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

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Objective

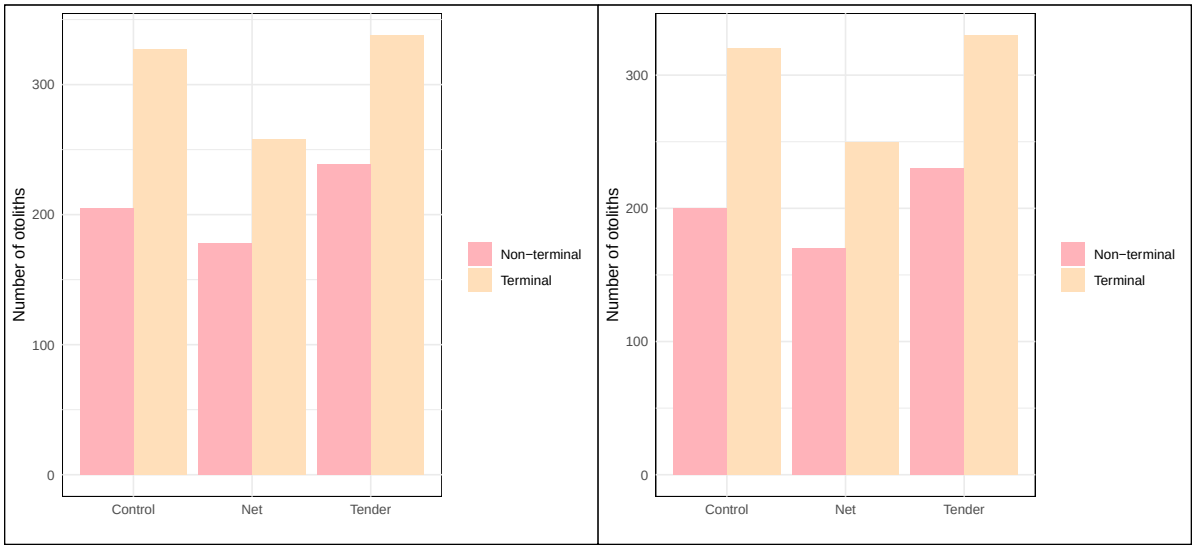
To increase the marine survival of Neets Bay chum salmon by reducing predation pressure of out-migrating fry, while not negatively impacting the homing behavior, fry were transported outside of Neets Bay for release. There were three release strategies (tender, net, control). The control group was released 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: χ^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
0.902 0.900
```

Combined *p*-value with Fisher's method

```
chisq =  0.4178937  with df =  4  p =  0.9809859
```

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)
```

	Random Effects Model
groupcontrol	0.416*
	(0.164)
groupnet	0.330*
	(0.164)
grouptender	-0.054
	(0.164)
SD (Intercept year)	0.268
Num.Obs.	9
R2 Marg.	0.374
R2 Cond.	0.948
AIC	353.2
BIC	354.0
ICC	0.9
RMSE	0.13

* p < 0.05, ** p < 0.01, *** p < 0.001
Standard errors shown in parenthesis.

Results #2: Binomial regression model

```
  effect         term    estimate std.error  statistic    p.value  conf.low
1  fixed groupcontrol  0.41594608 0.1636427  2.5417937 0.01102852 0.5237851
2  fixed     groupnet  0.32979875 0.1638533  2.0127685 0.04413899 0.5021630
3  fixed  grouptender -0.05360356 0.1637670 -0.3273159 0.74342896 0.4074345
  conf.high probability
1 0.6762694   0.6025128
2 0.6572235   0.5817104
3 0.5664481   0.4866023
```

```
 contrast         estimate     SE  df asymp.LCL asymp.UCL z.ratio p.value
 control - net      0.0861 0.0756 Inf   -0.0911     0.263   1.139  0.4898
 control - tender   0.4695 0.0746 Inf    0.2946     0.644   6.292  <.0001
 net - tender       0.3834 0.0750 Inf    0.2077     0.559   5.114  <.0001

Results are given on the log odds ratio (not the response) scale.
Confidence level used: 0.95
Conf-level adjustment: tukey method for comparing a family of 3 estimates
P value adjustment: tukey method for comparing a family of 3 estimates
```

Appendix

χ^2 Test: Net versus Control

Table 6: Chi-squared observed counts, 2023

	control	net
terminal	327	258
non-terminal	205	178

Table 7: Chi-squared expected counts, 2023

	control	net
terminal	321.51	263.49
non-terminal	210.49	172.51

Table 8: Chi-squared observed counts, 2024

	control	net
terminal	150	550
non-terminal	200	170

Table 9: Chi-squared expected counts, 2024

	control	net
terminal	228.97	471.03
non-terminal	121.03	248.97

p-values

```
   2023    2024
   0.49  <0.001
```

Combined *p*-value with Fisher's method

```
chisq =  16.62846  with df =  4  p =  0.002282033
```

χ^2 Test: Tender versus Control

Table 10: Chi-squared observed counts, 2023

	control	tender
terminal	327	338
non-terminal	205	239

Table 11: Chi-squared expected counts, 2023

	control	tender
terminal	319.01	345.99
non-terminal	212.99	231.01

Table 12: Chi-squared observed counts, 2024

	control	tender
terminal	150	227
non-terminal	200	230

Table 13: Chi-squared expected counts, 2024

	control	tender
terminal	163.51	213.49
non-terminal	186.49	243.51

p-values

```
 2023  2024
0.347 0.058
```

Combined *p*-value with Fisher's method

```
chisq =  7.810605  with df =  4  p =  0.09876758
```