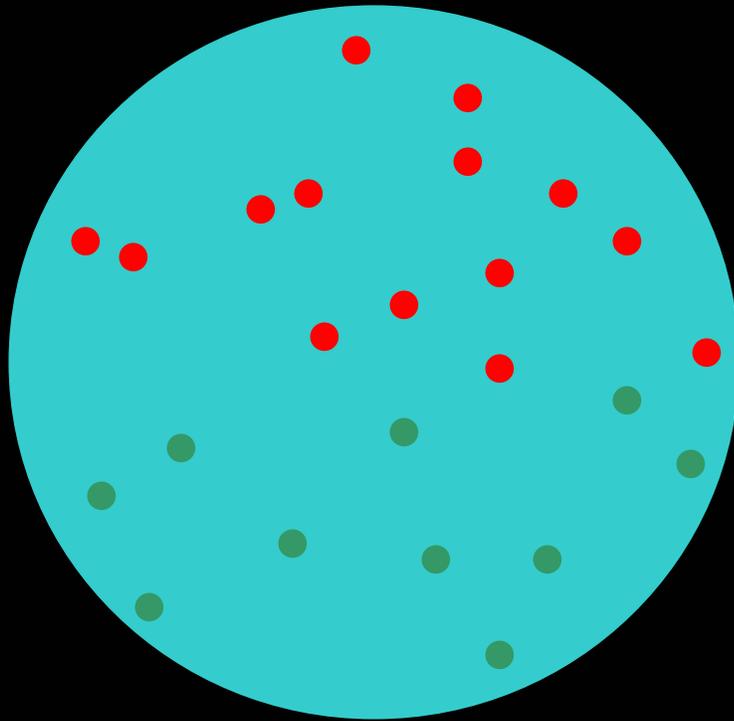
● = unsampled individual



1st Sample

● = unsampled individual

● = sampled individual

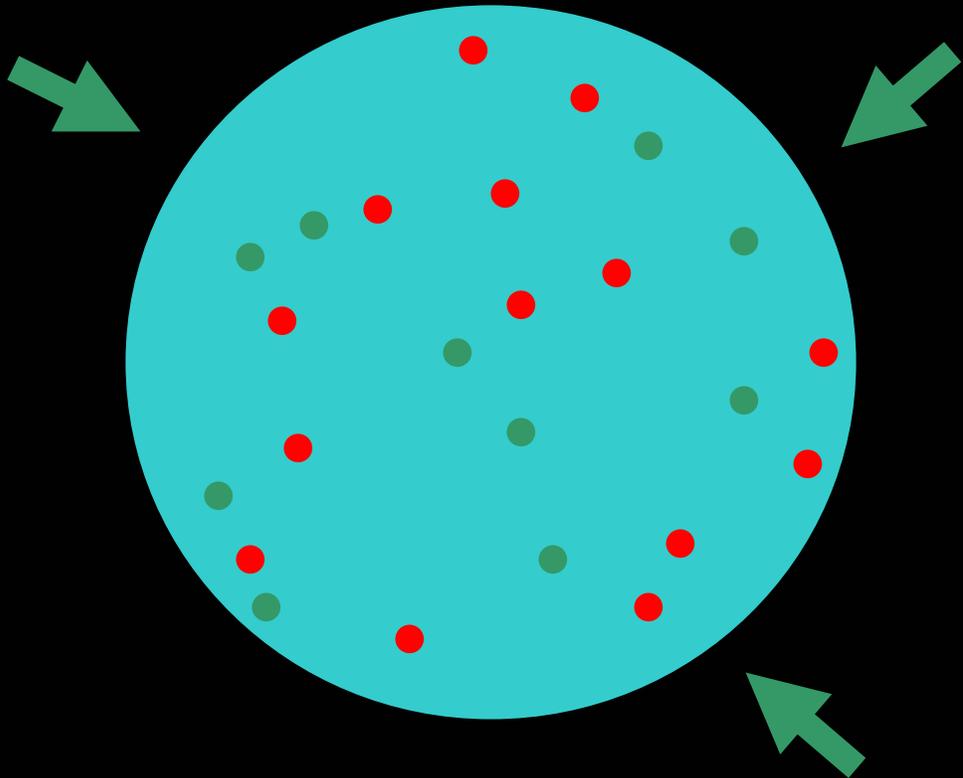


1st Sample

● = unsampled individual

● = sampled individual

If living animals, typically some mixing

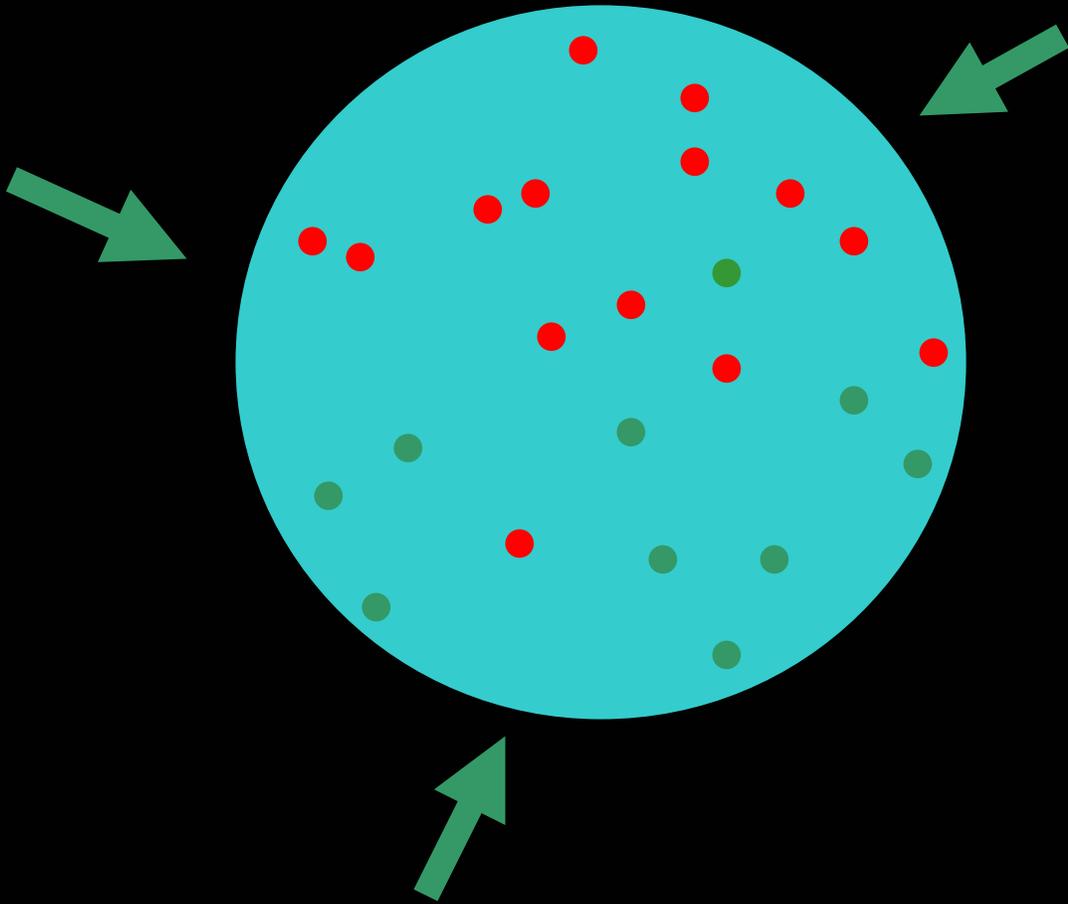


2nd sample can be taken anywhere with reasonably good results.

● = unsampled individual

● = sampled individual

If dead animals, minimal mixing..



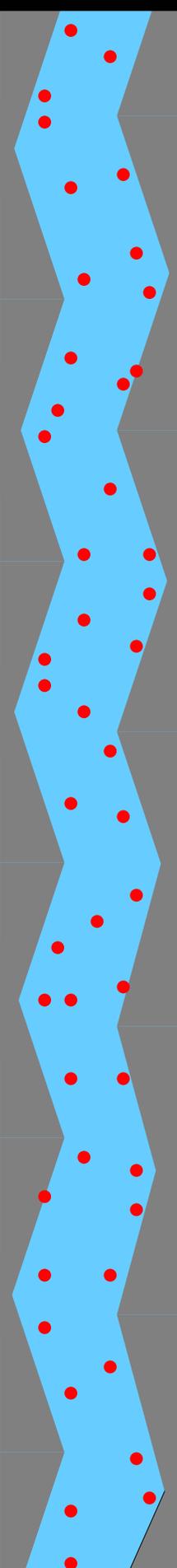
2nd sample anywhere will probably yield biased results

Other Considerations for Carcass Surveys

- Linear nature of rivers
 - most surveys cover 10-40 river miles
 - heterogeneity in physical conditions
 - » depths, water velocities, cover, etc.
 - » Tendency of large numbers of salmon carcasses to collect in particular areas



Idealized World (and
implicit assumption of many
sampling designs):

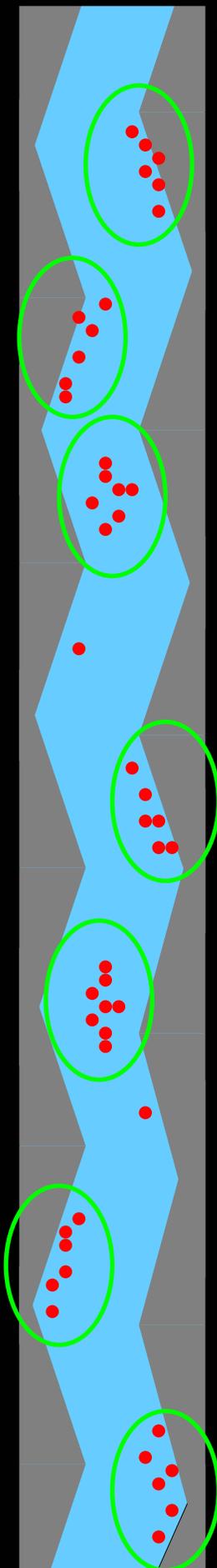


Large, mixed
population of carcasses

• = salmon carcass



Flow



Reality:



Many, small, unmixed
sub-populations of
carcasses

• = salmon carcass



Flow

Brief Overview:

Salmon Spawning Survey

Coded Wire Tag Sampling

- CWTs placed in juvenile salmon prior to emigration
- All or some portion of carcasses encountered checked for presence of CWT
 - Heads collected if CWT presence



Brief Overview:

Salmon Spawning Survey

Coded Wire Tag Sampling

Challenges with CWT Sampling:

- CWT sampling often given secondary consideration to spawning population estimate
- Number of individuals actually sampled for CWT often uncertain or incorrect
 - Which carcasses sampled? All? Fresh only?
- Adipose fin clips easy to overlook, but may also bias selection of carcasses for recovery
- Unpleasant and slow CWT collection process may encourage under-reporting
 - Heads are smelly, heavy and take up space
- “Collecting” CWTs vs. “sampling” for them

Approach to Carcass Surveys and CWT Sampling on the Feather River

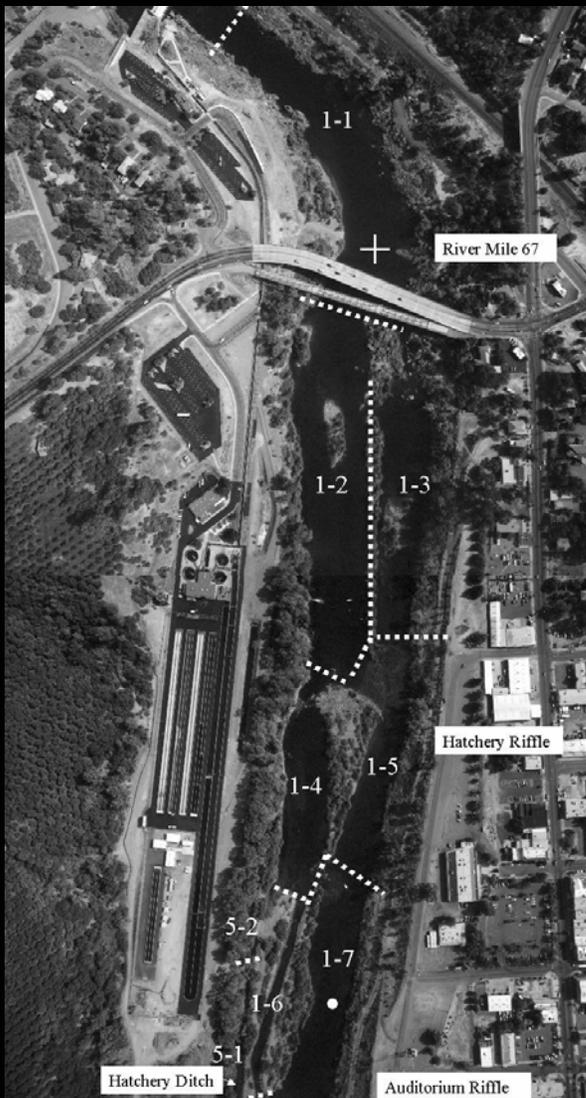
In 2000, we carried out a pilot study to test assumptions and assess importance of sampling design and effort on quality of spawning escapement estimates

We found that...

- Considerable increase in sampling effort was necessary
- Sampling design and implementation were critically important
- Violation of assumptions (and therefore biased estimates) likely if these precautions were not followed

Approach to Carcass Surveys and CWT Sampling on the Feather River

Total survey area (16 river miles) was
subdivided into roughly 25 sections.



Makes it possible to track
spatial distribution of
carcasses and evenly
distribute sampling effort

Prevents over-sampling
some areas while others
are under-sampled

Approach to Carcass Surveys and CWT Sampling on the Feather River

Sampling effort, equipment, training improved



Jet boats and long handled spears used to access river and retrieve carcasses from deep water

- 4 ten hour days/week
- 8 to 12 people/day on river
- 2-3 jet boats

Approach to Carcass Surveys and CWT Sampling on the Feather River

CWT sampling performed independent from carcass survey

- 2 person teams perform weekly, randomized sub-sampling for CWTs



- Also allows collection of other individual data (length, sex, tissues, otoliths, scales)
- Improves efficiency and statistical quality of carcass and CWT data

Select Carcass at Random

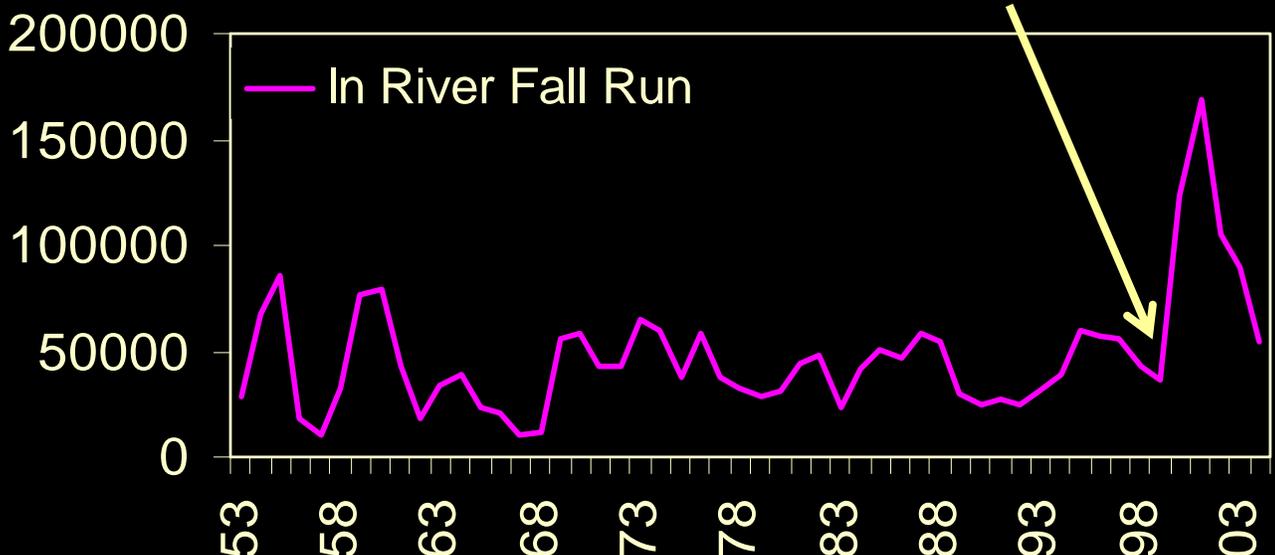


Approach to Carcass Surveys and CWT Sampling on the Feather River

Results:

- Study design and methodologies appear to have improved quality of estimates.
 - Supported by simulations and by contrast without earlier data (e.g. recovery rates)
- But, no estimates via independent methods are available for direct comparison

Year 2000
New Survey
Methods Implemented

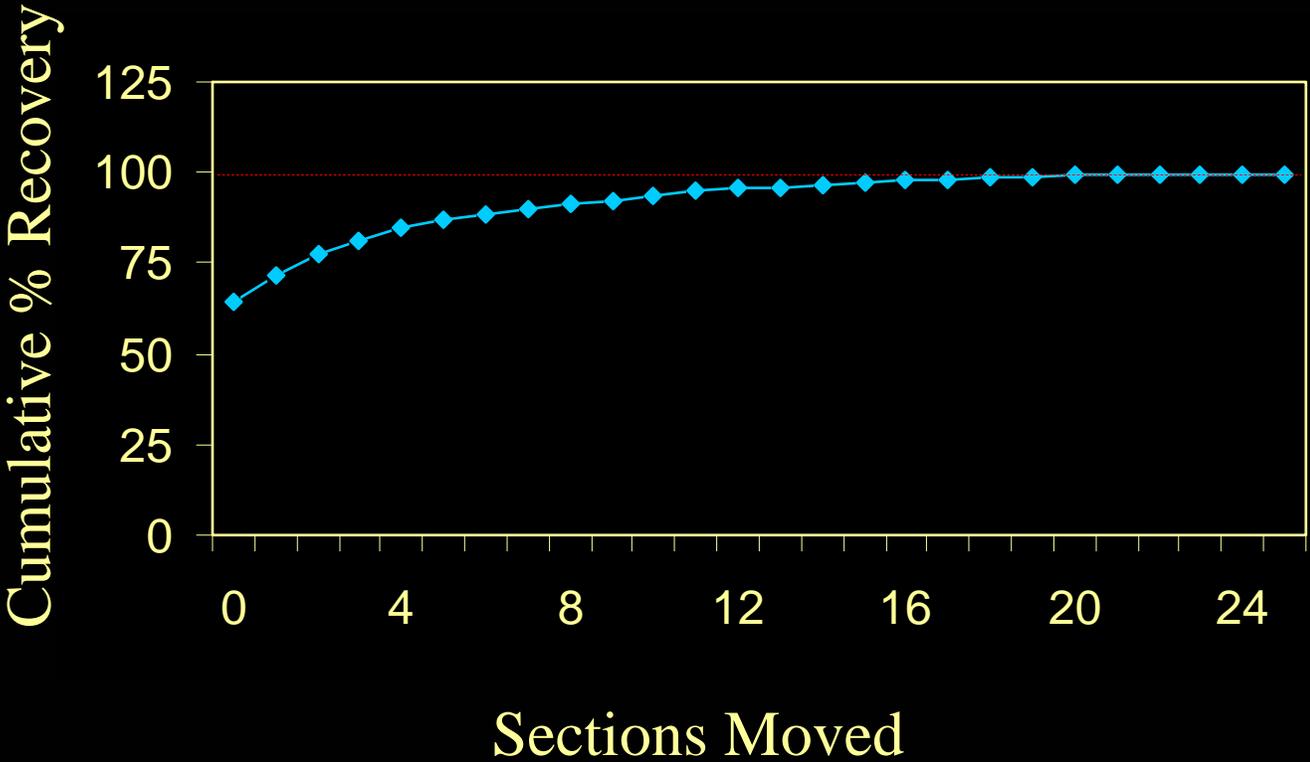


Conclusions

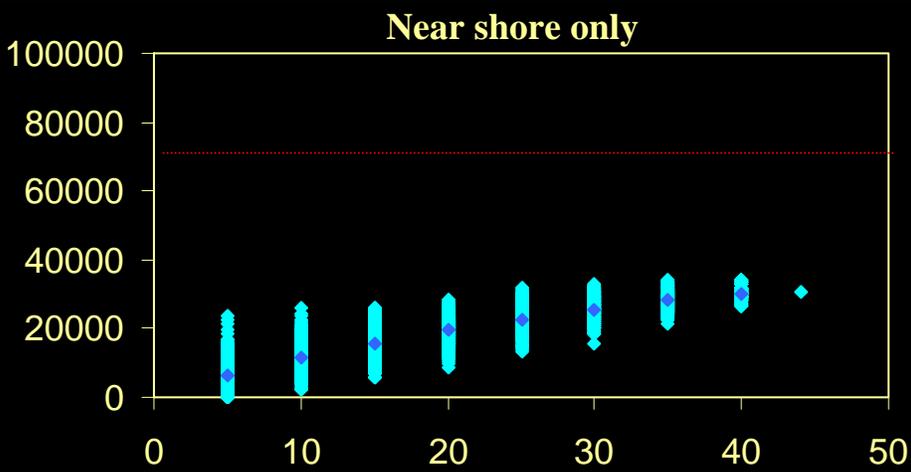
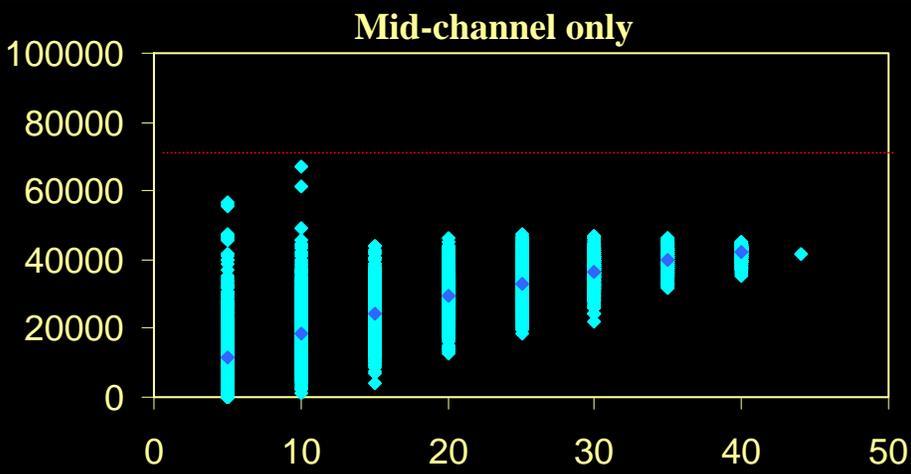
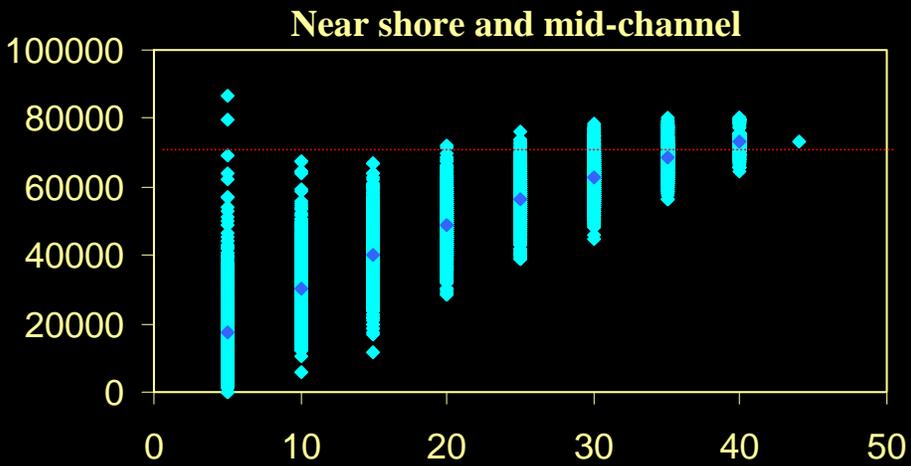
- All monitoring presents problems with sampling design, but carcass surveys are uniquely challenging, and require extreme care in design and execution
- Distribution and intensity of sampling effort is crucial to success
- Feather River lessons most applicable to larger rivers (or smaller rivers with large salmon runs), but probably good practice for all carcass surveys
- Given challenges, study designers and data analysts should be closely associated with data collection



Tagged Carcass Movement



Population Estimate



Number of River Sections Randomly Sampled