

Abundance modeling using in-stream PIT-tag detection systems

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IPTDS Subcommittee Meeting

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Today's Topics

Data Collection, Processing And Analysis

- PITcleanR:

<https://github.com/ryankinzer/PITcleanr/>

- STADEM:

<https://github.com/ryankinzer/STADEM/>

- DABOM:

<https://github.com/ryankinzer/DABOM/>



*Packages forked from **Kevin See**, WDFW*

Abundance Estimation

Data Collection

- LGR Window Observations
- LGR Trap; Representative Sampling
 - PIT-tagging
 - Genetic Sampling
 - Scale Sampling



Data Analysis

- STADEM - LGR Abundance
- PitCleanR - Data Processing
- DABOM - IPTDS Abundance



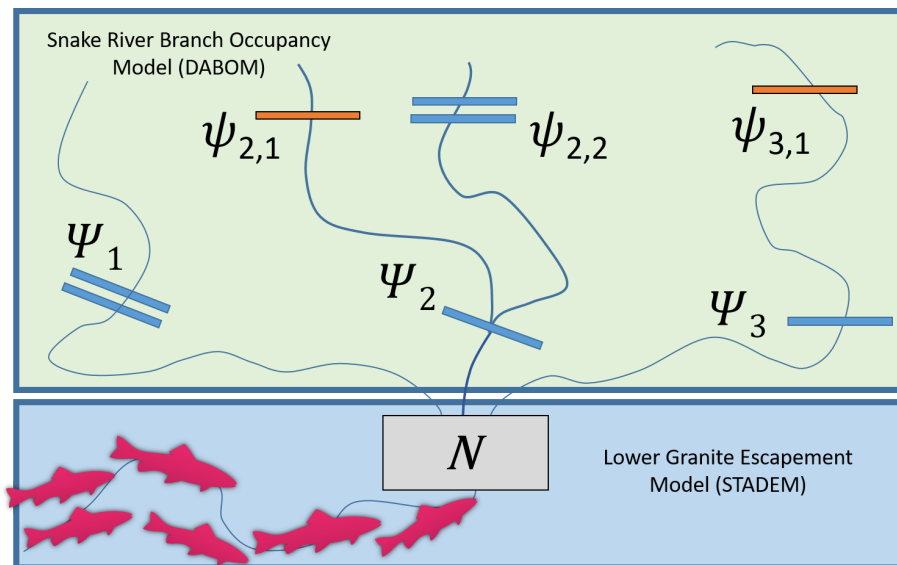
Abundance Estimation

Data Collection

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Data Analysis

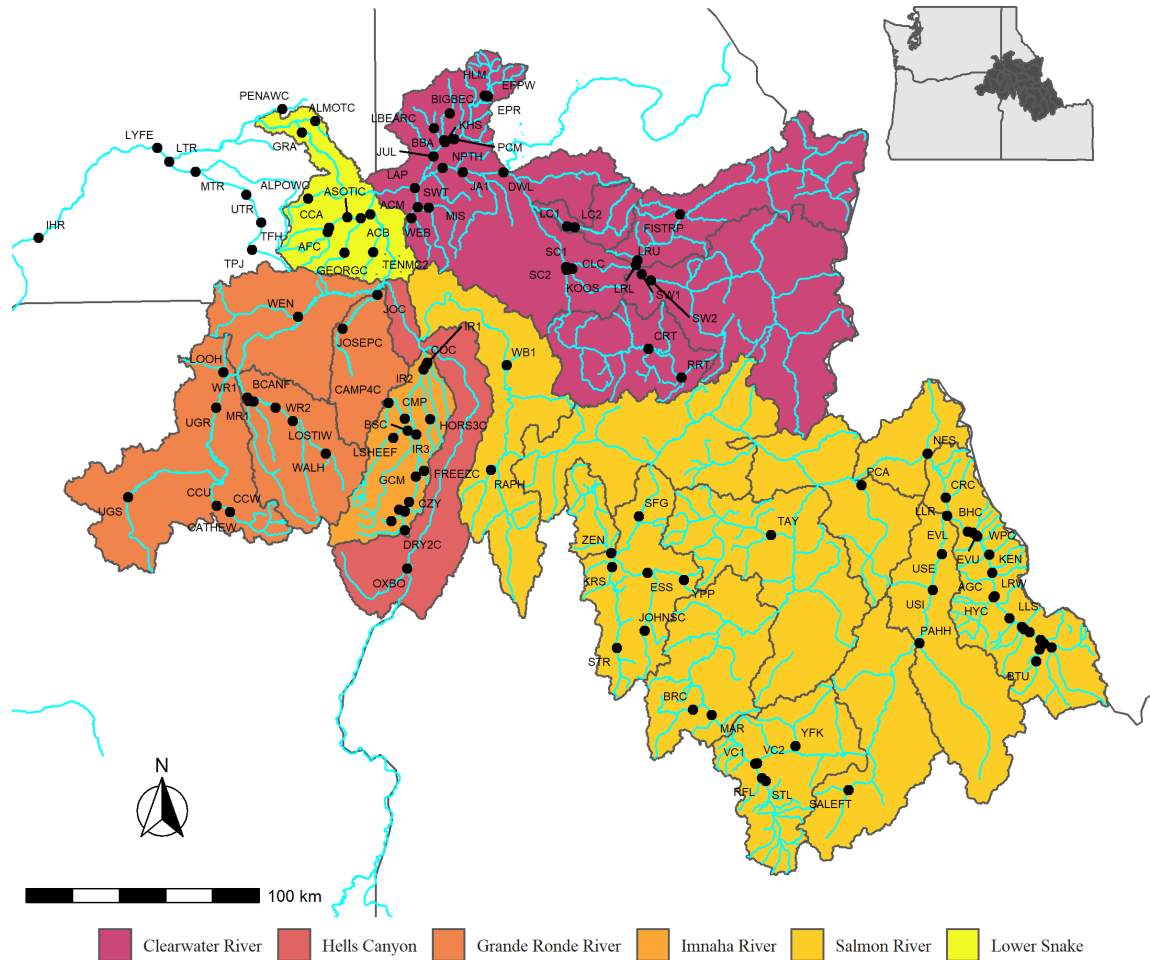
- STADEM - LGR Abundance
- PitCleanR - Data Processing
- DABOM - IPTDS Abundance





What's the problem?

Too many sites...





Too much data...

```
yr <- 2022
ptagis_file <- paste0(proj_path, 'data//CompleteTagHistories/LGR_Steelhead_', yr, '.csv')
observations = readCTH(ptagis_file)

n_distinct(observations$tag_code) # unique tag codes
```

```
## [1] 2308
```

```
n_distinct(observations$event_site_code_value) # unique event sites
```

```
## [1] 143
```

```
dim(observations)[1] # total observations
```

```
## [1] 79377
```

Too much data...

```
site_obs <- observations |>
  group_by(tag_code, event_site_code_value) |>
  summarise(n_obs = n()) |>
  arrange(-n_obs)
```

Search:

	tag_code	event_site_code_value	n_obs
	All	All	All
1	3DD.003D82B396	MTR	12794
2	3DD.003D82B1EC	MTR	2562
3	3DD.003D82B5A1	SC3	1362
4	3DD.003D82B356	SC4	757
5	3DD.003D82B885	SC3	722
6	3DD.003D82B213	SC3	696
7	3DD.003D82B549	GRA	575
8	3DD.003D82B48C	GRA	548
9	3DD.003D82B209	GRA	501
10	3DD.003D82B3FC	SC3	447
11	3DD.003D82B948	IR1	428

Showing 1 to 100 of 100 entries



What did we do?

Objectives:

- Efficiently summarize observations according to desired site layout.
- Prepare data for DABOM analysis and abundance estimation.

```
buildConfig() # get PTAGIS sites and establishes 'nodes'  
compress() # compresses into single row with min/max obs time  
addDirection() # upstream/downstream  
filterDetections() # processes obs into pathways
```





```
configuration <- buildConfig()
```

Search:

	site_code	config_id	antenna_id	node	start_date	end_date	site_type	site_name	antenn
	All	All	All	All	All	All	All	All	All
1	158	100	D1	158_U	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Up Eig
2	158	100	D2	158_M	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Mi Ck
3	158	100	D3	158_D	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Do Eig
4	158	100	D4	158_U	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Up Fif
5	158	100	D5	158_M	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Mi Ck
6	158	100	D6	158_D	2011-11-29T00:00:00Z		INT	Fifteenmile Ck at Eightmile Ck	Do Fif

Showing 1 to 100 of 100 entries



```
comp_obs <- compress(ptagis_file,
                      configuration = configuration,
                      ignore_event_vs_release = TRUE,
                      units = 'days')

# 3DD.003BDA1FD9
```

Search:

	tag_code	site_code	node	slot	event_type_name	n_dets	min_det	max_det	duration
	All	All	All	All	All	All	All	All	All
1	384.3B23A5DFD3	JOHTRP	JOHTRP	1	Mark	1	2016-06-30T08:39:00Z	2016-06-30T08:39:00Z	0
2	384.3B23A5DFD3	JDJ	JDA	2	Observation	15	2019-04-24T21:58:22Z	2019-04-24T22:00:00Z	0.001134
3	384.3B23A5DFD3	BO3	BON	3	Observation	12	2021-07-11T12:57:05Z	2021-07-11T13:41:56Z	0.031145
4	384.3B23A5DFD3	BO4	BON	3	Observation	15	2021-07-11T15:05:47Z	2021-07-11T16:07:08Z	0.042604
5	384.3B23A5DFD3	TD1	TDA	4	Observation	1	2021-07-13T09:45:56Z	2021-07-13T09:45:56Z	0
6	384.3B23A5DFD3	JO2	JDA	5	Observation	2	2021-07-14T16:10:36Z	2021-07-14T16:10:41Z	0.000057
7	384.3B23A5DFD3	MC1	MCN	6	Observation	14	2021-07-18T08:50:42Z	2021-07-18T10:31:59Z	0.070335
8	384.3B23A5DFD3	ICH	IHR	7	Observation	21	2021-08-28T14:36:51Z	2021-08-28T14:59:20Z	0.015613



```
obs_direct <- comp_obs %>%
  addDirection(parent_child = pc_nodes)
# need parent-child table
```

Search:

id	tag_code	site_code	node	slot	event_type_name	n_dets	min_det	max_det	d
1	All	All	All	All	All	All	All	All	All
1	1	384.3B23A5DFD3	LGR LDR	GRA	1	Recapture	1	2021-09-07T09:28:37Z	2021-09-07T09:28:37Z
2	2	3D9.1C2DD9D071	LGR LDR	GRA	1	Recapture	1	2021-11-12T10:35:56Z	2021-11-12T10:35:56Z
3	3	3D9.1C2DD9D071	GRS	GRS	2	Observation	1	2021-11-13T06:09:28Z	2021-11-13T06:09:28Z

Showing 1 to 100 of 100 entries



```
obs_direct <- steelhead_lifestage(obs_direct, spawn_year = yr, max_spawn_month = 3) %>%
  select(id, tag_code, life_stage, everything())
```

```
# Not part of PITcleanR
```

```
# 3DD.003D4935A3 - HYC
```

```
# 3DD.003D493774 - BON
```

Search:

id	tag_code	life_stage	site_code	node	direction	min_det	slot	event_type_name
A	All	All	All	All	All	All	All	All
1	1	384.3B23A5DFD3	spawner	LGRLDR	GRA	start	2021-09-07T09:28:37Z	1 Recapture
2	2	3D9.1C2DD9D071	spawner	LGRLDR	GRA	start	2021-11-12T10:35:56Z	1 Recapture
3	3	3D9.1C2DD9D071	spawner	GRS	GRS	downstream	2021-11-13T06:09:28Z	2 Observation

PITcleanR



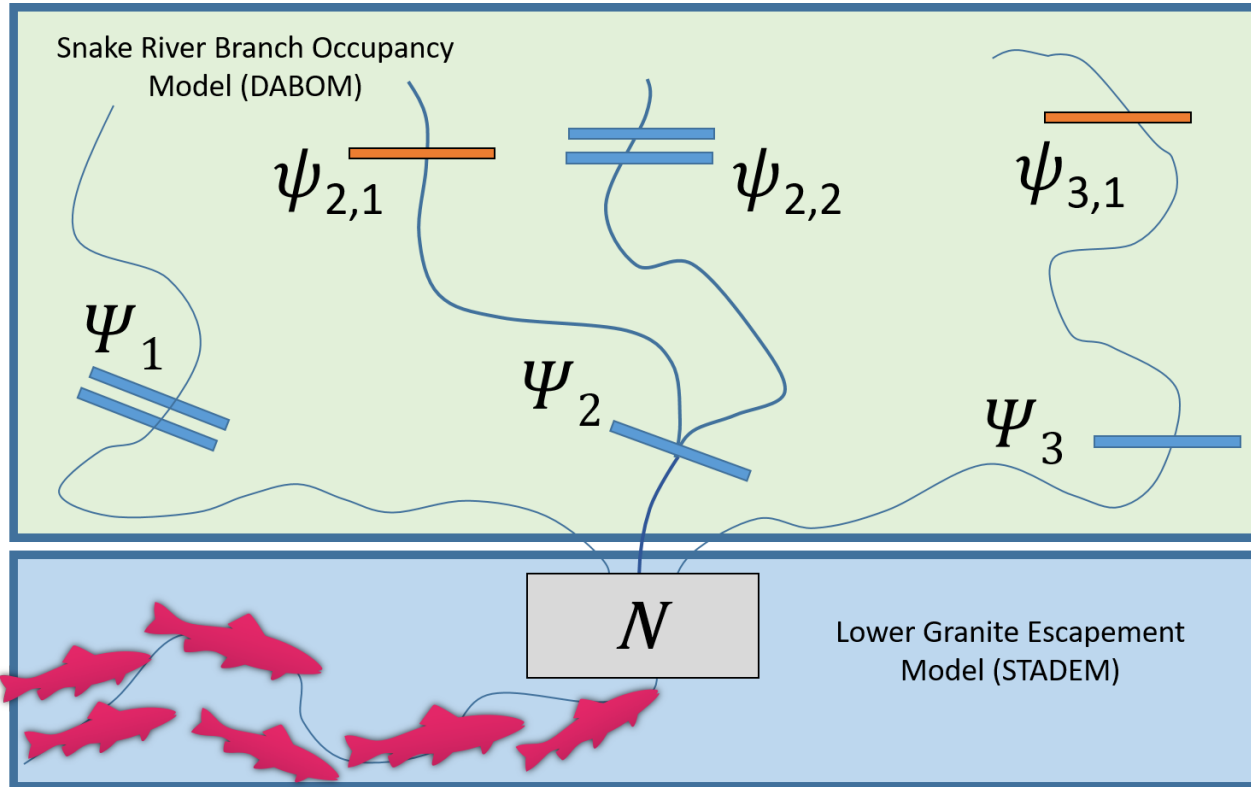
```
spawner_obs <- obs_direct %>%
  filter(life_stage == 'spawner') %>%
  filterDetections(parent_child = NULL, max_obs_date = NULL) %>%
  select(tag_code, auto_keep_obs, user_keep_obs,
         site_code, node, direction, everything())
# 3DD.003D82AF75 WR2/MR1
# 3DD.003D82AF7F GRS/LTR
# 3DD.003D82B0FA Walla Walla
# 3DD.003D82B139 Umatilla
```

Search:

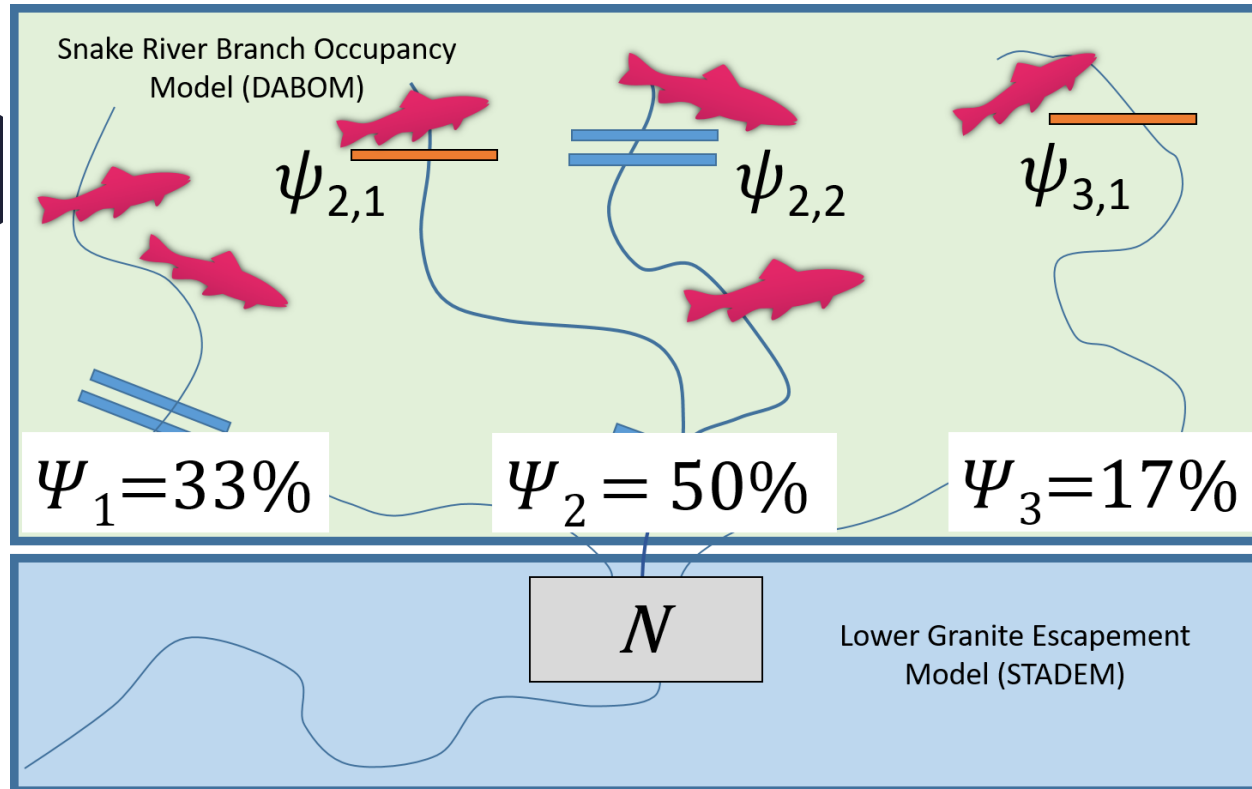
	tag_code	auto_keep_obs	user_keep_obs	site_code	node	direction	id	life_stage	mir
1	384.3B23A5DFD3	true	true	LGRLDR	GRA	start	1	spawner	(
2	3D9.1C2DD9D071	true	true	LGRLDR	GRA	start	2	spawner	:
3	3D9.1C2DD9D071	true	true	GRS	GRS	downstream	3	spawner	:
4	3D9.1C2DD9D071	true	true	GRA	GRA	upstream	4	spawner	:

Showing 1 to 1,000 of 1,000 entries

IPTDS Model Overview



IPTDS Model Overview



DABOM Details

Detection Process

- Likelihood: $tag_{i,node}^{obs} \sim Bernoulli(p_{node} * z_{i,j})$

where $z_{i,j}$ is the state of tag i in stream j

- Prior: $p_{node} \sim Beta(1, 1)$ or $p_{node} = 1.0$

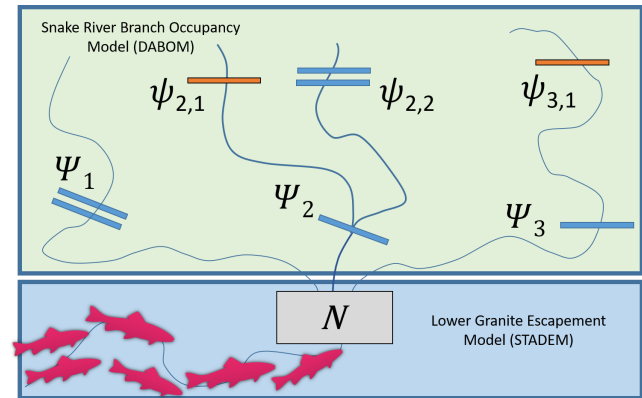
Transition Process

- Likelihood: $z_{i,j} \sim Multinomial(\Psi)$,

where $\Psi = [\psi_1, \psi_2, \dots, \psi_j]$, and

$j = \#$ streams

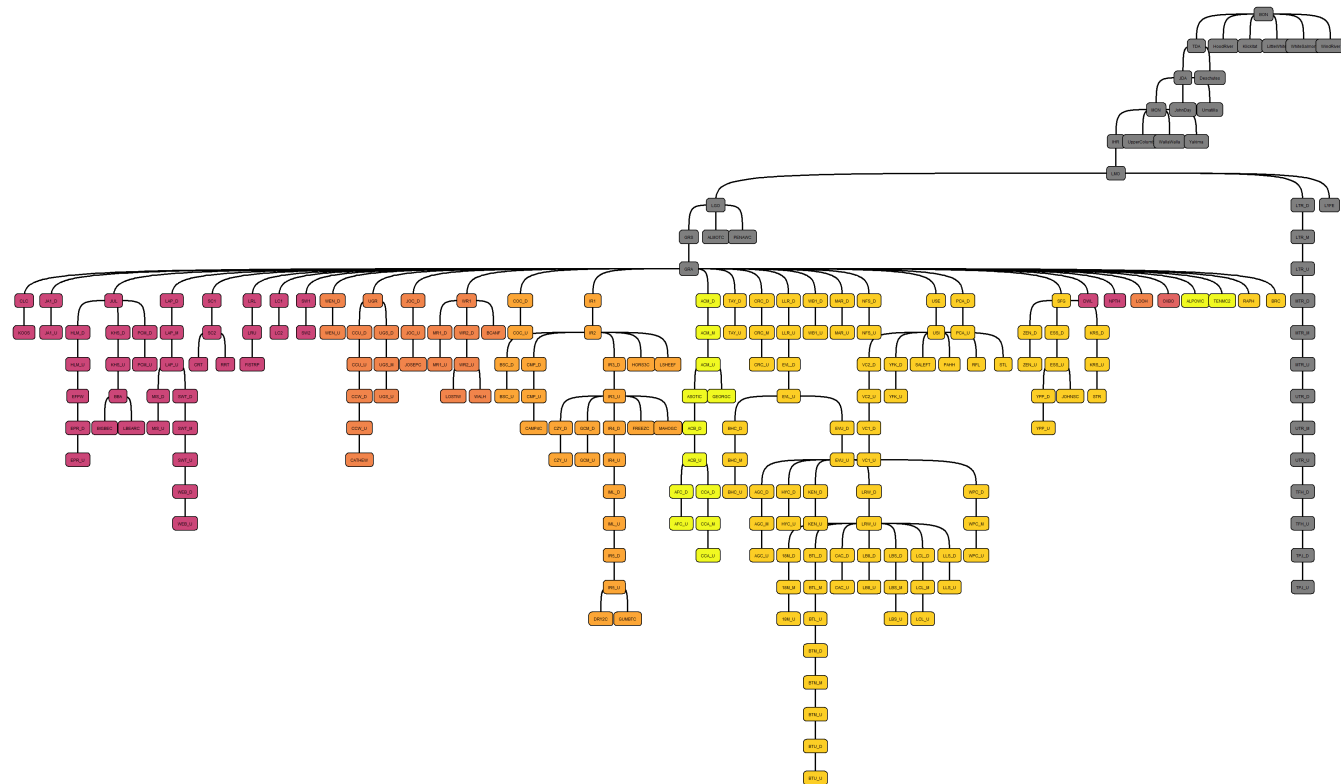
- Prior: $\Psi \sim Dirichlet(1_1, 1_2, \dots, 1_j)$



Abundance: $\hat{N}_j = N_{LGD}^{\wedge} * \hat{\psi}_j$

Life History: $= N_{j,k}^{\wedge} = \hat{N}_j * \hat{\rho}_k$

DABOM Model Structure



Clearwater River
 Hells Canyon
 Grande Ronde River
 Imnaha River
 Salmon River
 Lower Snake

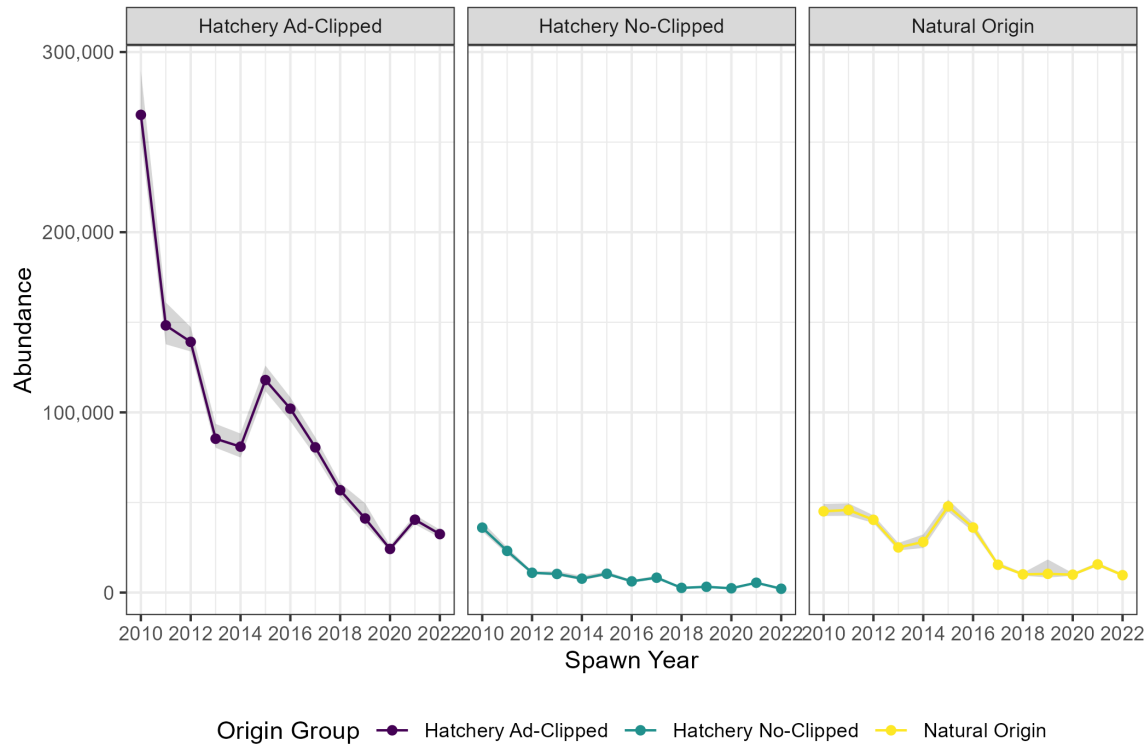


Model Outputs

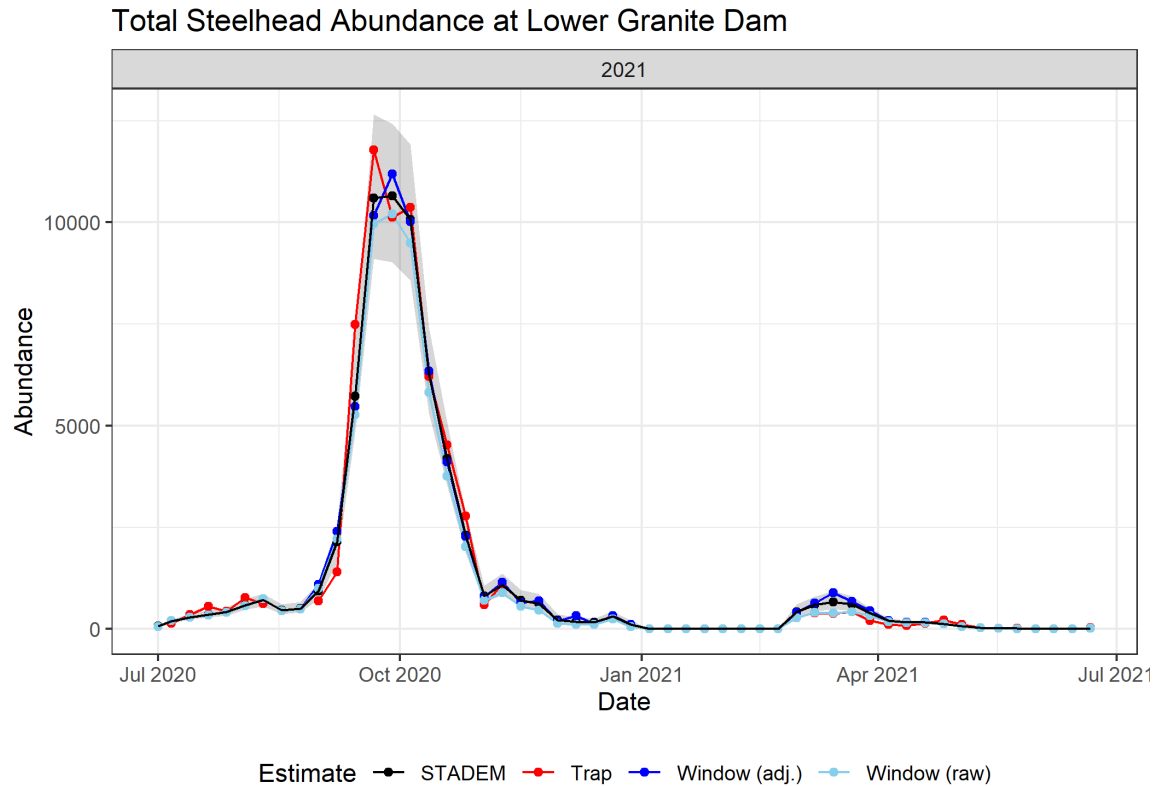
LGR Abundance



Unique Steelhead Abundance at Lower Granite Dam



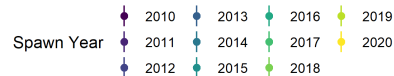
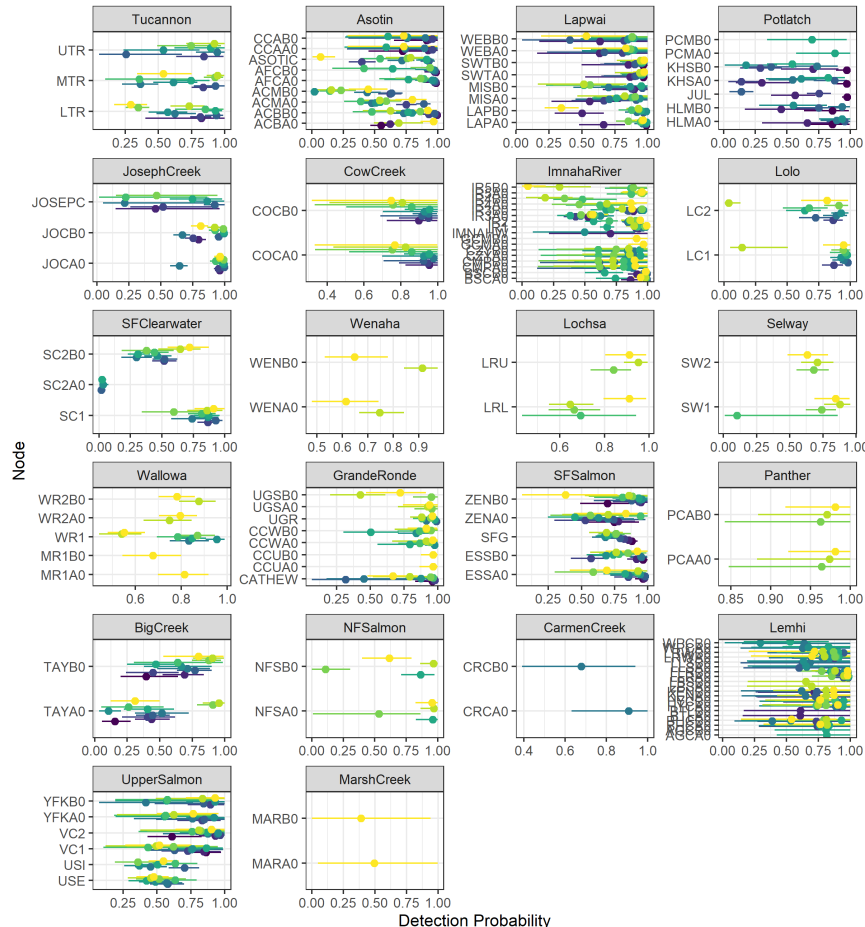
LGR Abundance - Weekly



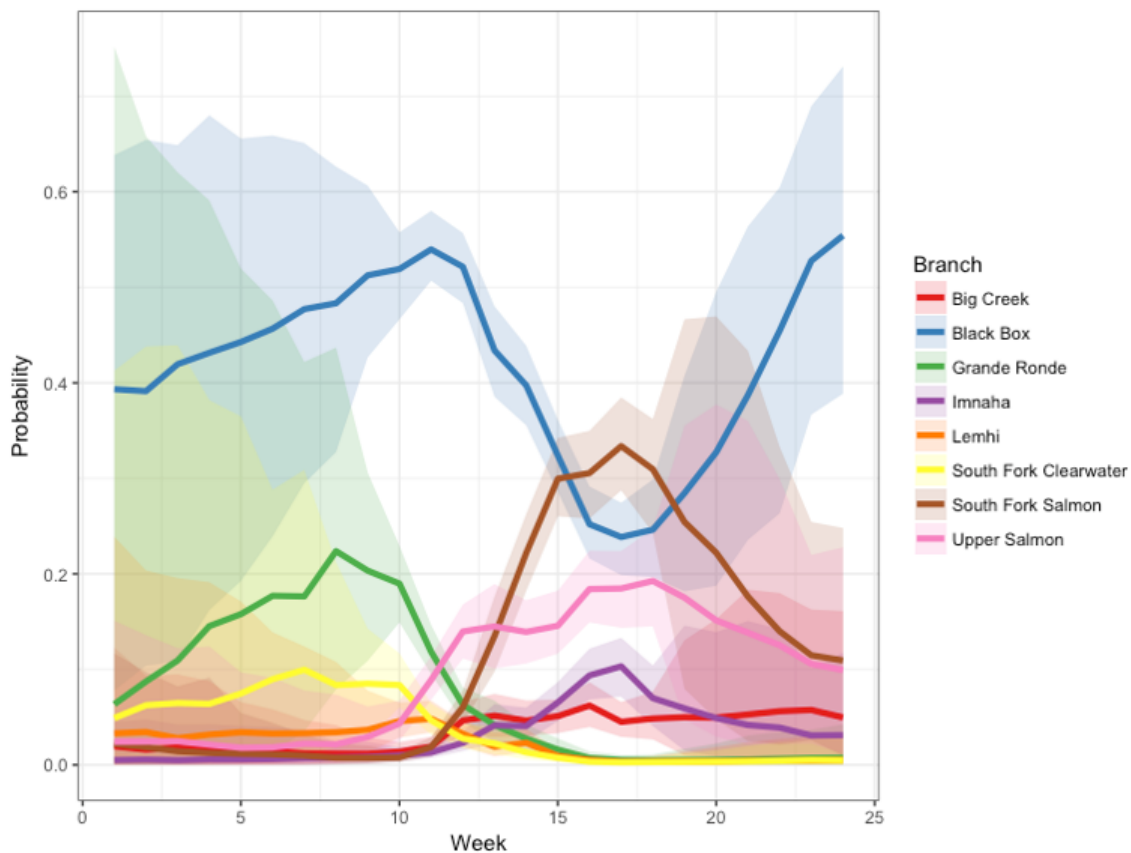
Detection Probabilities



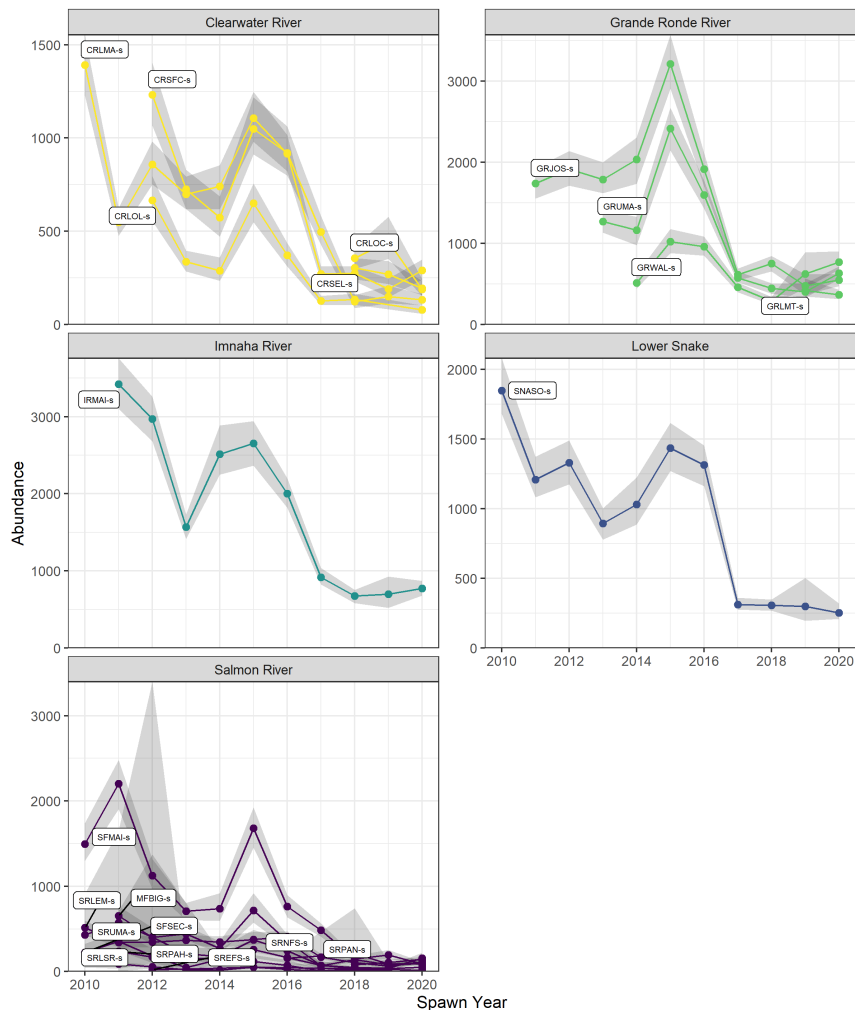
Natural-Origin Steelhead Detection Probabilities at DABOM Nodes



Transition Probabilities



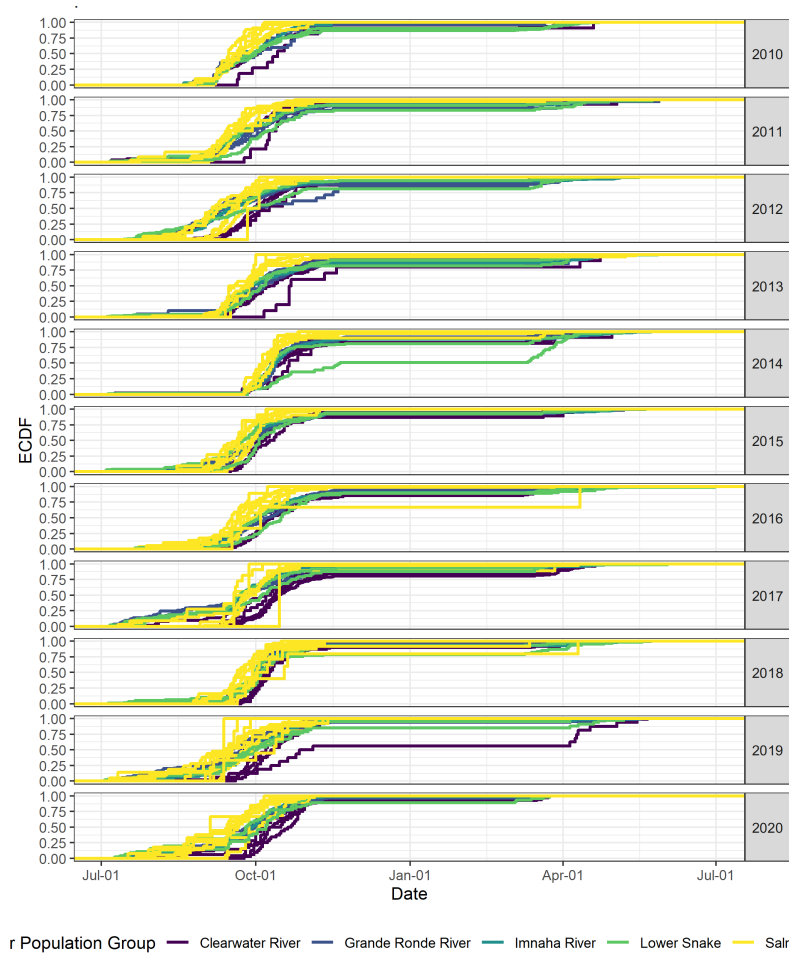
Population Abundance



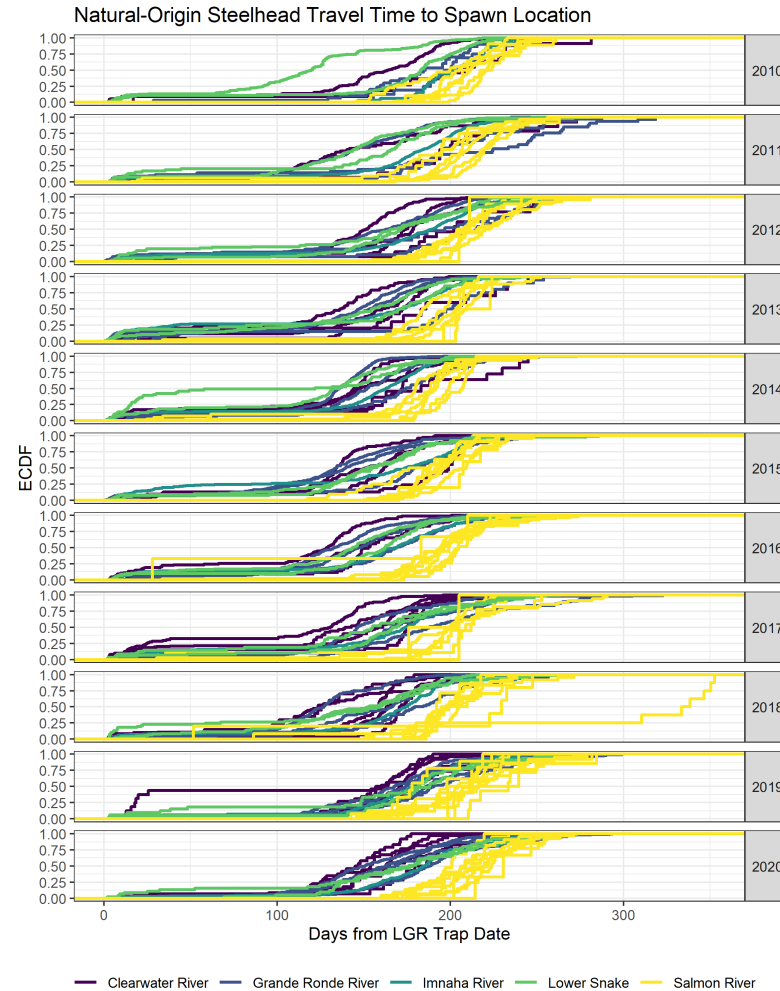
LGR Run-timing



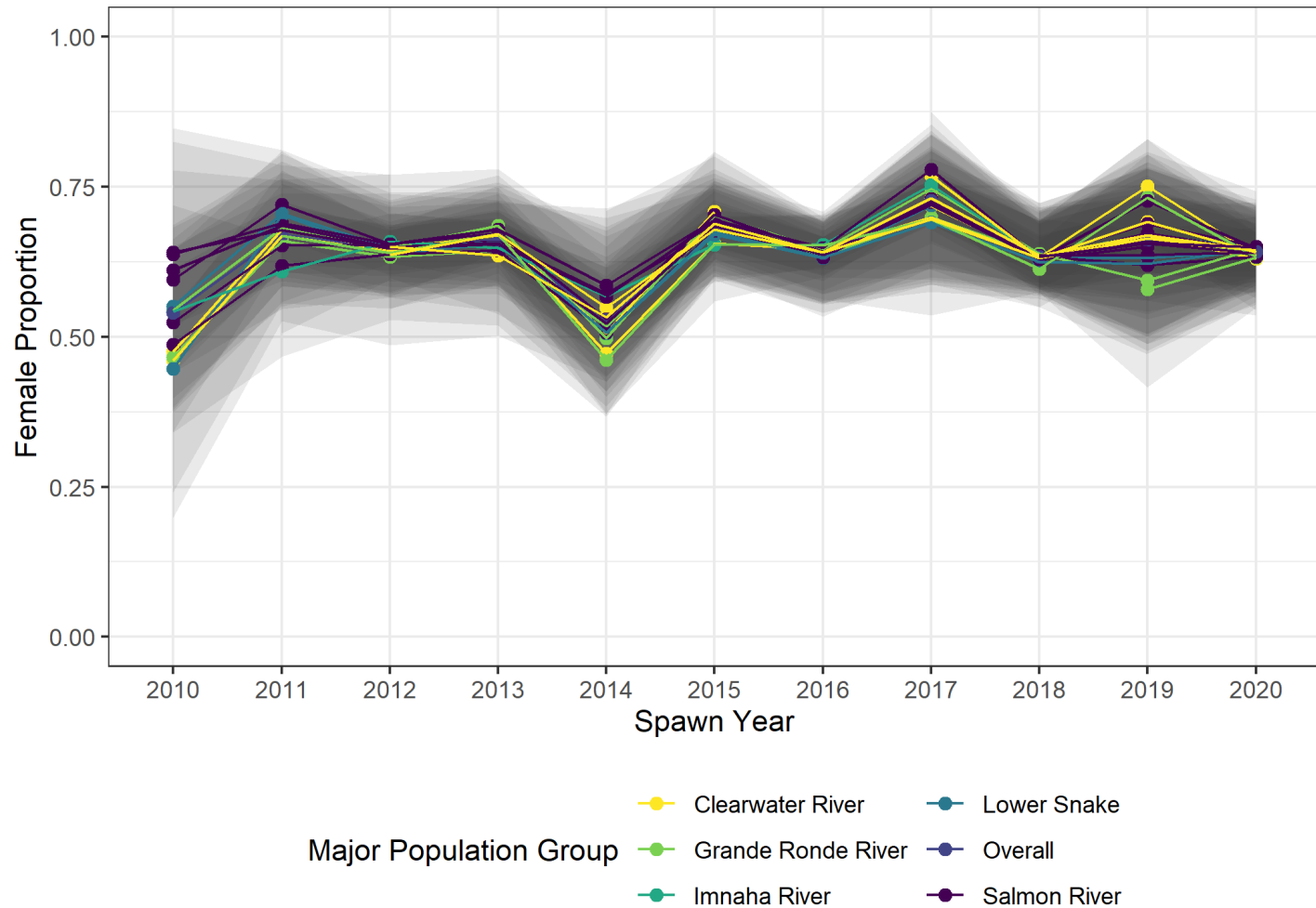
Natural-Origin Steelhead Arrival Timing at Lower Granite



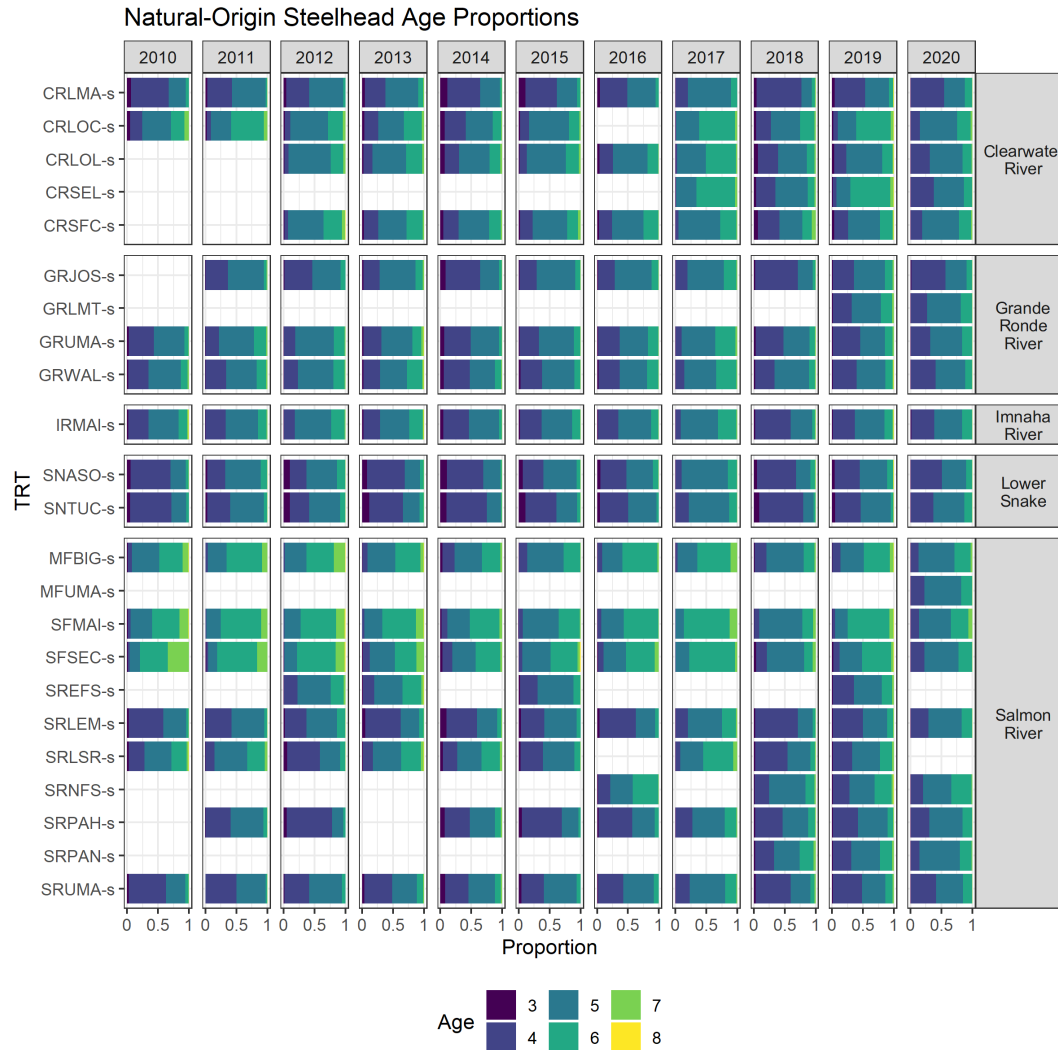
Travel time



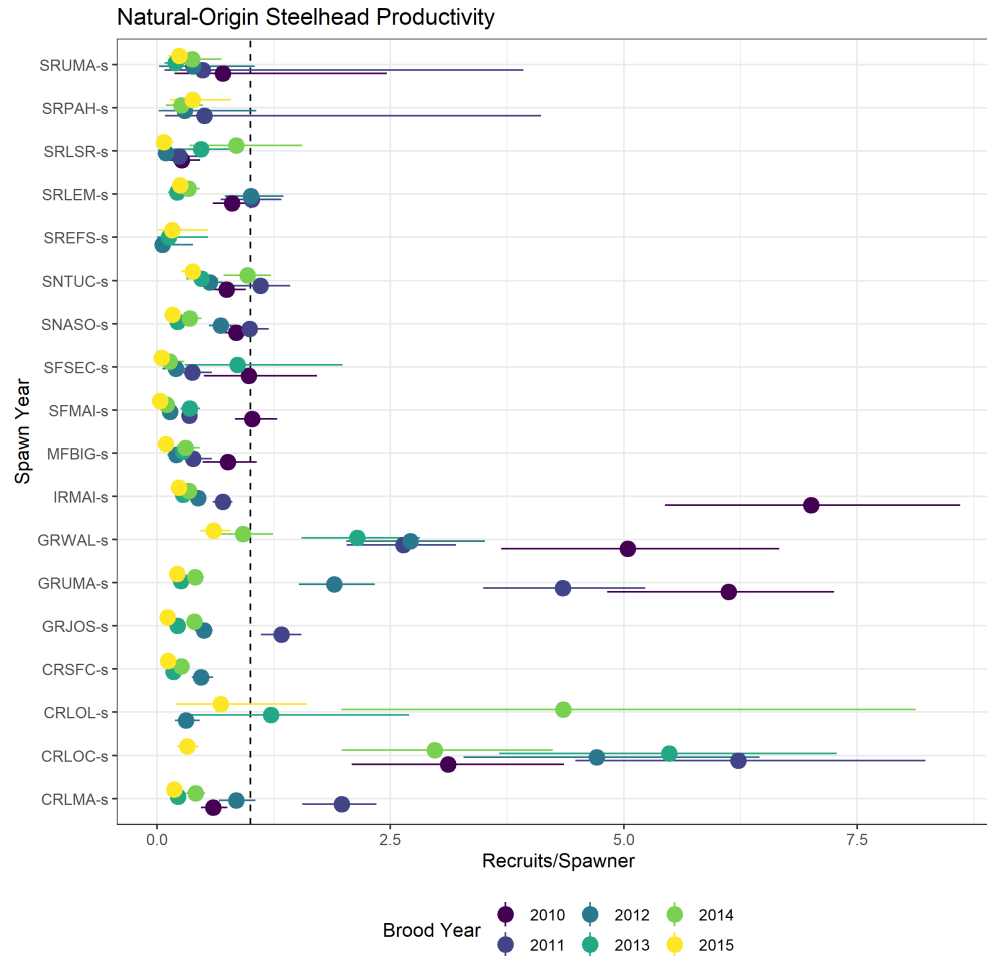
Female Proportion



Age Composition

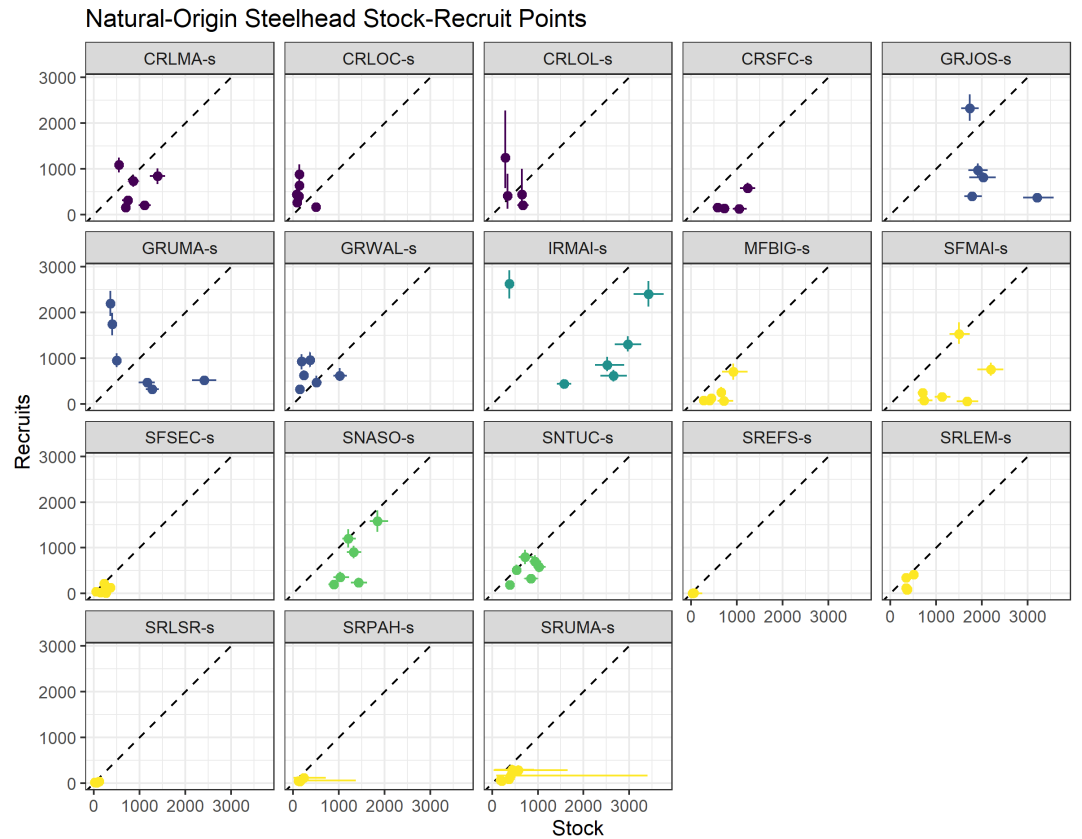


Productivity



** Productivity estimates exclude hatchery-origin spawners but includes their progeny as recruits.

Productivity



Future Direction

- Estimate hatchery-origin abundance

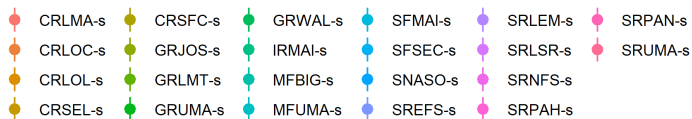
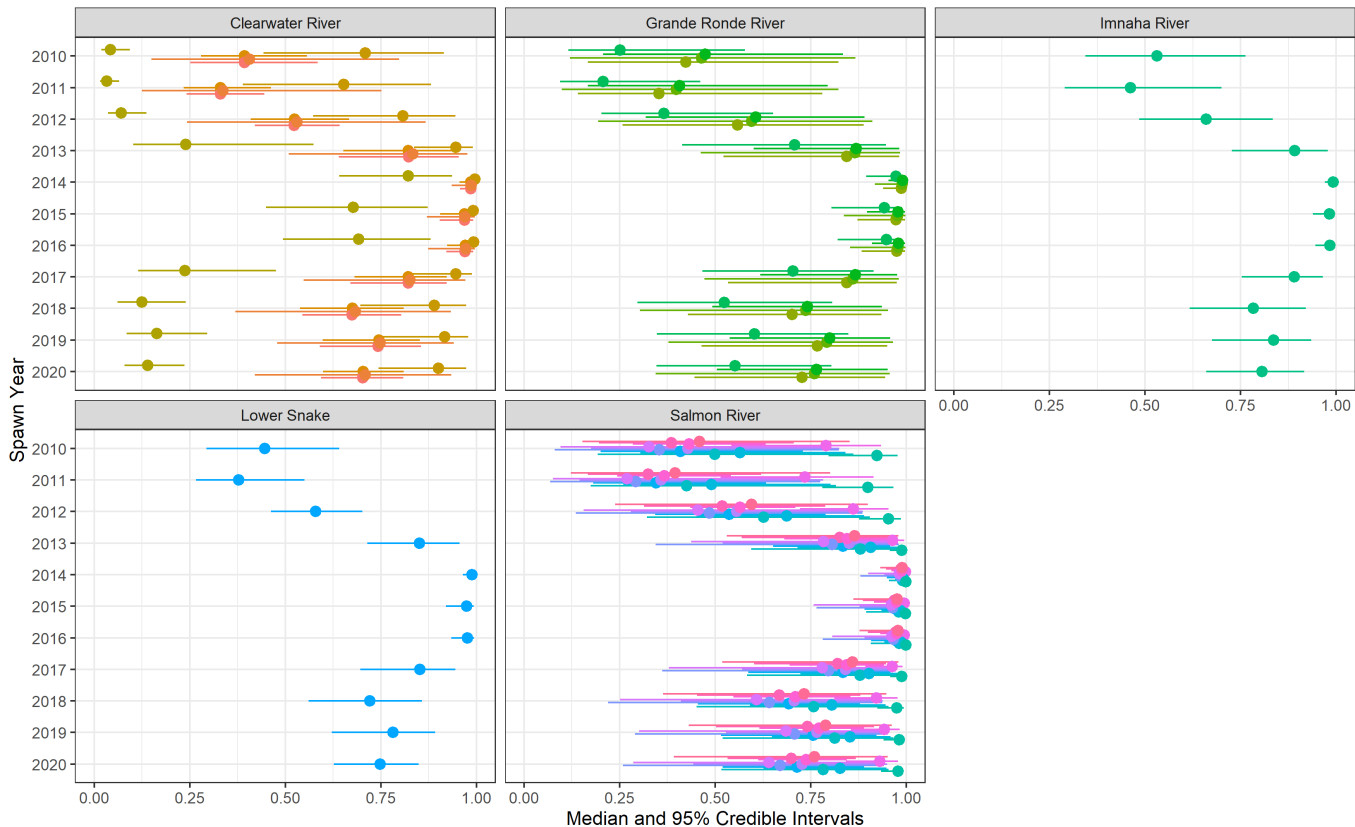
$$\frac{n_{PBT}^{LGD}}{N_{PBT}^{LGD}} = \frac{n_{PBT}^{pop}}{N_{PBT}^{pop}}$$

- Constructing the below Lower Granite node network
 - Estimate overshoot/fallback fish
 - Estimate survival and abundance of kelting/repeat spawners

Future Direction - Kelting Rates

Kelting Rate

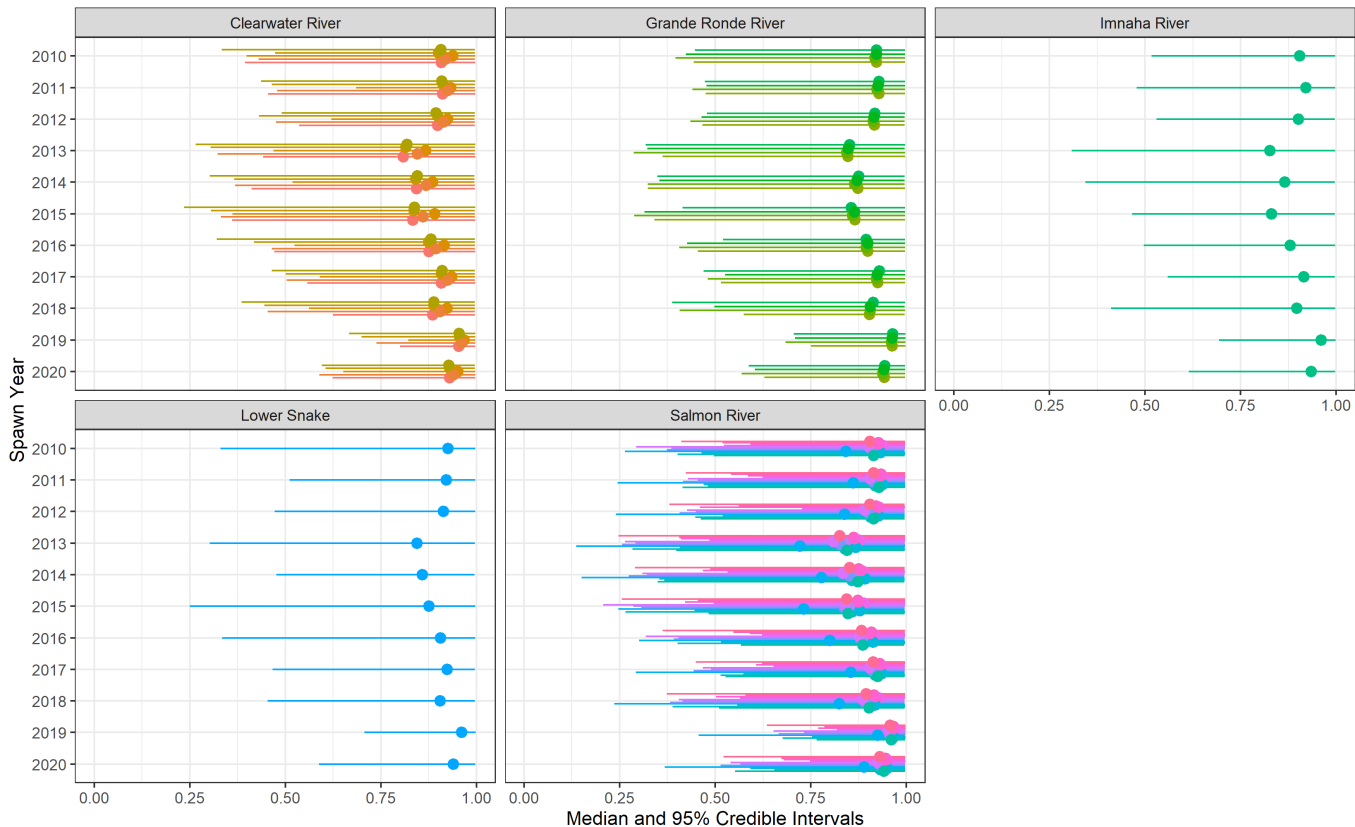
Survival of post-spawn kelt to population PIT-tag detection locations.



Future Direction - Kelt Survival

Kelt Survival

Survival of post-spawn kelt to Lower Granite Dam after leaving the spawning area.



- CRLMA-s
- CRSFC-s
- GRWAL-s
- SFMAI-s
- SRLEM-s
- SRPAN-s
- CRLOC-s
- GRJOS-s
- IRMAI-s
- SFSEC-s
- SRLSR-s
- SRUMA-s
- CRLLOL-s
- GRLMT-s
- MFBIG-s
- SNASO-s
- SRNFS-s
- CRSEL-s
- GRUMA-s
- MFUMA-s
- SREFS-s
- SRPAH-s

Thank you.

