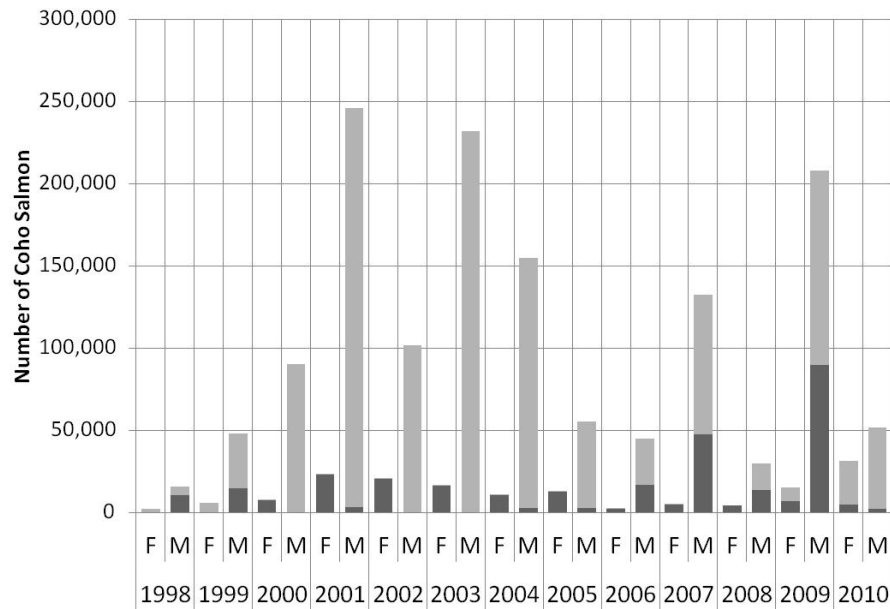


MSFs – What have we learned from CWTS and DITs?

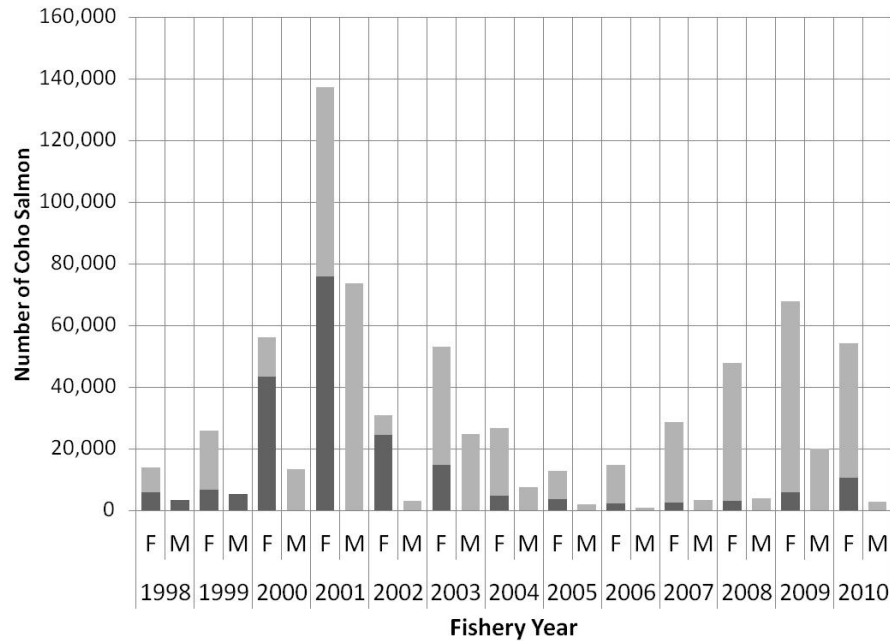
MSF Workshop 2013. NWIFC.

Marianna Alexandersdottir

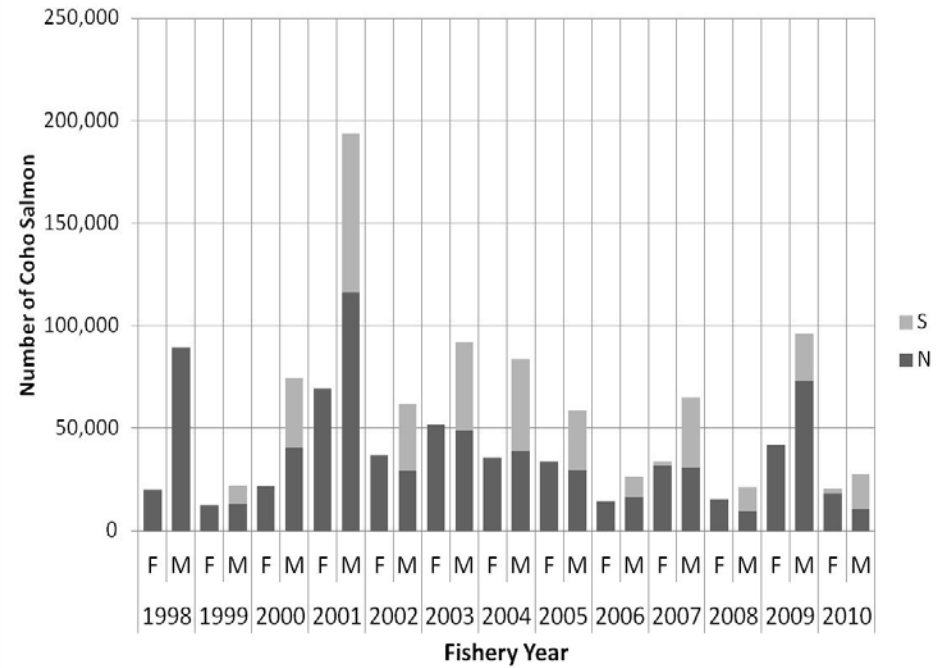
WA and OR Coast Coho Salmon



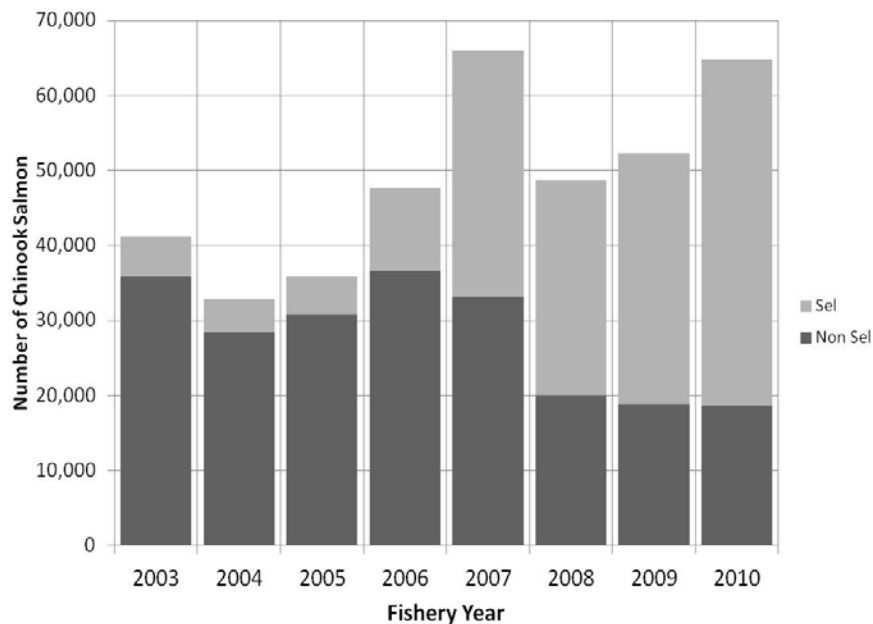
Columbia River Coho Salmon



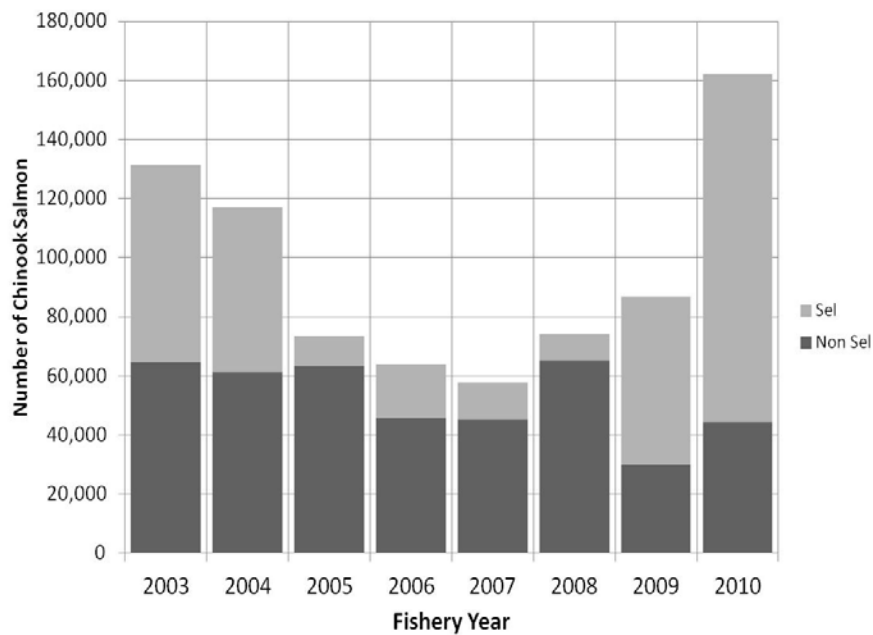
Puget Sound Coho Salmon



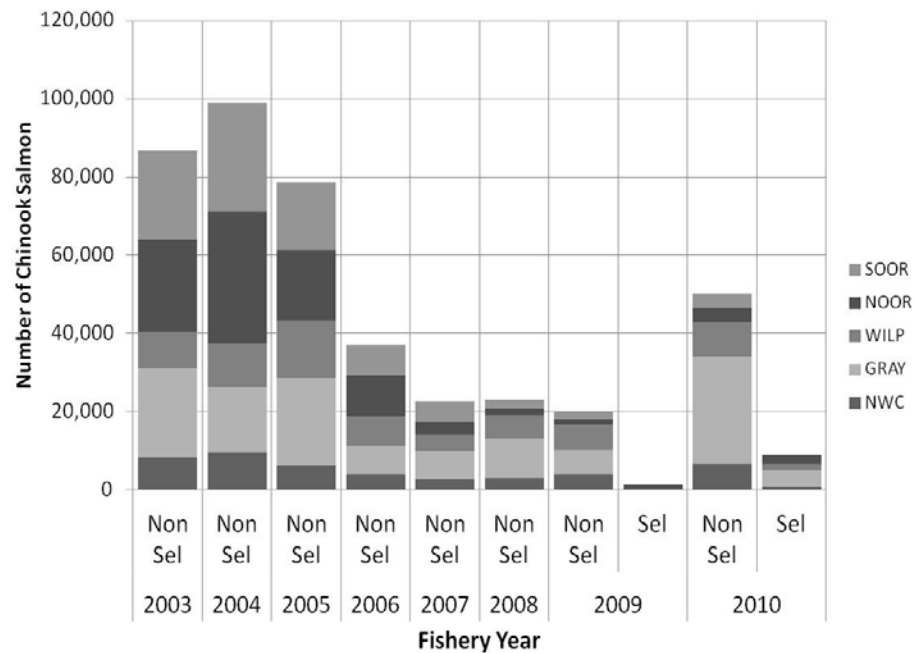
Puget Sound Chinook Salmon Sport Fisheries



Columbia River Chinook Salmon Sport Fisheries



WA and OR Coast Chinook Salmon Sport Fisheries



Management of Natural Stocks – Indicator Stock Programs

- 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.*
- Most of our indicator stocks are hatchery releases

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

Indicator Tag Groups

- Chinook salmon
 - PSC Chinook indicator groups
- Coho salmon
 - Tag outmigrating natural origin and hatchery release groups

Indicator tag groups provide estimates of exploitation rates which:

- Are used in all of our management models in PFMC and PSC management forums
 - provide information needed to track post season impacts of fisheries
- CWTs are the only source of data on fisheries from Alaska to California

Mass Marking and Mark Selective Fisheries

Problem and Solution

- Problem? The fishery impacts on tagged indicator stocks are representative of the impacts on natural production
- Solution? DITs or double index tags Two groups of fish, each with its own CWT, presumed identical, except that

One group is unmarked

This group now represents wild fish, but will not be sampled in MSFs

The other group is marked

This group provides complete sample coverage and allows estimation of unmarked impacts

Chinook Indicators

Area	Natural/Unmarked Stock Representation	Indicators DIT	
<input type="checkbox"/> S.E. Alaska	Southeast Alaska	2	
<input type="checkbox"/> British Columbia	Georgia Strait	4	
	Lower Fraser River	3	1
	North/Central BC	1	
	West Coast Vancouver Is	1	
<input type="checkbox"/> Puget Sound	Central Puget Sound	5	2
	Hood Canal	1	1
	North Puget Sound	2	2
	South Puget Sound	5	3
	Strait of Juan de Fuca	2	
<input type="checkbox"/> Washington Coast	North Wash. Coast	2	
<input type="checkbox"/> Columbia Basin	Columbia R. (WA)	6	2
	Columbia River (OR)	1	1
	Lower Columbia R.	3	1
	SNAKE RIVER	1	
	Upper Columbia R.	3	1
<input type="checkbox"/> Oregon Coast	North Oregon Coast	1	
Grand Total		43	14

Coho salmon

Region	Stock Representation	Values	
		Indicators	DITs
<input type="checkbox"/> BC North Coast	North Coast Wild	1	
	Skeena	1	
<input type="checkbox"/> Georgia Basin	North Vancouver Island	1	1
	East Coast Vancouver Island	2	
	East Coast Vancouver Island	1	
	Lower Fraser	1	1
	Lower Fraser Wild	1	
<input type="checkbox"/> Interior Fraser	Thompson River	3	
<input type="checkbox"/> West Coast Van Is.	West Coast Vancouver Island	1	
<input type="checkbox"/> Puget Sound	Strait of Juan de Fuca	1	1
	Dungeness	1	
	Nooksack	2	
	Skagit	2	1
	Stillaguamish/Snohomish	2	1
	Mid Puget Sound	1	1
	South Puget Sound	3	1
	North Hood Canal	3	1
	South Hood Canal	1	1
	Big Beef Creek (Hood Canal)	1	
<input type="checkbox"/> Washington Coast	Grays Harbor	4	1
	North Central Coast	2	1
	North Coast	2	2
	Quinault	1	1
	Willapa Bay	4	1
<input type="checkbox"/> Columbia River	Lower Columbia	3	3
Grand Total		45	18

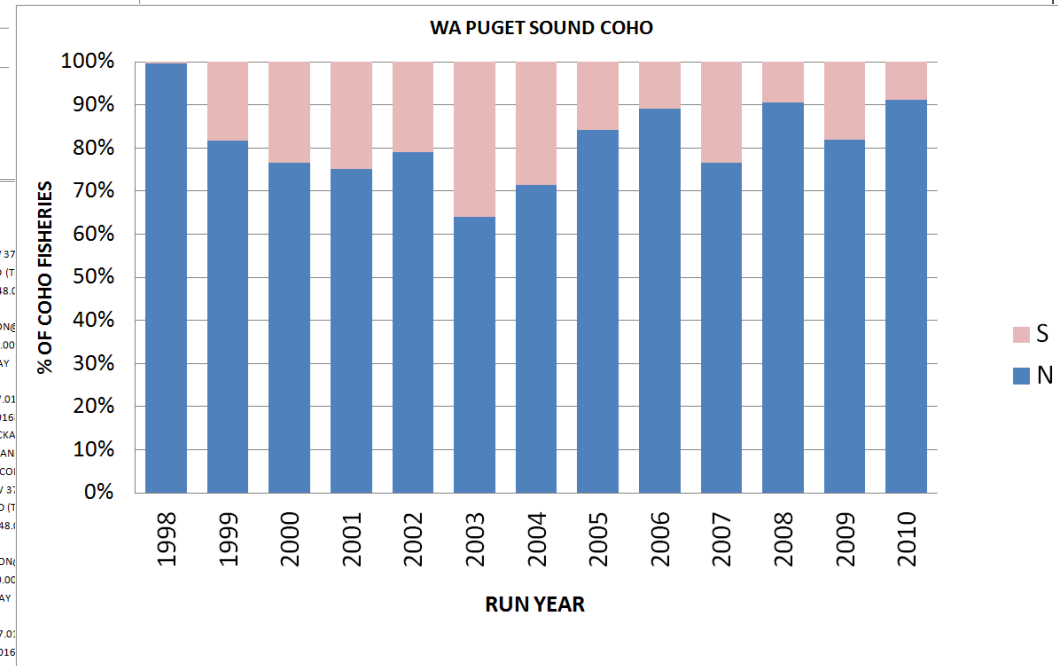
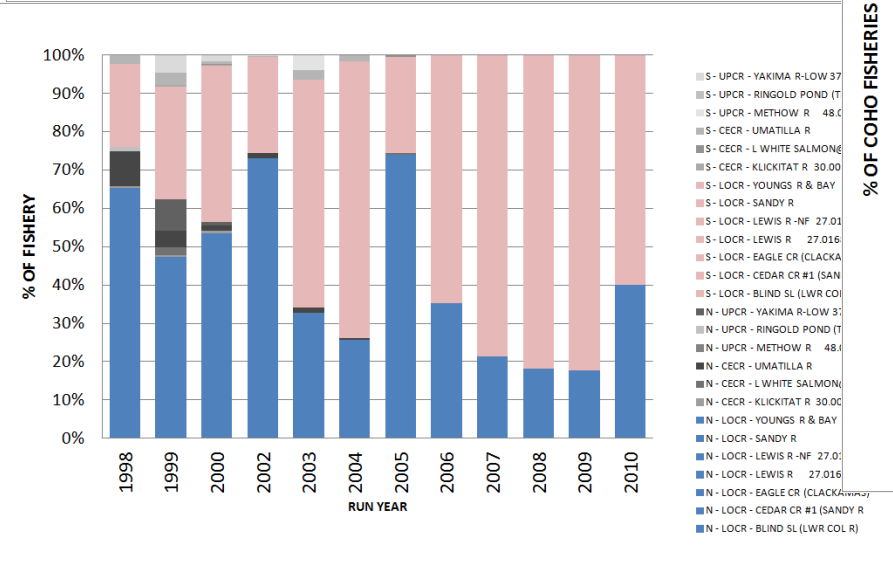
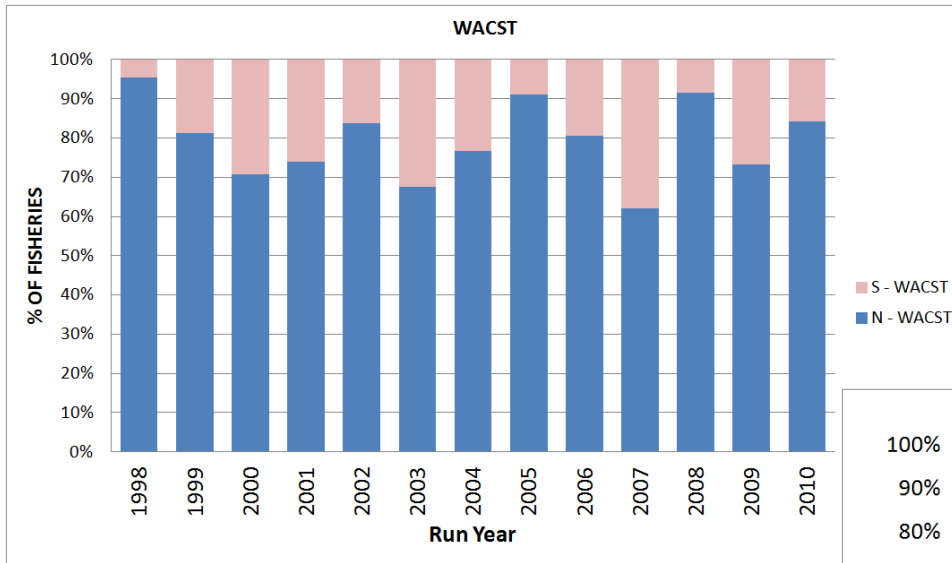
What have we learned from DITs?

- Size of MSF – Proportion of all marked fishery harvest that occurs in MSFs.
 - Can do this with all indicator groups, DITs and single index tag groups (SITs).
- Ask the question whether there has been a difference in the impact on marked and unmarked salmon
 - Can only do this with DITs
- Estimate mortalities of unmarked fish released in MSFs
 - Method depends on whether there is a DIT or not.

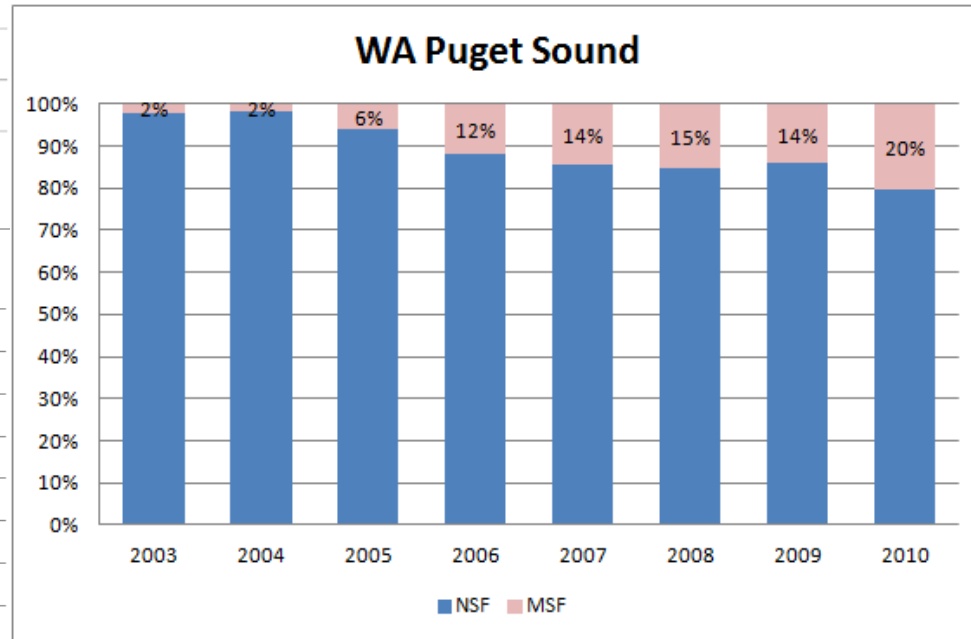
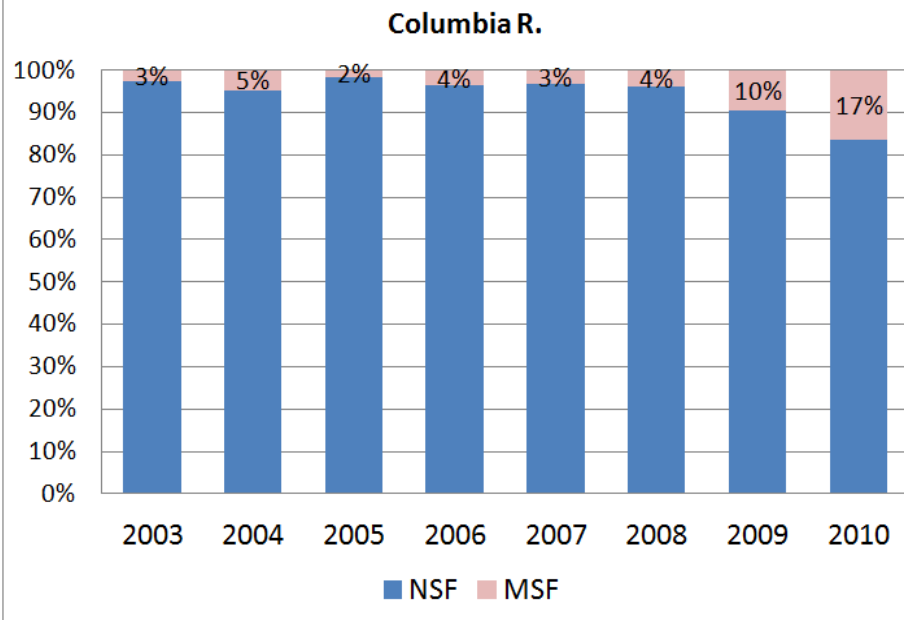
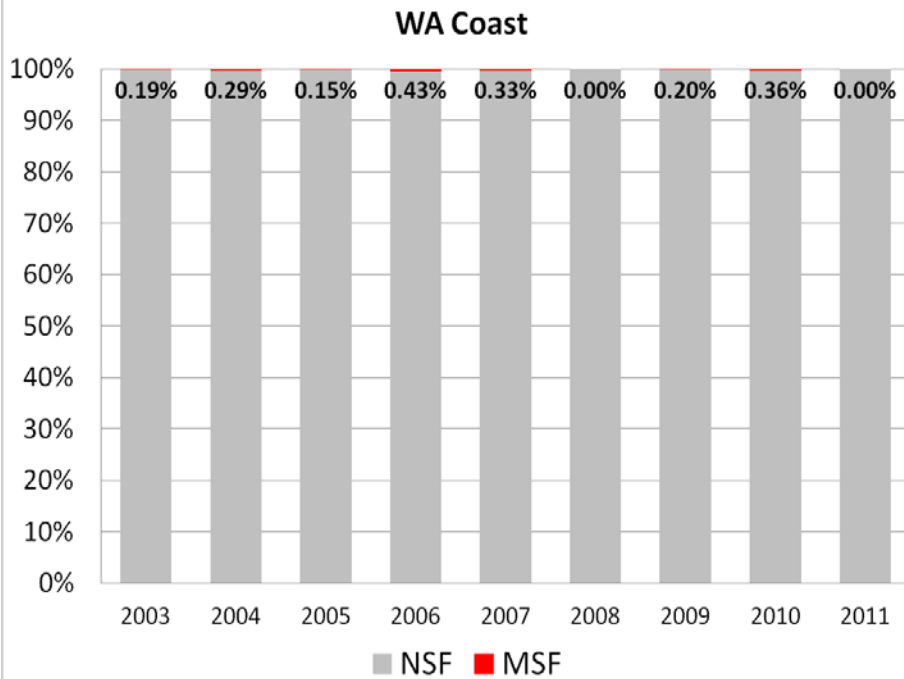
What have we learned from DITs?

- Size of MSF – Proportion of all marked fishery harvest that occurs in MSFs.
 - Can do this with all indicator groups, DITs and single index tag groups (SITs).
- Ask the question whether there has been a difference in the impact on marked and unmarked salmon
 - Can only do this with DITs
- Estimate mortalities of unmarked fish released in MSFs
 - Method depends on whether there is a DIT or not.

Coho Salmon marked tag groups by region of origin



Chinook Salmon marked indicators by region of origin



What have we learned from DITs?

- Size of MSF – Proportion of all marked fishery harvest that occurs in MSFs.
 - Can do this with all indicator groups, DITs and single index tag groups (SITs).
- Ask the question whether there has been a difference in the impact on marked and unmarked salmon
 - Can only do this with DITs
- Estimate mortalities of unmarked fish released in MSFs
 - Method depends on whether there is a DIT or not.

Difference in the impact on marked and unmarked salmon?

- Ratio of number of unmarked to marked

- At release –

$$\lambda_{Rel} = \frac{N_{unmarked\ released}}{N_{marked\ released}}$$

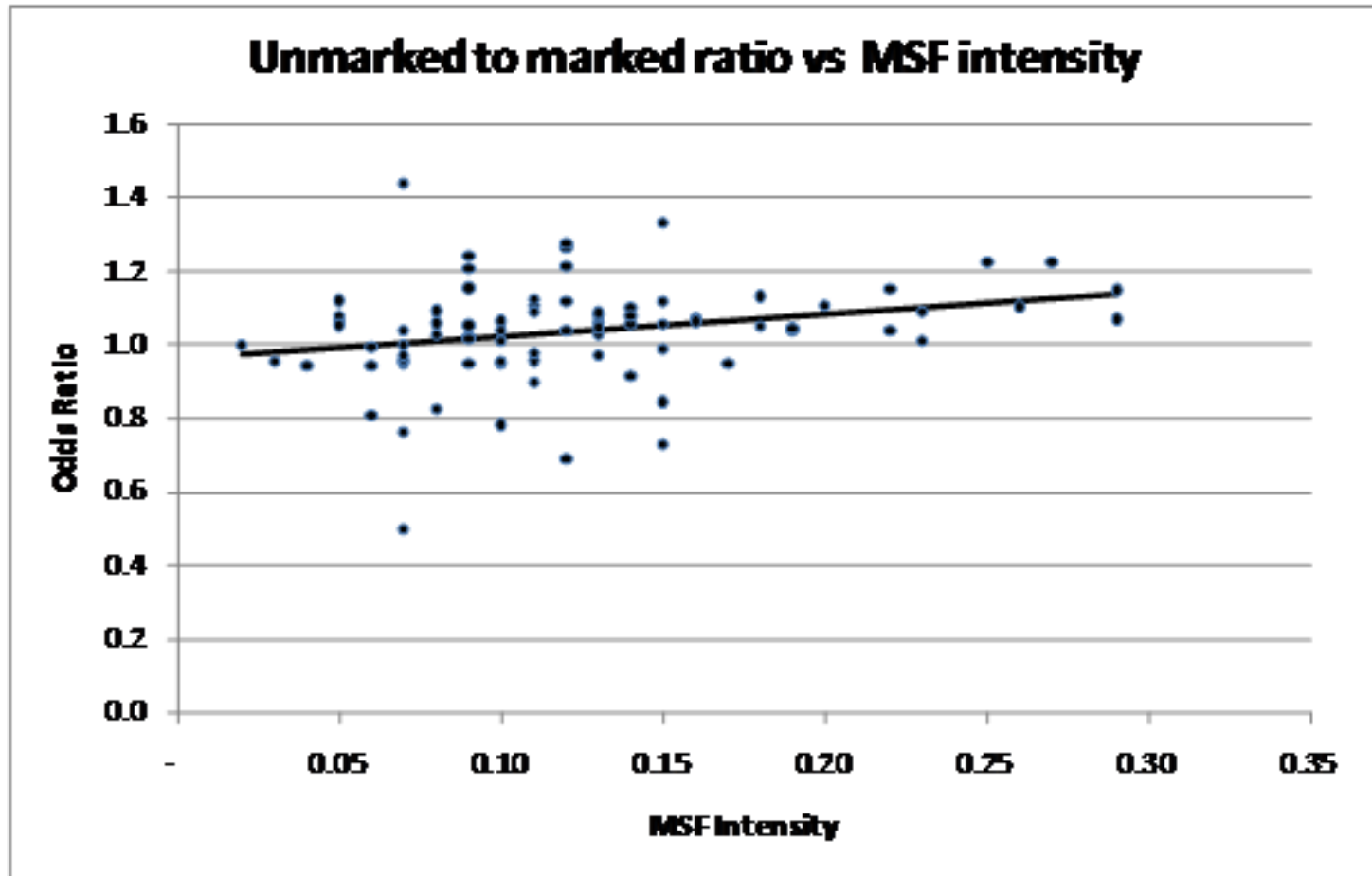
- At escapement

$$\lambda_{Esc} = \frac{N_{unmarked\ Escaping}}{N_{marked\ Escaping}}$$

- Odds Ratio

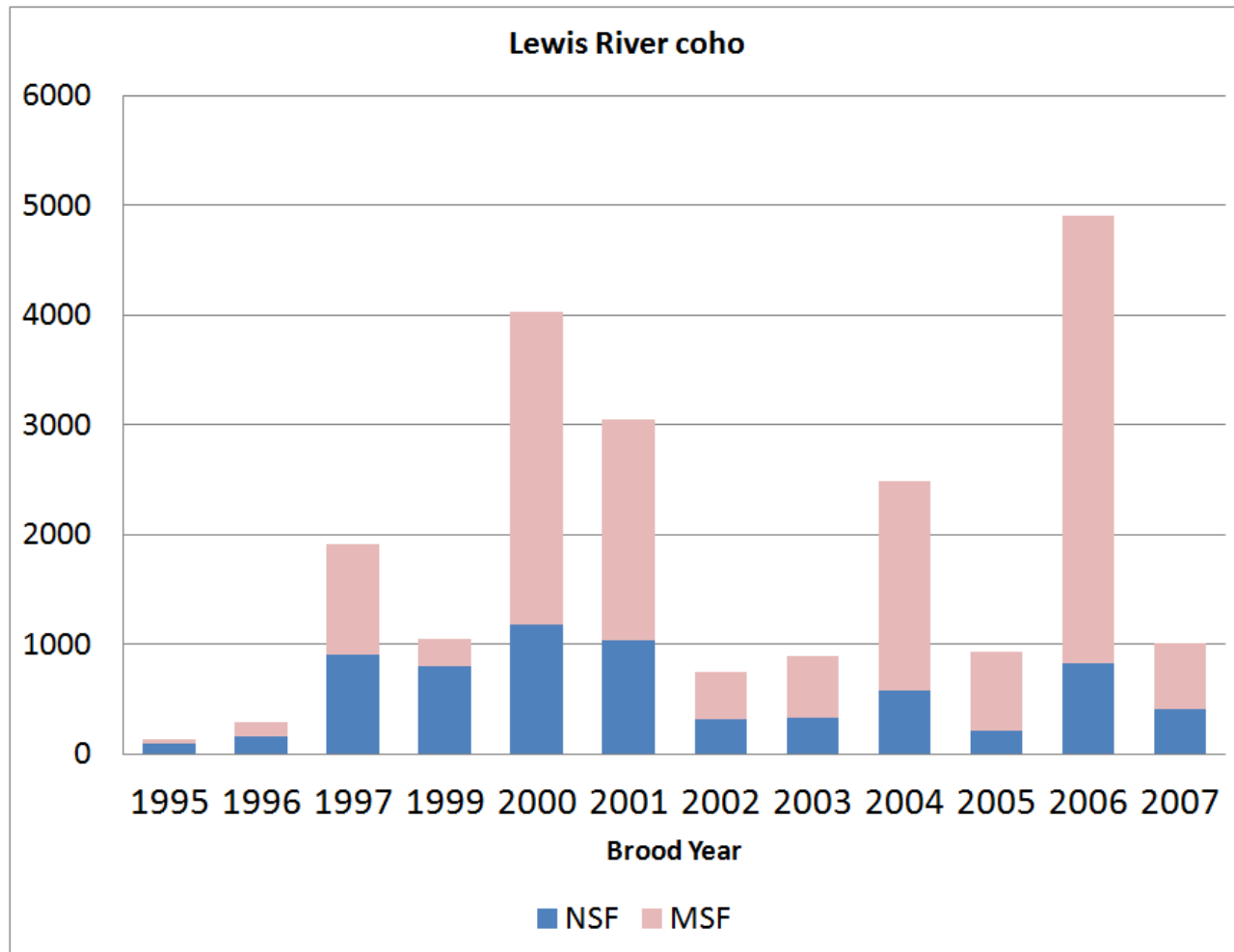
$$Odds\ Ratio = \frac{\lambda_{Esc}}{\lambda_{Rel}}$$

Coho salmon 1998-2003 broods



Lewis River Coho Salmon

% of fishery catch in MSF

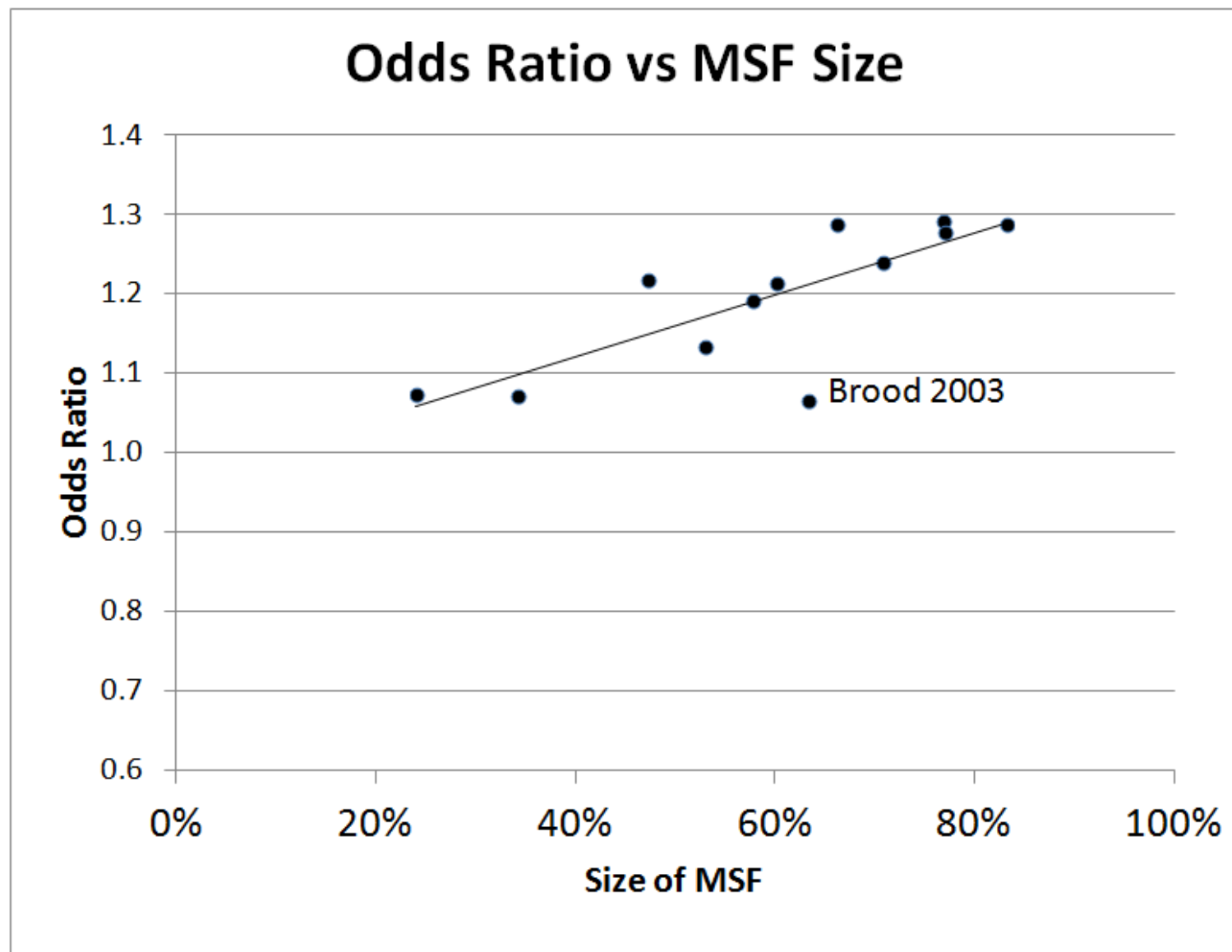


Lewis River Coho Salmon

Significant Impact?

	Unmarked		Marked					ODDS
Brood Year	Escapement	Release	Escapement	Release	λ rel	λ esc	Significant?	RATIO
1995	478	70,617	435	68,835	1.0259	1.0993		1.072
1996	1,517	73,168	1,255	73,416	0.9966	1.2086	Y	1.217
1997	2,990	148,824	2,605	146,633	1.0149	1.1477	Y	1.133
1998	7,511	140,955	5,867	140,277	1.0048	1.2802	Y	1.289
1999	2,218	154,700	1,880	140,763	1.0990	1.1796	Y	1.074
2000	6,712	147,207	5,362	144,605	1.0180	1.2518	Y	1.241
2001	3,990	148,082	2,930	139,249	1.0634	1.3621	Y	1.289
2002	3,892	145,971	3,017	134,198	1.0877	1.2901	Y	1.191
2003	3,196	133,663	2,936	130,636	1.0232	1.0886	Y	1.066
2004	3,763	140,823	2,929	140,677	1.0010	1.2847	Y	1.291
2005	4,211	140,292	3,397	143,739	0.9760	1.2396	Y	1.278
2006	4,896	150,865	3,859	152,003	0.9925	1.2689	Y	1.288
2007	3,614	151,574	3,011	152,599	0.9933	1.2003	Y	1.214

Lewis River Coho Salmon

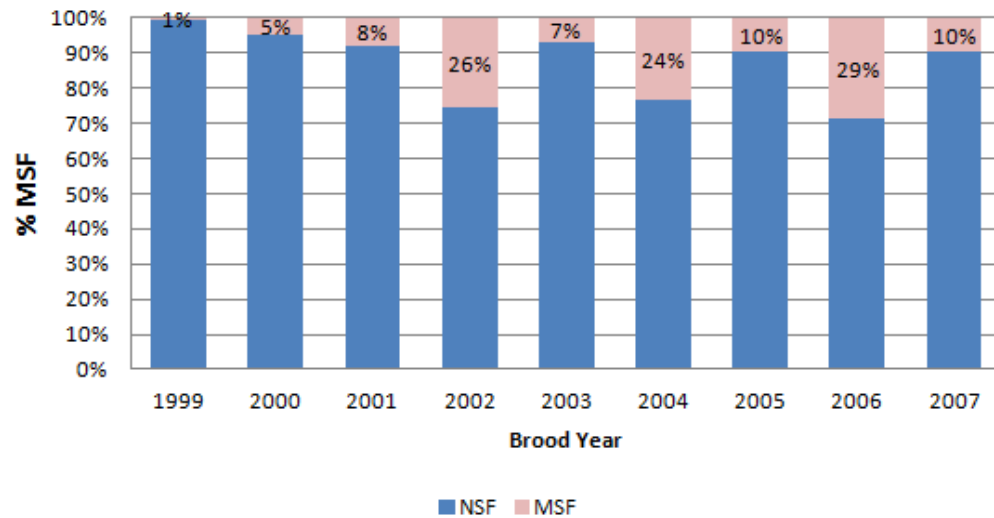


Chinook Salmon MSF

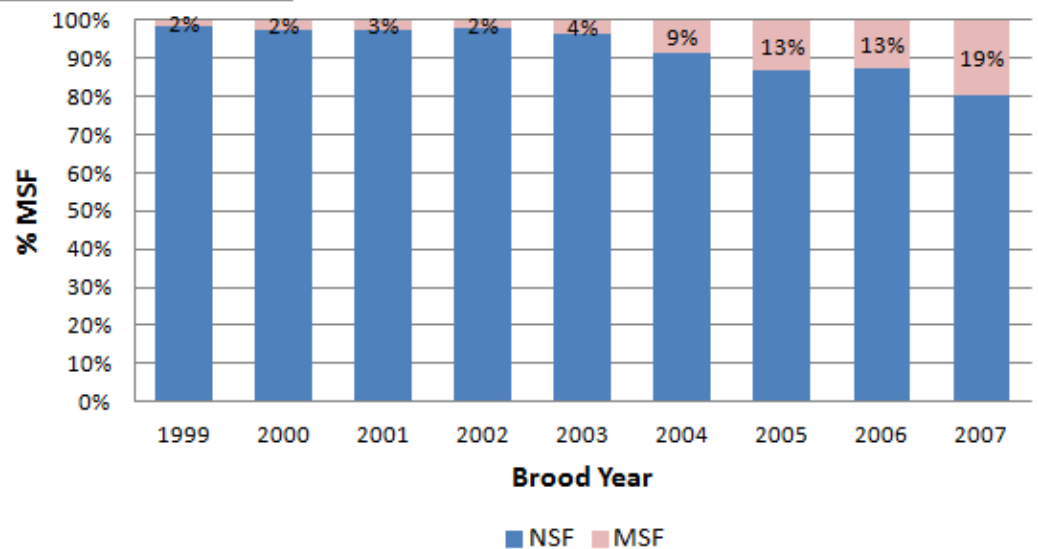
Location	Period	2003	2004	2005	2006	2007	2008	2009	2010
BC Strait of Juan de Fuca, selected subareas	March-April						√	√	√
WA/OR Ocean Area 1-4	June								√
WA PS Area 5	Summer	√	√	√	√	√	√	√	√
WA PS Area 6	Summer	√	√	√	√	√	√	√	√
WA PS Area 7	Winter						√	√	√
WA PS Area 8.1	Winter			√	√	√	√	√	√
WA PS Area 8.2	Winter			√	√	√	√	√	√
WA PS Area 9	Summer					√	√	√	√
WA PS Area 9	Winter						√	√	√
WA PS Area 10	Summer					√	√	√	√
WA PS Area 10	Winter						√	√	√
WA PS Area 11	Summer					√	√	√	√
WA PS Area 11	Winter							√	√
WA PS Area 12	Winter								√
WA PS Area 13	Summer					√	√	√	√
Nooksack	Sep-Dec		√	√	√	√	√	√	√
Skykomish	Jun-July	√	√	√	√	√	√	√	√
Carbon & Puyallup R	Aug-Dec	√	√	√	√	√	√	√	√
Upper Skagit	Jun-July			√	√	√	√	√	√
Nisqually	Jul-Jan				√	√	√	√	√
Skokomish	Aug-Dec								√

Chinook Salmon

North Puget Sound



South Puget Sound



Ho: There is no difference in proportion of release returning to escapement between marked and unmarked DIT groups

		Unmarked		Marked							p(Z)	
Stock	Brood Year	Escapemen	Release	Escapemen	Release	λ rel	λ esc	Ages in	Terminal	Z-statistic	two tailed	Significant?
Green River	2001	108	162,160	88	178,119	0.910	0.813	2-5		2.08	0.04	Y
	2002	493	198,321	550	192,443	1.031	1.116	2-5		(2.26)	0.02	Y
	2004	578	204,269	507	204,698	0.998	0.879	2-5		2.14	0.03	Y
	2005	938	198,542	807	196,353	1.011	0.860	2-4		2.87	0.00	Y
	2006	229	204,385	165	204,795	0.998	0.721	2-3		3.19	0.00	Y
Grovers Cree	2003	1,431	151,492	1,348	163,799	0.925	0.942	2-5		3.65	0.00	Y
	2004	1,133	133,455	872	118,197	1.129	0.770	2-5		3.06	0.00	Y
	2005	1,115	169,954	1,076	136,519	1.245	0.965	2-4		(3.94)	0.00	Y
Nisqually	1998	668	192,165	485	202,103	0.951	0.726	2-5	Y	6.00	0.00	Y
	2002	572	99,688	426	88,909	1.121	0.745	2-5	Y	2.79	0.01	Y
	2002	500	92,560	382	91,385	1.013	0.765	2-5	Y	3.71	0.00	Y
	2003	1,235	203,624	1,096	207,975	0.979	0.887	2-5	Y	3.30	0.00	Y
	2004	1,102	209,905	924	208,724	1.006	0.838	2-5	Y	3.71	0.00	Y
	2005	674	127,293	510	120,154	1.059	0.757	2-4	Y	3.62	0.00	Y
	2006	334	204,613	268	204,221	1.002	0.801	2-3	Y	2.41	0.02	Y
Skagit Spring	2002	561	60,000	436	59,777	1.004	0.777	2-5	Y	3.92	0.00	Y
	2003	338	75,418	242	74,590	1.011	0.715	2-5	Y	3.87	0.00	Y
	2004	718	71,942	465	73,668	0.977	0.648	2-5	Y	7.71	0.00	Y
Skykomish	2002	408	197,105	325	195,075	1.010	0.797	2-5	Y	2.83	0.00	Y
	2003	469	173,116	416	176,427	0.981	0.887	2-5	Y	1.99	0.05	Y
	2004	966	199,529	807	200,398	0.996	0.835	2-5	Y	3.70	0.00	Y
	2006	103	206,362	75	205,344	1.005	0.726	2-3	Y	2.01	0.04	Y

What have we learned from DITs?

- Size of MSF – Proportion of all marked fishery harvest that occurs in MSFs.
 - Can do this with all indicator groups, DITs and single index tag groups (SITs).
- Ask the question whether there has been a difference in the impact on marked and unmarked salmon
 - Can only do this with DITs
- Estimate mortalities of unmarked fish released in MSFs
 - Method depends on whether there is a DIT or not.

Estimate unmarked mortalities in MSF Chinook

Release Location	Brood	Return Year	DIT Group Id	Obs	Lambda	Observed		Retained			Var	Encoun.	Unmarked		
						Unmark	Marked	Marked	Var	Unmark			Var	Mort.	Var
CLEAR CREEK HATCHERY	2003	2005	142004DI02	1	0.98	0	1	3.70	11.37	-	-	3.62	10.90	0.36	0.11
DUNGENESS HATCHERY	2002	2005	420031002	1	0.95	0	1	3.70	11.37	-	-	3.52	10.30	0.35	0.10
GEORGE ADAMS HATCHRY	2001	2005	420021021	1	0.94	0	1	3.70	11.37	-	-	3.47	10.00	0.35	0.10
GEORGE ADAMS HATCHRY	2002	2005	420031025	7	1.00	0	7	26.40	150.16	-	-	26.30	149.01	2.63	1.49
GROVERS CR HATCHERY	2002	2005	142003DI01	1	0.98	1	0	-	-	3.70	11.37	-	10.83	3.70	11.48
KENDALL CR HATCHERY	2002	2005	420031019	1	1.01	0	1	3.70	11.37	-	-	3.75	11.68	0.38	0.12
KENDALL CR HATCHERY	2003	2005	420041024	1	0.98	0	1	3.70	11.37	-	-	3.63	10.93	0.36	0.11
MARBLEMOUNT HATCHERY	2002	2005	420041021	2	1.00	0	2	7.40	25.89	-	-	7.43	26.09	0.74	0.26
SAMISH HATCHERY	2001	2005	420021029	2	0.97	0	2	7.65	26.99	-	-	7.45	25.60	0.75	0.26
SAMISH HATCHERY	2002	2005	420031023	2	1.01	0	2	7.40	25.89	-	-	7.48	26.43	0.75	0.26
SOOS CREEK HATCHERY	2001	2005	420021009	1	0.91	0	1	3.95	12.25	-	-	3.60	10.15	0.36	0.10
SOOS CREEK HATCHERY	2002	2005	420031026	1	1.03	0	1	3.70	11.37	-	-	3.81	12.07	0.38	0.12
WALLACE R HATCHERY	2002	2005	420031010	1	1.01	0	1	3.70	11.37	-	-	3.74	11.61	0.37	0.12
CLEAR CREEK HATCHERY	2002	2006	142003DI02	2	1.12	0	2	7.77	28.69	-	-	8.71	36.07	0.87	0.36
CLEAR CREEK HATCHERY	2002	2006	142003DI03	1	1.01	0	1	3.69	12.35	-	-	3.74	12.67	0.37	0.13
CLEAR CREEK HATCHERY	2003	2006	142004DI02	7	0.98	1	6	22.92	114.16	3.69	12.35	22.44	121.27	5.93	13.56
GEORGE ADAMS HATCHRY	2003	2006	420041012	3	0.99	0	3	11.07	43.98	-	-	11.01	43.49	1.10	0.43
GROVERS CR HATCHERY	2002	2006	142003DI01	2	0.98	0	2	7.77	28.69	-	-	7.58	27.34	0.76	0.27
GROVERS CR HATCHERY	2003	2006	142004DI01	5	0.92	0	5	18.84	87.30	-	-	17.42	74.68	1.74	0.75
H-Chilliwack River H	2003	2006	032004H000C	1	1.00	0	1	4.08	13.79	-	-	4.09	13.84	0.41	0.14
KENDALL CR HATCHERY	2003	2006	420041024	1	0.98	0	1	3.69	12.35	-	-	3.62	11.87	0.36	0.12
LYONS FERRY HATCHERY	2003	2006	420051060	4	1.00	0	4	15.15	65.45	-	-	15.16	65.57	1.52	0.66
SAMISH HATCHERY	2002	2006	420031023	3	1.01	0	3	11.85	47.87	-	-	11.97	48.86	1.20	0.49
SAMISH HATCHERY	2003	2006	420041008	3	0.98	0	3	11.46	45.91	-	-	11.20	43.83	1.12	0.44
SOOS CREEK HATCHERY	2002	2006	420031026	3	1.03	1	2	7.77	28.69	3.69	12.35	8.01	43.58	4.49	12.78
SOOS CREEK HATCHERY	2003	2006	420041023	1	1.00	0	1	4.08	13.79	-	-	4.08	13.76	0.41	0.14
WALLACE R HATCHERY	2003	2006	420041022	2	0.98	0	2	7.38	27.01	-	-	7.24	26.00	0.72	0.26

Estimate unmarked mortalities and ERs in MSFs and

- RAID provides estimates of unmarked mortalities
- Coho Tech. Committee is using DITs to estimate ERs for new Coho PSC model
- SFEC and CTC are developing methods to incorporate DITs in Chinook ERA