MSF Impacts on CWT System

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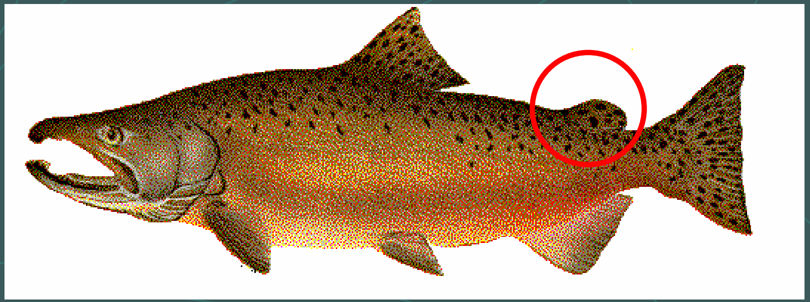
Mark-Selective What?

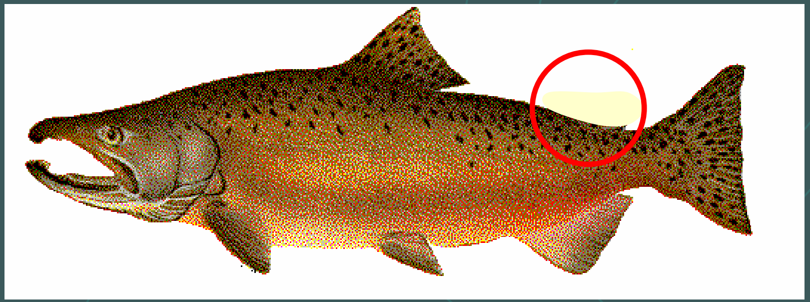
- Concerns over impacts to the viability of the CWT system in the presence of MSF’s.
- How much do MSFs impact the CWT system relative to other impacts?
- How can we weigh the benefits against the costs (both informationally and financially)

What is Mark-Selective Fishing?

- Release any salmon with an intact adipose fin



- Keep any salmon without an adipose fin



	Marked Hatchery	Wild	Unmarked Hatchery
Release			
	ER^M 1	ER^U 1	ER^U 1
	ER^M 2	ER^U 2	ER^U 2
	ER^M 3	ER^U 3	ER^U 3
	ER^M 4	ER^U 4	ER^U 4
Escapement			

What is DIT?

- Two tag groups for each indicator stock.
  - One group is mass marked with an ad clip
  - The second group is not mass marked
  - Both are tagged
- The unmarked DIT group now represents the unmarked production.
- Assumption: both groups are identical except for clip.

	Unmarked Hatchery DIT	
Release	Tags	
MSF 1	Est Tags	Estimate the tags well, and the ER^U's are ok
MSF 2	Est Tags	
NSF 1	Tags	
NSF 2	Tags	Estimate the tags poorly and the ER^U's are biased
Escapement	Tags	

What are the MSF Impacts?

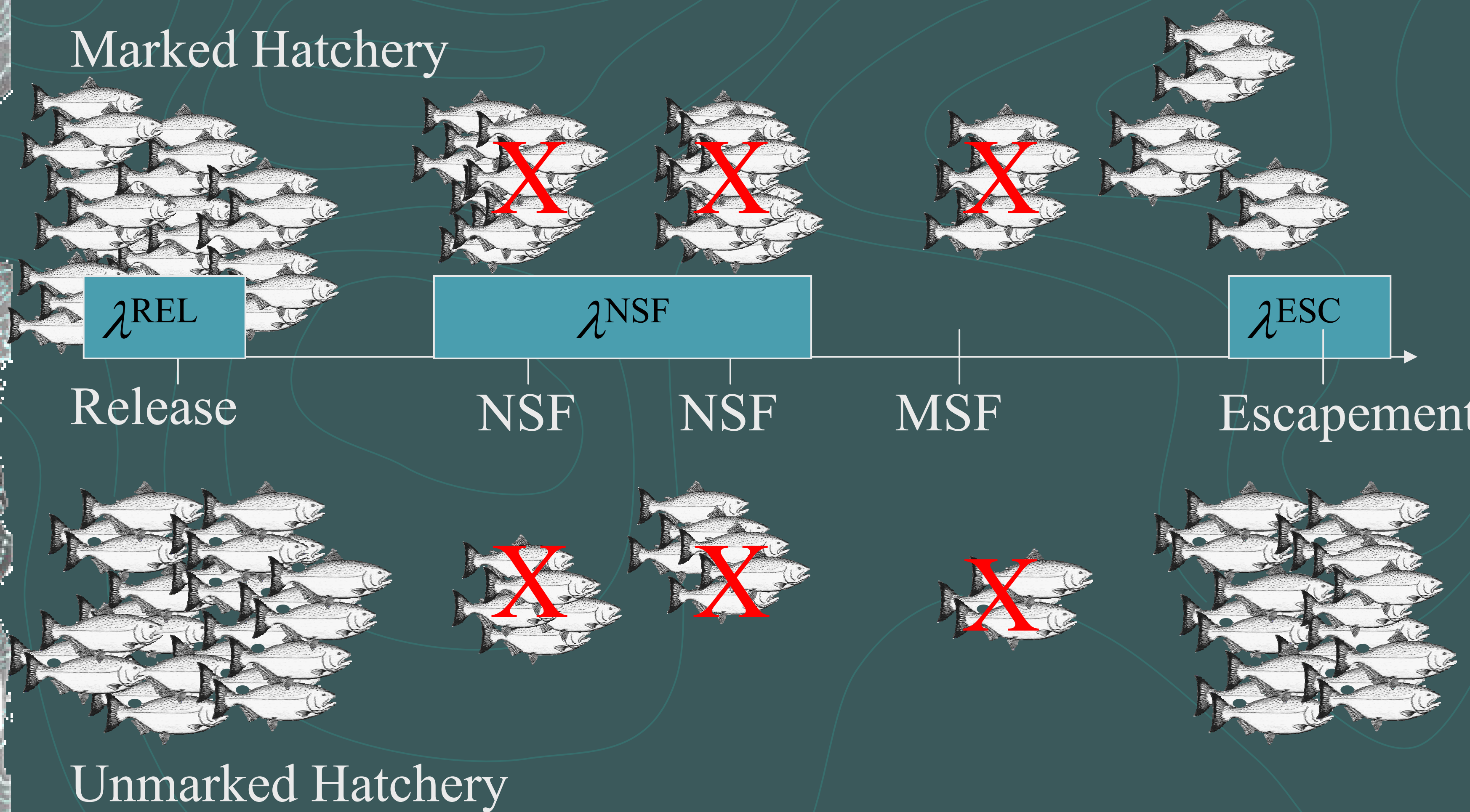
- Depending on analytical method used, introduction of bias or imprecision to ER’s of MSF’s.
  - Requires the substitution of assumed parameters for otherwise observed data.
- Similar to unreported tags, will bias the ER’s of other NSF’s exploiting the same stocks.

Estimating MSF Incidental Unmarked Mortalities

$$\overbrace{\text{Observed Marked Encounters} * \lambda}^{\text{Estimate of Unmarked Encounters}} * \overbrace{sfm}^{\text{Incidental hook and release mortality rate}}$$

λ is the unmarked to marked ratio for specific DIT groups encountered

Estimating Unmarked to Marked Ratio (λ)



Example: Salmon River Coho

MSF	Marked Recoveries	SE (M)
Coos Bay	1.74	1.13
Tillamook	1.20	0.49
WA Area 1	25.33	5.31
WA Area 2	66.25	9.24
WA Area 3	3.58	0.84
WA Area 4	8.65	4.04
SUM	105.01	11.49

Example: Salmon River Coho: $\lambda^{\mathbf{REL}}$

$$\lambda^{\mathrm{REL}} = \frac{68{,}234}{72{,}236} = 0.945$$

$$\sum U^{MSF} = \left(\sum M^{MSF}\right)\lambda^{REL} sfm = 105.01 * 0.945 * 0.14 = 13.89$$

$$SE\left(\sum U^{MSF}\right) \cong \sqrt{V\left(\sum M^{MSF}\right)\left(\lambda^{REL}\right)^2 sfm^2} = \sqrt{132.12} * 0.945 * 0.14 = 1.52$$

Example: Salmon River Coho: λ^{NSF}

$$\lambda^{NSF} = \frac{7.48}{7.48} = 1.0$$

$$V\left(\lambda^{NSF}\right) \cong \left(\frac{1}{7.48}\right)^2 48.44 + 48.44\left(\frac{1}{7.48}\right)^2 = 1.73$$

$$\sum U^{MSF} = \left(\sum M^{MSF}\right)\lambda^{NSF} sfm = 105.01 * 1.0 * 0.14 = 14.7$$

$$SE\left(\sum U^{MSF}\right) \cong \sqrt{\left(\sum M^{MSF}\right)^2 \left(sfm^2\right) V\left(\lambda^{NSF}\right) + V\left(\sum M^{MSF}\right)\left(\lambda^{NSF}\right)^2 sfm^2}$$

$$= \sqrt{(105.01)^2\left(0.14^2\right)1.73 + 132.12(1.0)^2\left(0.14^2\right)} = 19.53$$

Example: Salmon River Coho: λ^{ESC}

$$\lambda^{\mathrm{ESC}} = \frac{856.5}{611.6} = 1.4$$

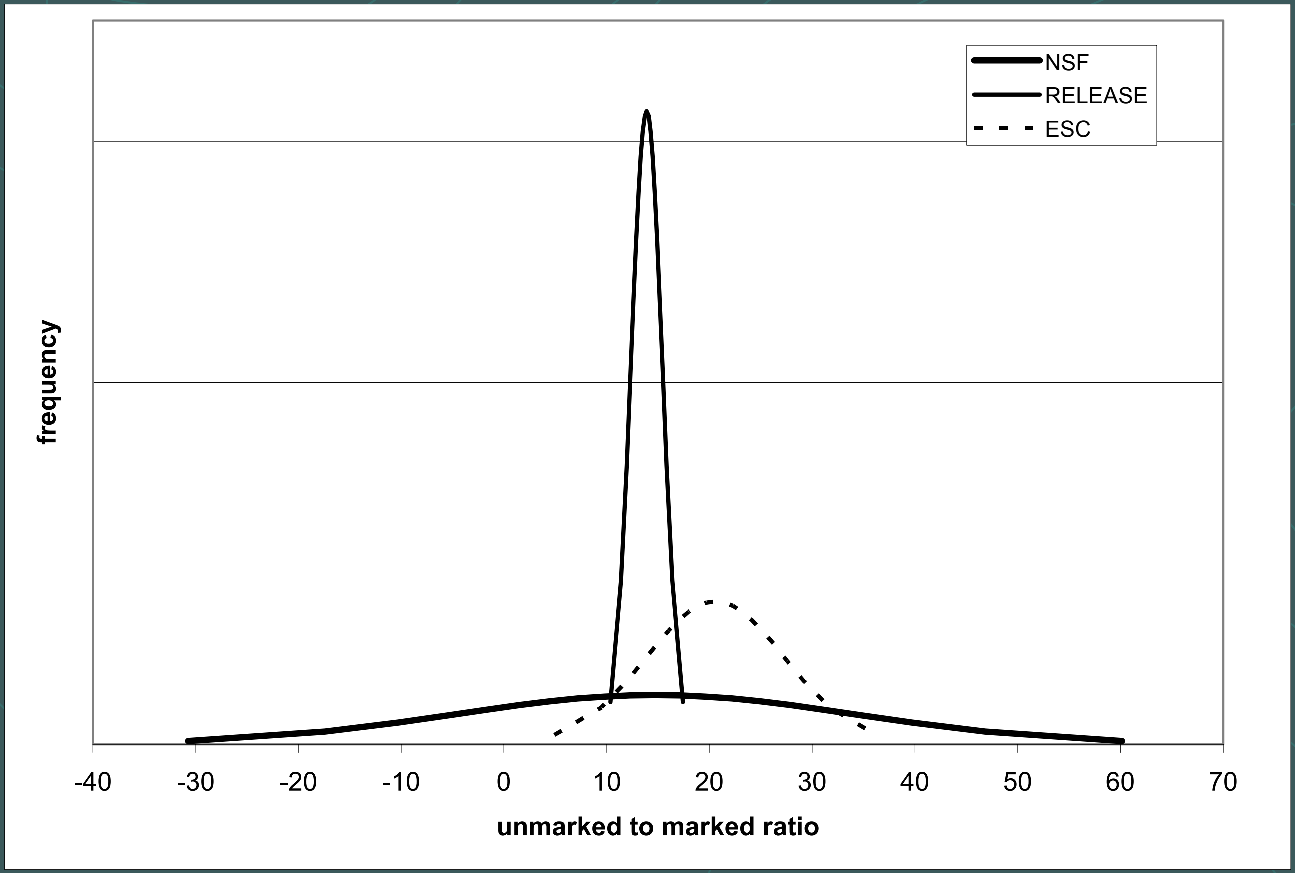
$$V\left(\lambda^{ESC}\right) \cong \left(\frac{1}{M^{ESC}}\right)^2 V\left(U^{ESC}\right) + V\left(M^{ESC}\right)\left(\frac{\lambda^{ESC}}{M^{ESC}}\right)^2 = 0.187$$

$$\sum U^{MSF} = \left(\sum M^{MSF}\right)\lambda^{ESC} sfm = 105.01 * 1.4 * 0.14 = 20.58$$

$$SE\left(\sum U^{MSF}\right) \cong \sqrt{\left(\sum M^{MSF}\right)^2 \left(sfm^2\right) V\left(\lambda^{ESC}\right) + V\left(\sum M^{MSF}\right)\left(\lambda^{ESC}\right)^2 sfm^2}$$

$$= \sqrt{(105.01)^2\left(0.14^2\right)0.187 + 132.12(1.4)^2\left(0.14^2\right)} = 6.74$$

REL vs. NSF vs. ESC



Maximum Bias Estimate

Release λ < MSF λ < Escapement λ

λ^{REL} with a negative bias

λ^{ESC} with a positive bias

$$M*\lambda^{ESC}*sfm - M*\lambda^{REL}*sfm = M*sfm\ (\lambda^{ESC} - \lambda^{REL})$$

Confidence Intervals

λ^{REL} with a negative bias $\left(\hat{U} - 2\sqrt{Bias^2 + Var}, \hat{U} + 2\sqrt{Var}\right)$

(10.86, 27.62)

λ^{NSF} with no bias $\left(\hat{U} - 2\sqrt{Var}, \hat{U} + 2\sqrt{Var}\right)$

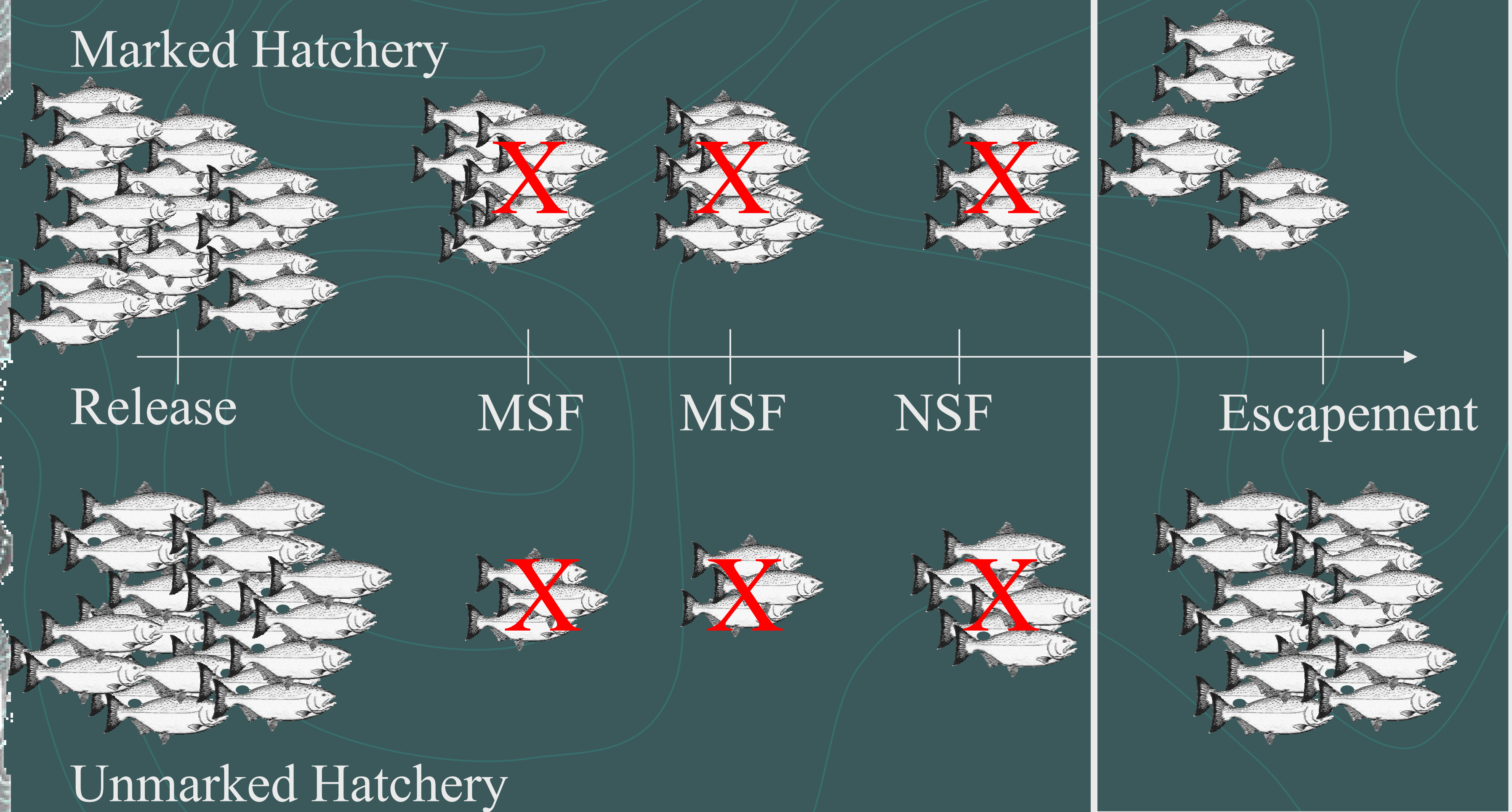
(-24.36, 53.76)

λ^{ESC} with a positive bias $\left(\hat{U} - 2\sqrt{Var}, \hat{U} + 2\sqrt{Bias^2 + Var}\right)$

(1.58, 34.06)

Region	Hatchery	Brood Year	Marked NSF	Marked SF	Unmarked NSF	Unmarked SF
Region	Bingham Creek	1995	18.9%	6.8%	10.1%	1.0%
		1996	8.6%	3.5%	6.9%	2.4%
		1997	27.2%	6.8%	28.5%	2.4%
	Forks Creek	1995	56.7%	2.2%	54.9%	0.3%
	Humptulips	1995	58.9%	3.2%	58.1%	0.4%
		1996	27.8%	3.0%	22.9%	0.4%
	Makah NFH	1996	15.3%	5.6%	20.4%	1.1%
		1997	1.8%	8.7%	3.1%	1.7%
	Quinault NFH	1995	58.5%	0.2%	46.9%	0.0%
		1996	47.9%	4.5%	52. 4%	0.8%
		1997	44.3%	9.8%	51.1%	1.9%
	Salmon River	1996	38.7%	9.1%	38.8%	1.4%
		1997	37.3%	14.7%	34.9%	2.1%
	Solduc	1996	9.8%	7.6%	9.5%	1.1%
		1997	0.9%	11.2%	0.2%	2.0%
Coastal Total			29.8%	6.6%	28.9%	1.3%

So … how big are the MSF Impacts?



Comparison of return rates to hatchery (Coho DIT Report)

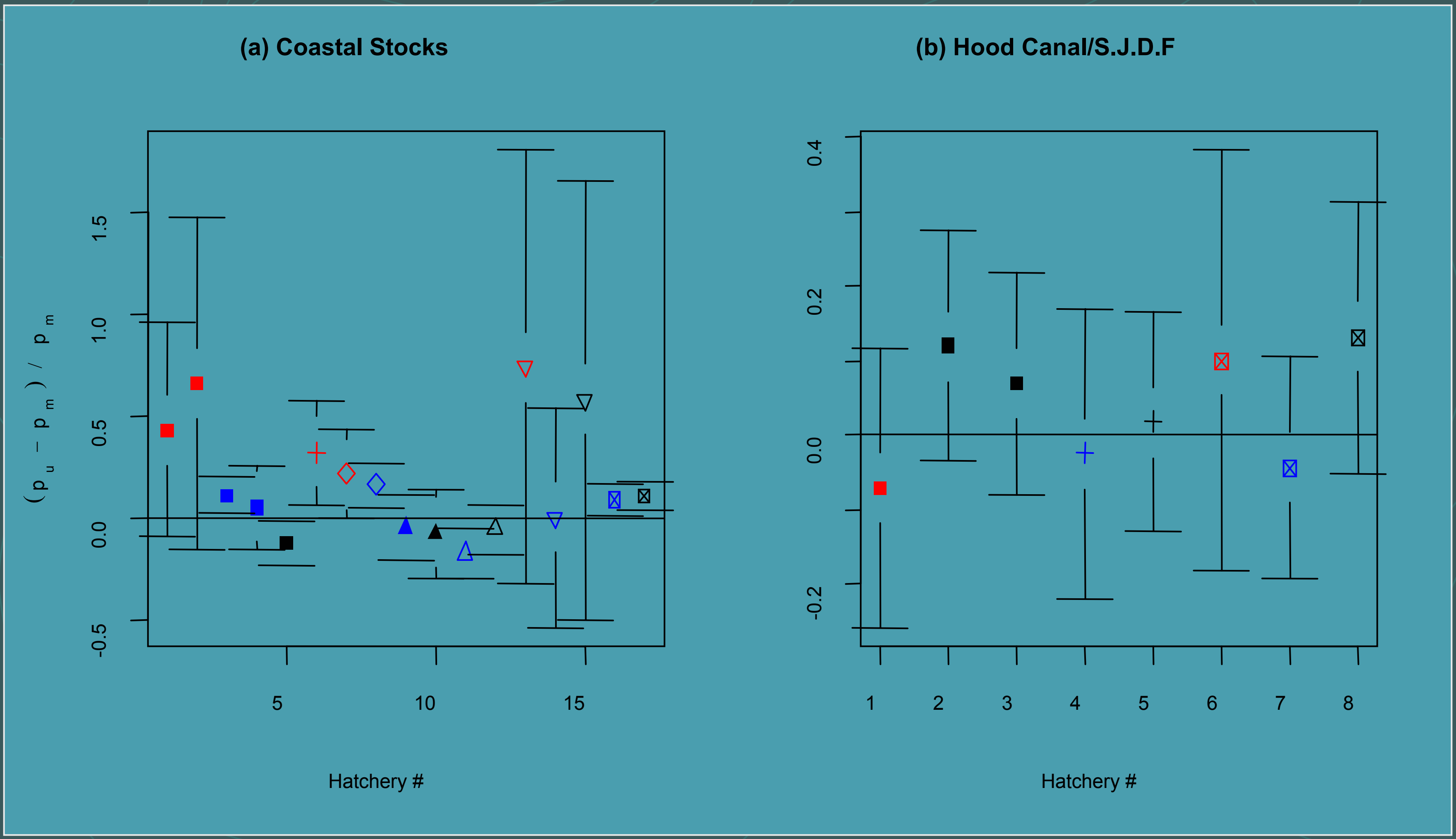
$$z = \frac{\hat{p}_u - \hat{p}_m}{\sqrt{V\hat{a}r(\hat{p}_u) + V\hat{a}r(\hat{p}_m)}}$$

Comparison of return rates to hatchery (Coho DIT Report)

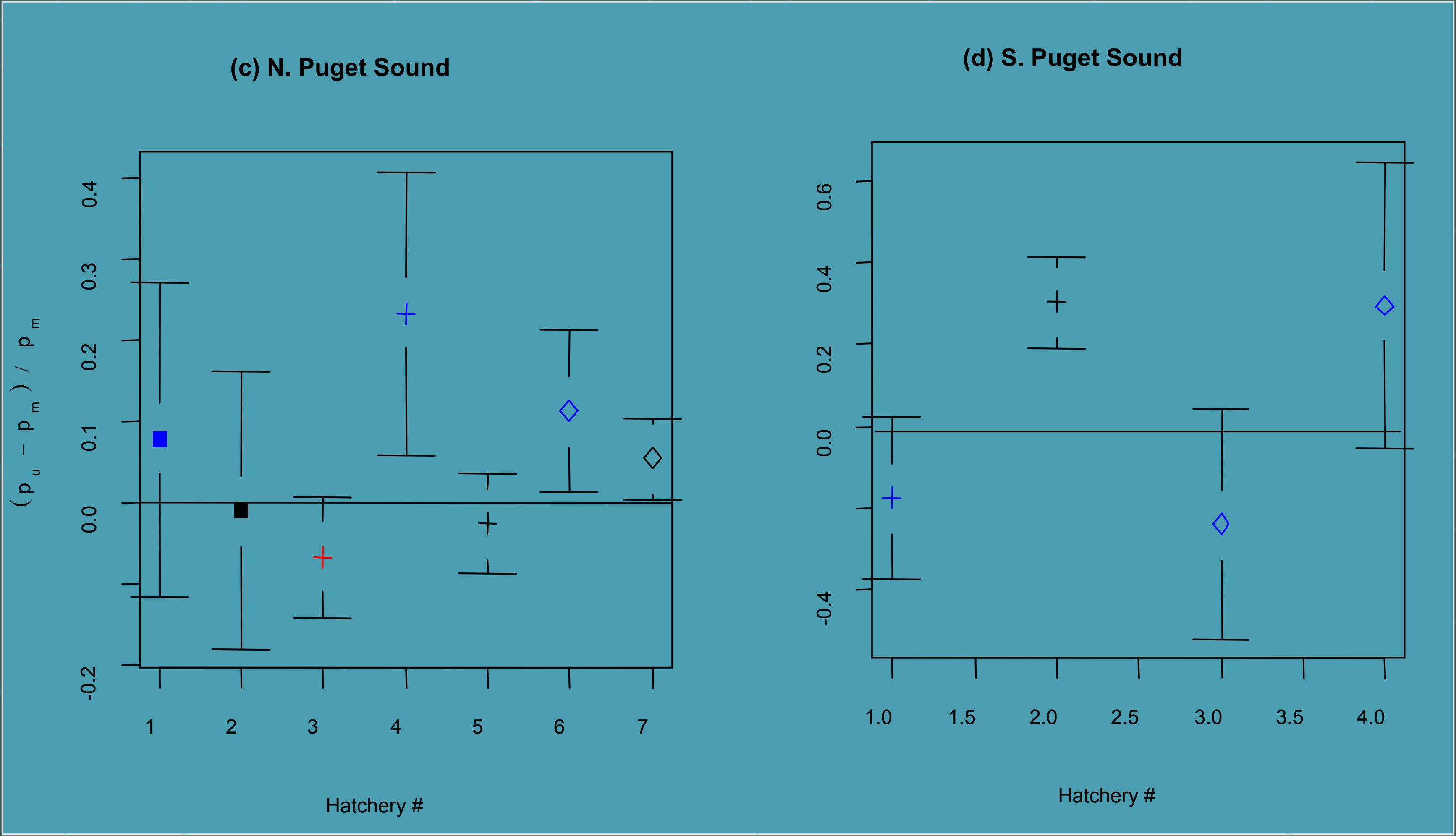
Table 1. Summary of escapement return rate tests by brood year summarized from Table 15.

Run Year	$p_m > p_u$ ($P < 0.05$)	$p_u > p_m$ ($P < 0.05$)	Non-significant
1998	0	2	6
1999	1	5	10
2000	1	3	9

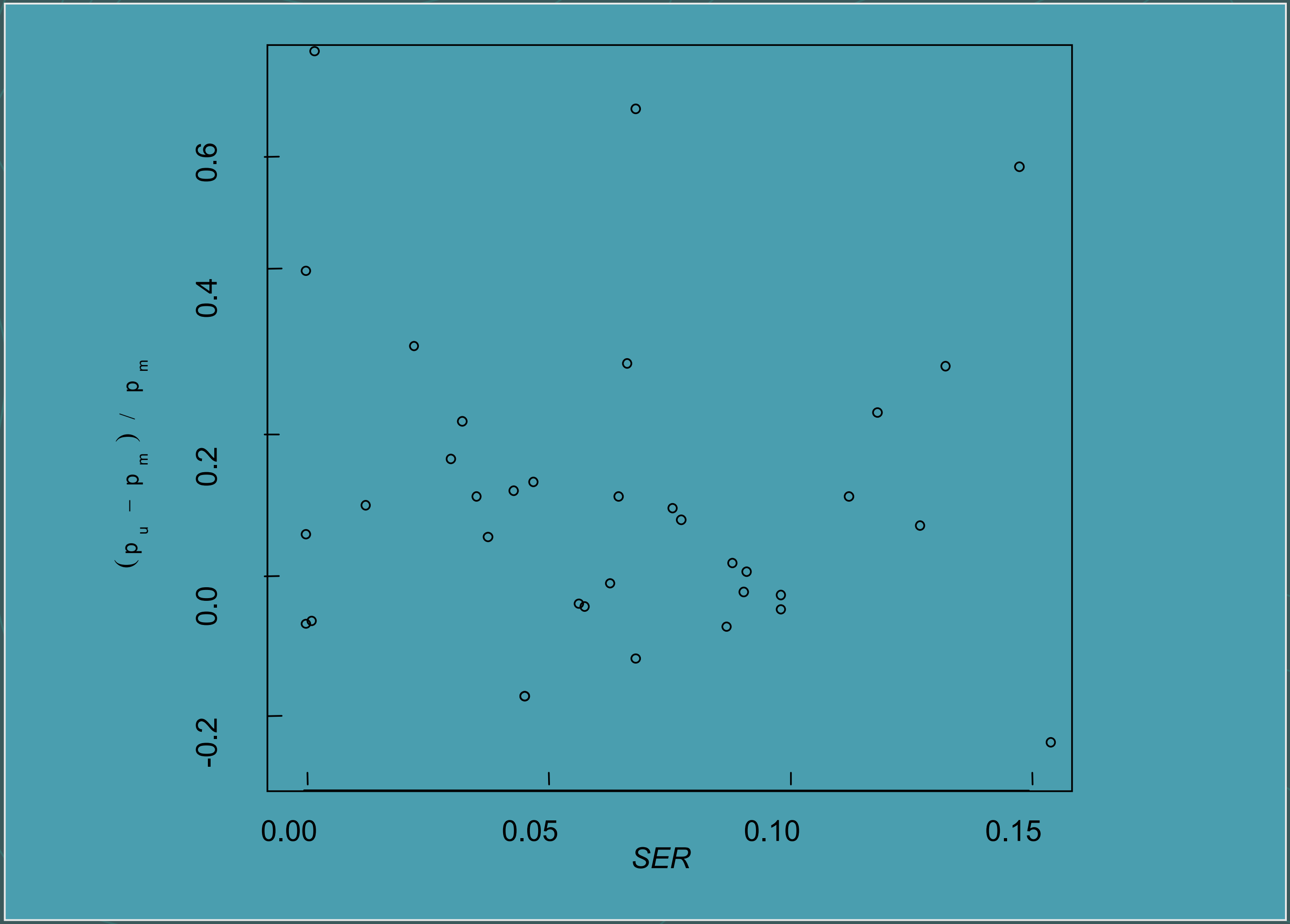
MSF Impact on Coho



MSF Impact on Coho



MSF Impact on Coho



Similarities to Other Incidental Mortalities

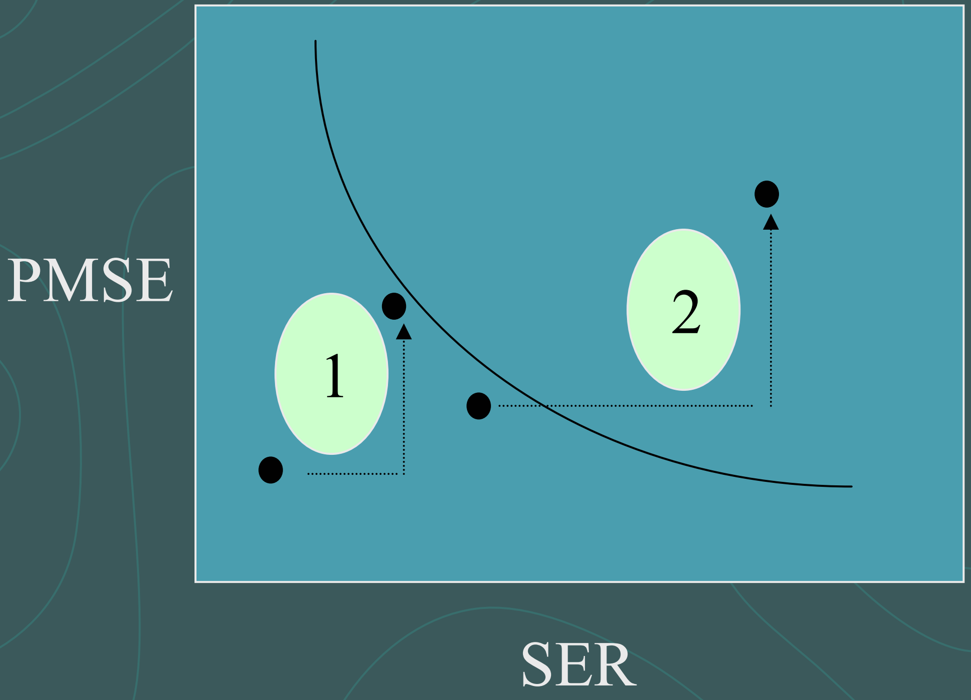
Estimate of Unmarked Encounters	*	Incidental hook and release mortality rate
Estimate of Sub-legal Encounters	*	Incidental hook and release mortality rate
Estimate of CNR Encounters	*	Incidental hook and release mortality rate
Estimate of drop-off Encounters	*	Incidental hook and release mortality rate

Differences From Other Sources of Incidental Mortalities

- With MSF’s there is a differential impact between the unmarked and marked DIT groups not shared by other listed sources of incidental mortalities.

On the Other Hand …

- Bias in number of mortalities biases the ER's, and bias is a statistical property that can be compared among different sources of incidental mortalities.



What about chinook?

- There was a preterminal MSF on chinook in the Strait of Juan de Fuca in 2003.
- Marked CWTs were recovered from
  - G. Adams, Grovers, Chilliwack, Shuswap, Kalama, Lewis, Lyons Ferry, Marblemount, Nisqually, Samish, Soos, White River and Whitehorse Pond

What about chinook?

- With an *sfm* of 0.14:

Grovers Creek age 4	M = 23.97	U^{REL} = 3.34
Projected	M = 14.17	U^{REL} = 1.98
Grovers Creek age 3	M = 29.84	U^{REL} = 4.23
Projected	M = 23.05	U^{REL} = 3.27

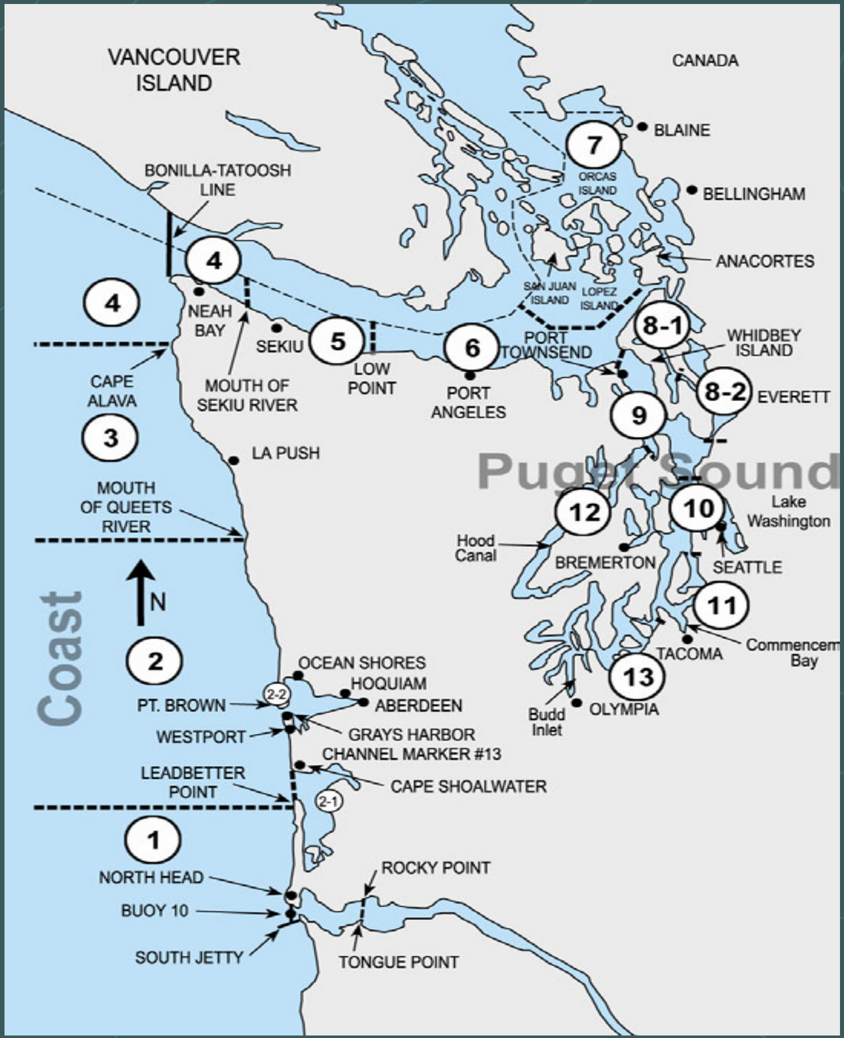
What about chinook?

- With an *sfm* of 0.14:

Soos Creek age 4	M =12.80	U^{REL} = 1.83
Projected	M = 20.43	U^{REL} = 2.93
Soos Creek age 3	M =30.69	U^{REL} = 4.48
Projected	M = 19.86	U^{REL} = 2.9

Distribution Issues

- A large MSF in ST JDF
  - $\lambda = 1.0$
- A second MSF in Area 9
  - $\lambda = 2.0$
- Escapement including fish from ST Georgia with no MSF's
  - $\lambda = 1.2$



Do we need DIT?

$$U = M * \lambda^{REL} * \text{sfm}$$

$$\text{SER(U)} = \frac{M * \lambda^{REL} * sfm}{\text{Unmarked Cohort}}$$

$$= \frac{M * \lambda^{REL} * sfm}{\text{Marked Cohort} * \lambda^{REL}}$$

$$= \text{SER(M)} * sfm$$

DIT in NSF Fisheries

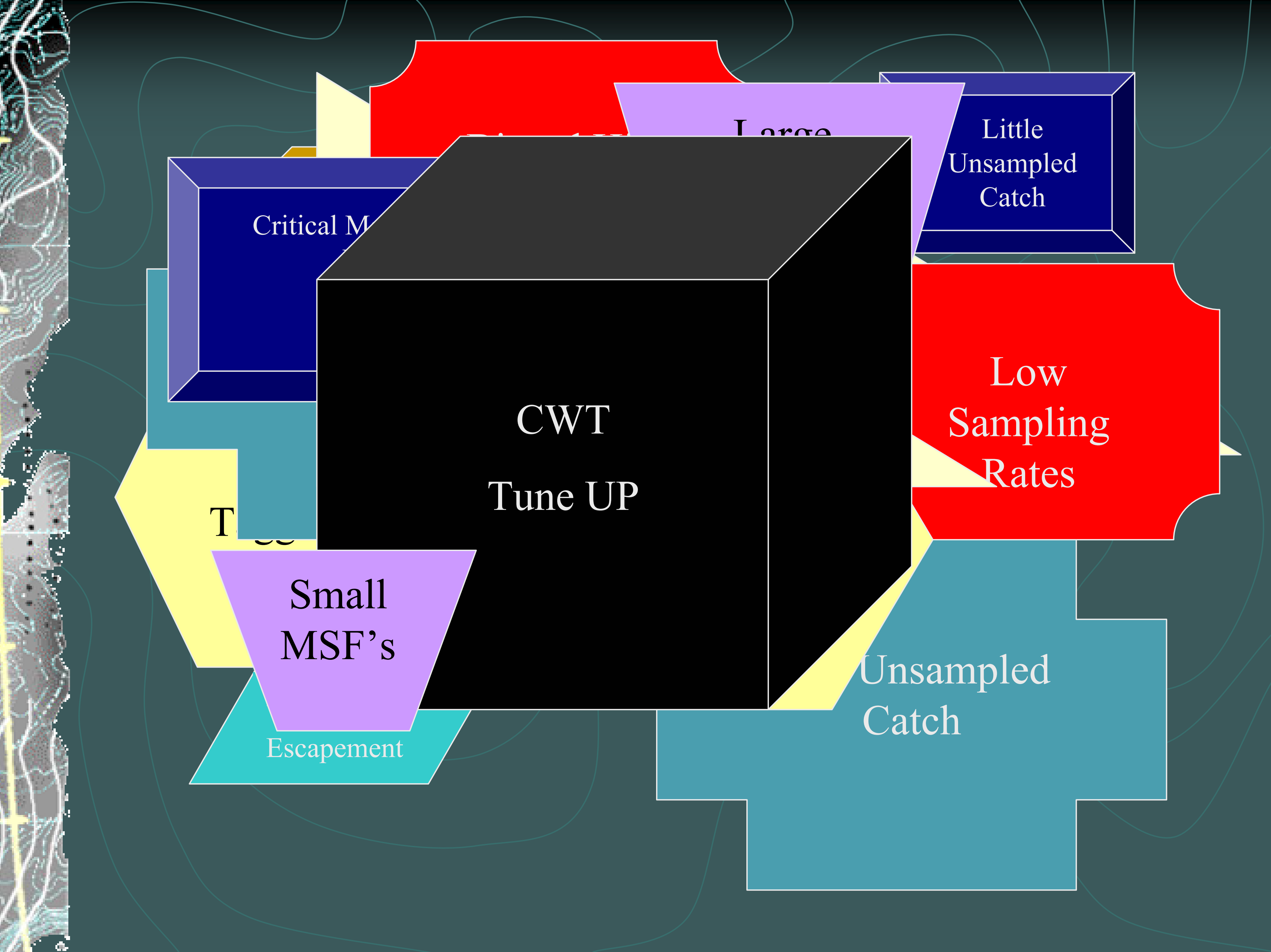
Fishery	True Marked Mortalities (*M*)[1]	True Unmarked Mortalities (*U*)	True Unmarked Exploitation Rate	Estimated Unmarked Mortalities (est'd U) w/DIT[1]	Estimated Unmarked Exploitation Rate w/DIT	Estimated Unmarked Exploitation Rate w/o DIT
Initial Cohort Size	1000	1000		998.65		
MSF 1 HR = 0.15	150	15	0.015	15	0.015	0.015
MSF 2 HR = 0.10	85	9.85	0.00985	8.5	0.0085	0.0085
NSF 1 HR = 0.20	153	195.03	0.195	195.03	0.1953	0.153
NSF 2 HR = 0.10	61.2	69.15	0.06915	69.15	0.0692	0.0612
Escapement	550.8	710.97		710.97		

With DIT

- We have a data based means of bounding bias on ER's where the escapement λ is an overestimate.
- We have a means of monitoring the MSF impact
- We have less biased ER's in NSF's.

Conclusions

- There is more than one way to do the MSF analyses (e.g. release, NSF, or escapement λ)
- Some methods are biased, others imprecise
- In the coho MSF's the MSF impact was difficult to detect (even with SER's ~ 15%).
- DIT provides monitoring information, a means for bounding bias.


Little Unsampled Catch
Critical M
Low Sampling Rates
CWT
Tune UP
T
Small MSF's
Unsampled Catch
Escapement