

Information Requirements for Assessing Impacts of Mark Selective Fishing

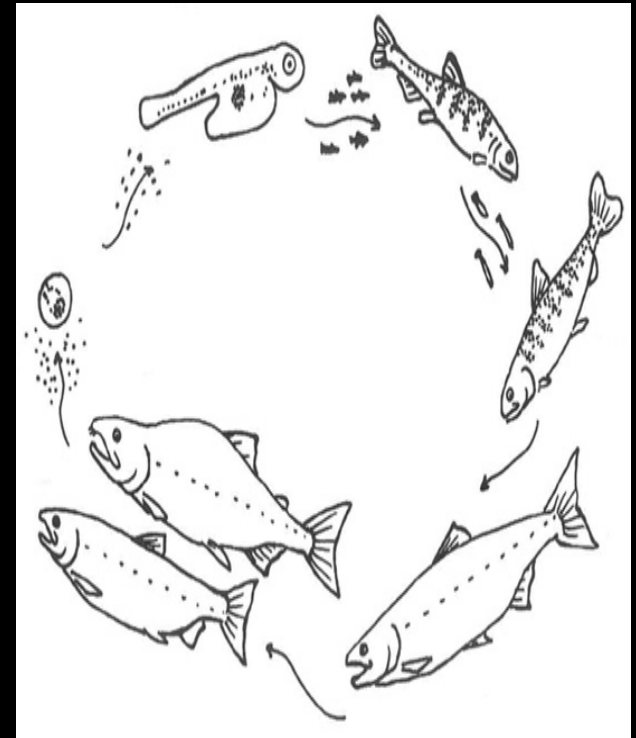
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Chinook and coho salmon

- Life cycle of salmon
 - Immature ocean migration
 - Mature adult migration to spawning areas
- Harvested as immature and mature in ocean and terminal fisheries



Management of Salmon Fisheries

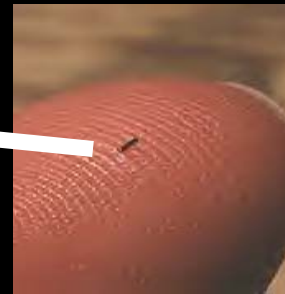
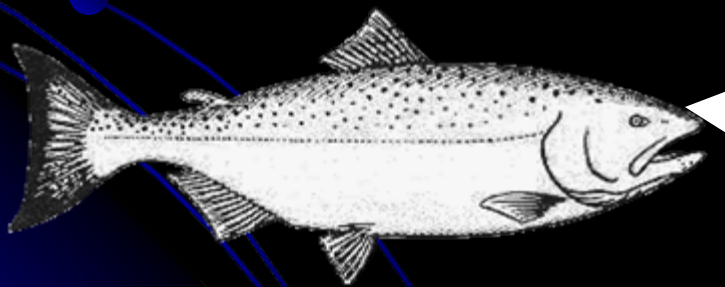
- International and domestic agreements set obligations for sharing harvest and conservation responsibility
- Fishing regimes for Chinook and coho are based on constraining ***Exploitation Rates*** (ERs) for selected naturally spawning populations.

$$\mathbf{ER} = \frac{\mathbf{Mortality}}{\mathbf{Cohort Size}}$$

- *Cohort - all fish available to all fisheries in a defined period.*
- *Fishery Mortalities –*
 - *Landed Mortality*
 - *Non-Landed Mortality*

How do we obtain information for estimation of ERs?

- Use Coded Wire Tags (CWTs) placed in juvenile salmon prior to emigration from freshwater



Management Information

- CWT groups representative of natural stocks are tagged and released
 - *Tagged wild fish or hatchery fish selected based on brood stock and rearing/release strategies and regional representation.*

Assumption - Tagged and the untagged fish they represent (i.e. natural stocks) have the same exploitation patterns

CWT System is Coast Wide (Alaska to California)

- Sample fisheries and hatchery and spawning ground escapement for CWTs
- Expand observed tags to tagged fish harvested or escaping
 - sample expansion = total catch or escapement over number sampled
- Report tag releases, recoveries, sample and catch/escapement information to coast wide database (Regional Mark Information System - RMIS)

Pacific Salmon Treaty Memorandum of Understanding

“The Parties agree to maintain a coded-wire tagging and recapture program designed to provide statistically reliable data for stock assessments and fishery evaluations.”

A viable CWT system

What do we mean by viability?

The PSC ASFEC (1995) defined viability as:

- Use CWT data for assessment and management of Chinook and coho salmon
- Estimate stock-specific exploitation rates by fishery and age
- **Without increasing management risk from *uncertainty* to unacceptable levels.**

Uncertainty

Two components to uncertainty – Precision and Bias

- Precision – improves as number of recovered tags increases.
 - *Can be improved with additional tagging or sampling*
 - *Precision can be measured*
- Bias – due to violation of assumptions.
 - *Contribute to control through sample design*
 - *Additional tagging or sampling will not reduce bias*
 - *Bias usually cannot be measured*

Mass Marking and Mark Selective Fisheries

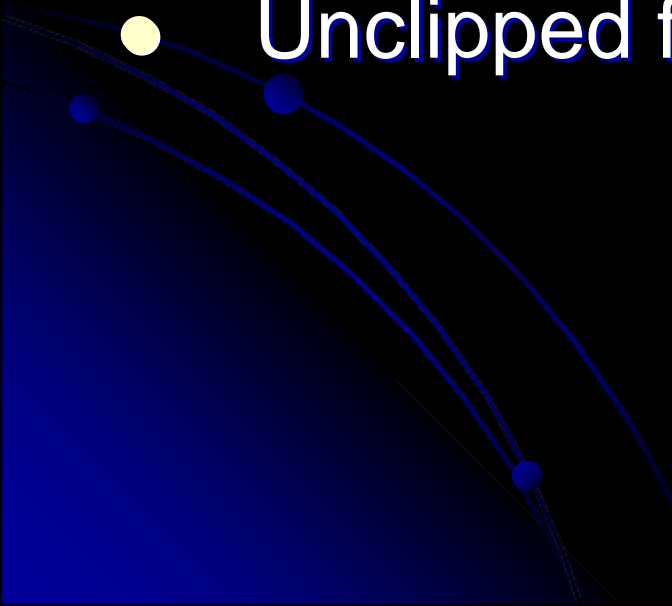
Mass Marking (MM)

- For many years the adipose fin clip was used to identify tagged fish
- Adipose fin clip is now designated as a hatchery mass mark

Mark Selective Fisheries (MSF)

- Only adipose fin clipped fish can be retained

How can MSFs affect the viability of the CWT Program?

- Mass marked fish can be kept
 - Unclipped fish must be released
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How can MSFs affect the viability of the CWT Program?

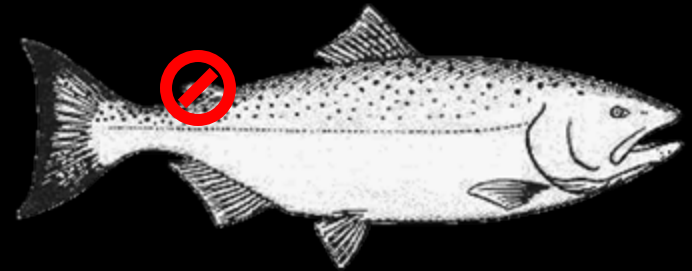
- Assumption that tagged and untagged fish have same exploitation pattern is now violated
 - Clipped and tagged fish cannot represent natural stocks, which are not clipped
 - *Cannot use clipped CWT indicators to estimate impacts and ERs for unmarked fish*
- ***Remember definition of viability***
 - ***Use CWT data for assessment and management of Chinook and coho salmon***
 - ***Estimate stock-specific exploitation rates by fishery and age***

Solution ?

Double Index Tagging (DIT)

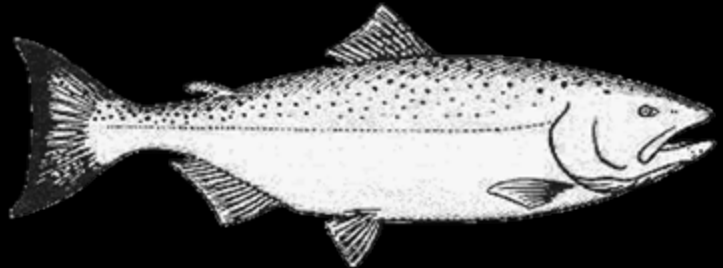
- Two groups of fish, each with its own CWT, presumed identical, except that

One group is marked



And the other is unmarked

This group now represents wild fish



Requirements for DITs

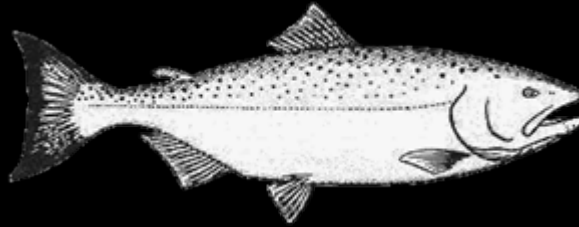
- *The two groups must be identical except for the mark*
- *They must have received the same treatment in the hatchery during rearing, tagging and release*



DIT Groups

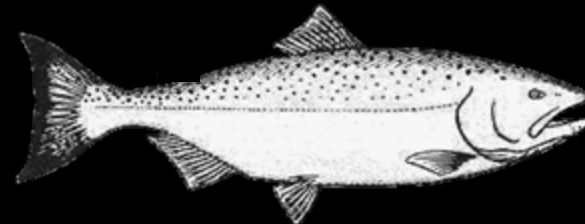
- Marked fish

- Clipped
- Sampled in all fisheries and escapement



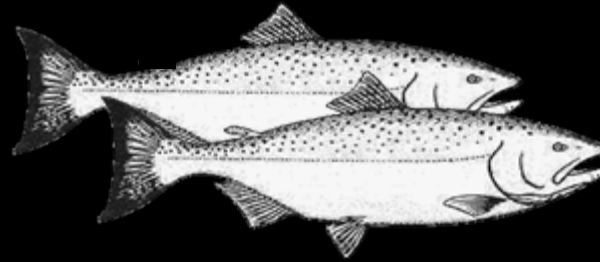
- Unmarked fish

- Unclipped
- Are not landed in MSFs and so mortalities are not sampled
- Sampled in non-selective fisheries and escapement *if electronic sampling is used*

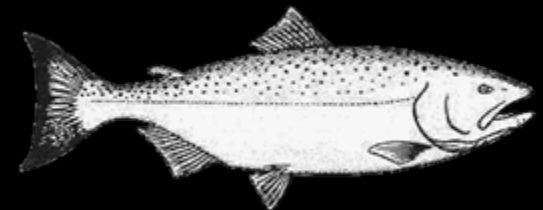


Electronic Sampling

- Sampling programs must be able to detect CWTs in unmarked fish, within their migratory range
 - *Electronic sampling gear must be used to detect these tags*



- *Visual sampling (using adipose fin clip as indicator) results in missing unmarked DIT groups in non-selective fisheries or escapement.*

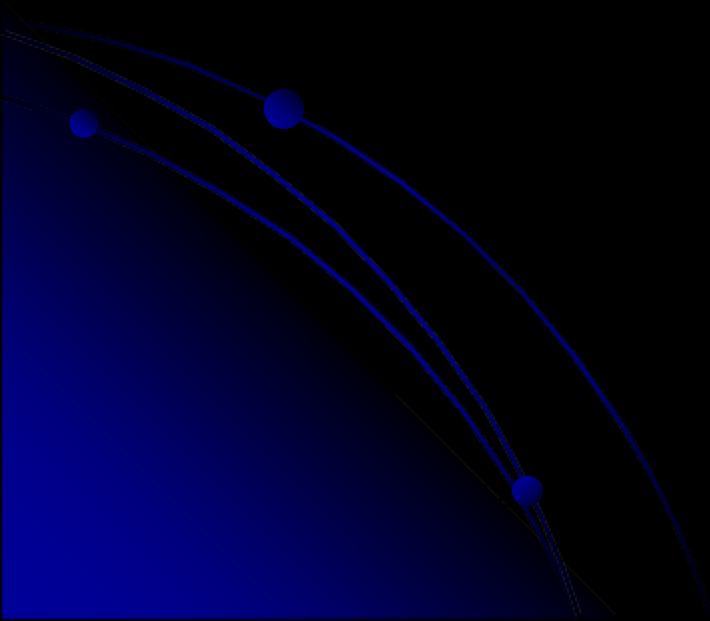


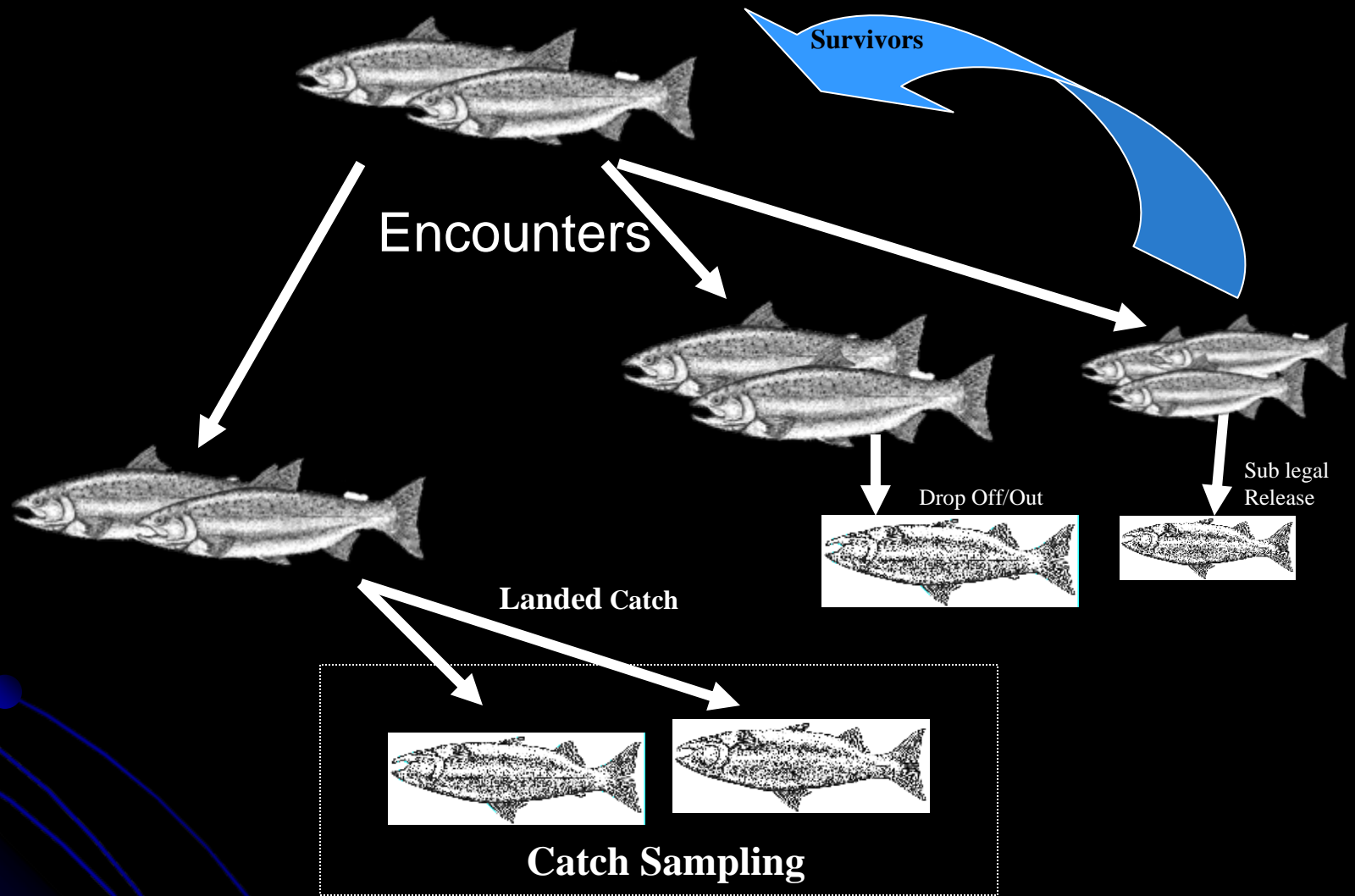
Additional information to be reported

- Sampling programs must record and report information on
 - mark and tag status
 - tag detection methods
 - fishery regulation type (Non or Mark Selective)
- Tagging programs must record and report information on DIT group
 - DIT group identifier
 - Mark status for each tag code

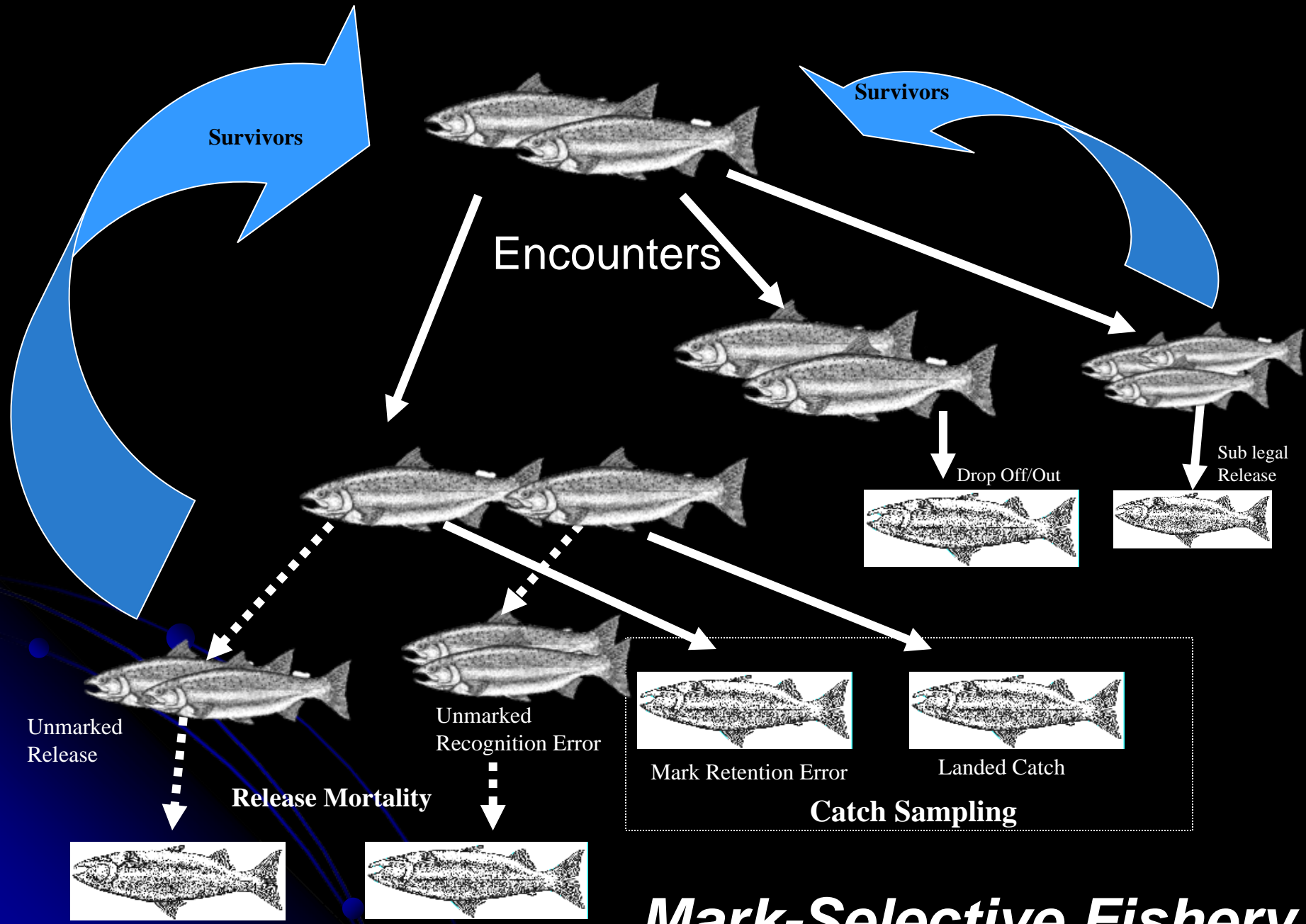
Additional Mortalities to be Estimated

- *Fishery Mortalities* –
 - *Landed Mortality*
 - *Non-Landed Mortality*





Non-selective Fishery



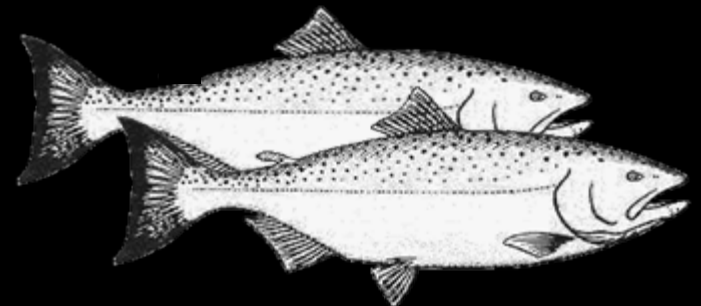
Mark-Selective Fishery

DIT Estimation

- *Unmarked fish now represent natural stocks – restoring assumption that tagged and untagged have same exploitation pattern*
- *Must use relationship between the DIT groups to estimate impacts on unmarked fish*
 - *Use difference between marked and unmarked returns to escapement to estimate total MSF mortality of unmarked fish*
 - *Use ratio of unmarked to marked fish to estimate encounters of unmarked fish and release mortality rate to estimate mortalities*

What is the price to be paid?

- New Assumptions for estimation of impacts on unmarked fish
 - Independence of CWT groups is lost
 - We must use two CWT groups, the DIT pair, to estimate impacts on unmarked fish



Cost in increased uncertainty

- Cost in uncertainty introduced by using indirect methods to estimate mark selective release
 - *Cannot directly sample unmarked fish released in MSFs and so must estimate the release using the relationship between marked and unmarked DIT groups*
 - *Additional assumptions introduce additional potential for bias in our estimates*

 *Increased uncertainty*

Viability

- DIT allows us to make unbiased estimates of total MSF mortality using the difference between marked and unmarked DIT groups
- Fishery and age specific MSF mortality estimates will be biased when there are multiple MSFs

Viability

- Additional uncertainty added due to this bias,
 - size of this uncertainty will depend on the **magnitude** of the MSFs
 - additional tagging or sampling can improve precision but cannot reduce bias
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