

# SSRAA compare homing from tow and control - chum samon Neets Bay

Bobby Hsu, Lorna Wilson, Sara Miller

2025-04-25

## Table of contents

<b>Objective</b>	<b>2</b>
<b>Data</b>	<b>2</b>
<b>Method #1: <math>\chi^2</math> Test</b>	<b>3</b>
Net versus Tender . . . . .	3
<b>Results #1</b>	<b>4</b>
<p><i>p</i>-values . . . . .</p> Combined <i>p</i> -value with Fisher's method . . . . .	<p>4</p> 4
<b>Method #2: Binomial regression model</b>	<b>4</b>
<b>Results #2: Binomial regression model</b>	<b>5</b>
<b>Appendix</b>	<b>6</b>
$\chi^2$ Test: Net versus Control . . . . .	6
<p><i>p</i>-values . . . . .</p> Combined <i>p</i> -value with Fisher's method . . . . .	<p>6</p> 6
$\chi^2$ Test: Tender versus Control . . . . .	7
<p><i>p</i>-values . . . . .</p> Combined <i>p</i> -value with Fisher's method . . . . .	<p>7</p> 7

## Objective

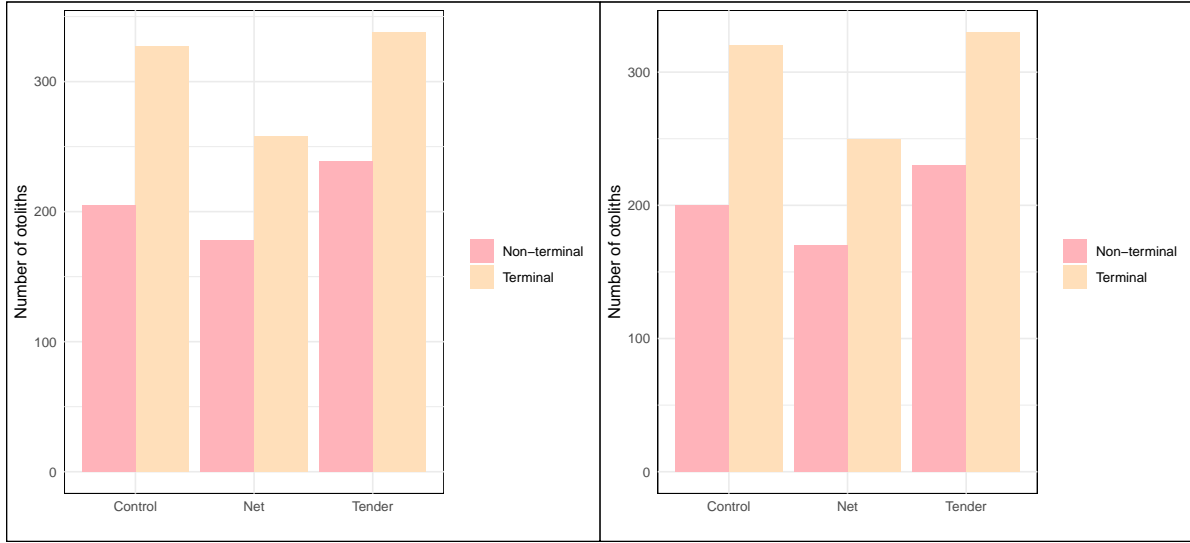
To increase the marine survival of Neets Bay chum salmon by reducing predation pressure of out-migrating fry, while not negatively impacting the homing behavior, fry were transported outside of Neets Bay for release. There were three release strategies (tender, net, control). The control group was released from saltwater pens at the head of Neets Bay, adjacent to the hatchery. Evaluation of homing by release group was based on salmon harvested in the terminal areas (Neets Bay hatchery rack, common property commercial and cost recovery in terminal areas) and non-terminal areas (fisheries and areas outside of Neets Bay), and the otolith recovery mark (distinguishes release strategy). Details of the study can be found in Frost et al. 2021.

The objective of the following analysis is to assess the effects of release strategy (towed net pens, tender, control) on the fish homing behavior of Neets Bay hatchery chum salmon. If the ratio of otolith recoveries for the transport groups (net, tender) in the two sample locations (terminal, non-terminal) compared is significantly different ( $p < 0.05$ ) compared to the ratio observed for the control group, then the transport release strategy may affect homing behavior.

## Data

Table 1: Neets Bay chum salmon data

Year	Group	Terminal return	Non-terminal return	Total
2023	control	327	205	532
2023	net	258	178	436
2023	tender	338	239	577
2024	control	320	200	520
2024	net	250	170	420
2024	tender	330	230	560



(a) Neets Bay chum salmon data, 2023.

(b) Neets Bay chum salmon data, 2024.

Figure 1: Neets Bay chum salmon data.

## Method #1: $\chi^2$ Test

### Net versus Tender

Table 2: Chi-Squared observed counts, 2023

	net	tender
terminal	258	338
non-terminal	178	239

Table 3: Chi-Squared expected counts, 2023

	net	tender
terminal	256.52	339.48
non-terminal	179.48	237.52

Table 4: Chi-squared observed counts, 2024

	net	tender
terminal	250	330
non-terminal	170	230

Table 5: Chi-squared expected counts, 2024

	net	tender
terminal	248.57	331.43
non-terminal	171.43	228.57

## Results #1

### *p*-values

2023 2024  
0.904 0.899

### Combined *p*-value with Fisher's method

chisq = 0.4167958 with df = 4 p = 0.9810788

## Method #2: Binomial regression model

A binomial model with proportions for recoveries in terminal areas and recoveries in non-terminal areas as the response variable and release method as the explanatory variable. Group is a fixed effect and year is included as a random intercept term accounting for variation across different years. Intercept is removed.

```
# model
home_random <- glmer(cbind(terminal, non_terminal) ~ group -1 + (1 | year),
                     family = binomial,
                     data = tag_dat)
```

Table 6: Binomial regression model results

	Random Effects Model
groupcontrol	0.468*** (0.063)
groupnet	0.378*** (0.070)
grouptender	0.354*** (0.060)
SD (Intercept year)	0.000
Num.Obs.	6
R2 Marg.	0.311
AIC	47.8
BIC	47.0
RMSE	0.00

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Standard errors shown in parenthesis.

## Results #2: Binomial regression model

Table 7: Binomial regression model output.

effect	term	estimate	std.error	statistic	p.value	conf.low	conf.high	probability
fixed	groupcontrol	0.4685	0.0634	7.3934	0	0.5852	0.6440	0.6150
fixed	groupnet	0.3783	0.0696	5.4362	0	0.5602	0.6259	0.5935
fixed	grouptender	0.3537	0.0602	5.8710	0	0.5586	0.6158	0.5875

Table 8: Pairwise comparison between release groups.

contrast	estimate	SE	df	asympt.LCL	asympt.UCL	z.ratio	p.value
control - net	0.0902	0.0941	Inf	-0.1304	0.3107	0.9582	0.6033
control - tender	0.1148	0.0874	Inf	-0.0901	0.3197	1.3128	0.3880
net - tender	0.0246	0.0920	Inf	-0.1911	0.2403	0.2672	0.9614

## Appendix

### $\chi^2$ Test: Net versus Control

Table 9: Chi-squared observed counts, 2023

	control	net
terminal	327	258
non-terminal	205	178

Table 10: Chi-squared expected counts, 2023

	control	net
terminal	321.51	263.49
non-terminal	210.49	172.51

Table 11: Chi-squared observed counts, 2024

	control	net
terminal	320	250
non-terminal	200	170

Table 12: Chi-squared expected counts, 2024

	control	net
terminal	315.32	254.68
non-terminal	204.68	165.32

### ***p*-values**

2023   2024  
0.494   0.556

### **Combined *p*-value with Fisher's method**

chisq = 2.582592   with df = 4   p = 0.62991

## $\chi^2$ Test: Tender versus Control

Table 13: Chi-squared observed counts, 2023

	control	tender
terminal	327	338
non-terminal	205	239

Table 14: Chi-squared expected counts, 2023

	control	tender
terminal	319.01	345.99
non-terminal	212.99	231.01

Table 15: Chi-squared observed counts, 2024

	control	tender
terminal	320	330
non-terminal	200	230

Table 16: Chi-squared expected counts, 2024

	control	tender
terminal	312.96	337.04
non-terminal	207.04	222.96

### ***p*-values**

2023   2024  
0.371   0.369

### **Combined *p*-value with Fisher's method**

chisq = 3.97633   with df = 4   p = 0.4092188