Using spatially continuous mark-recapture to estimate abundance, distribution, and age structure of juvenile steelhead in freshwater

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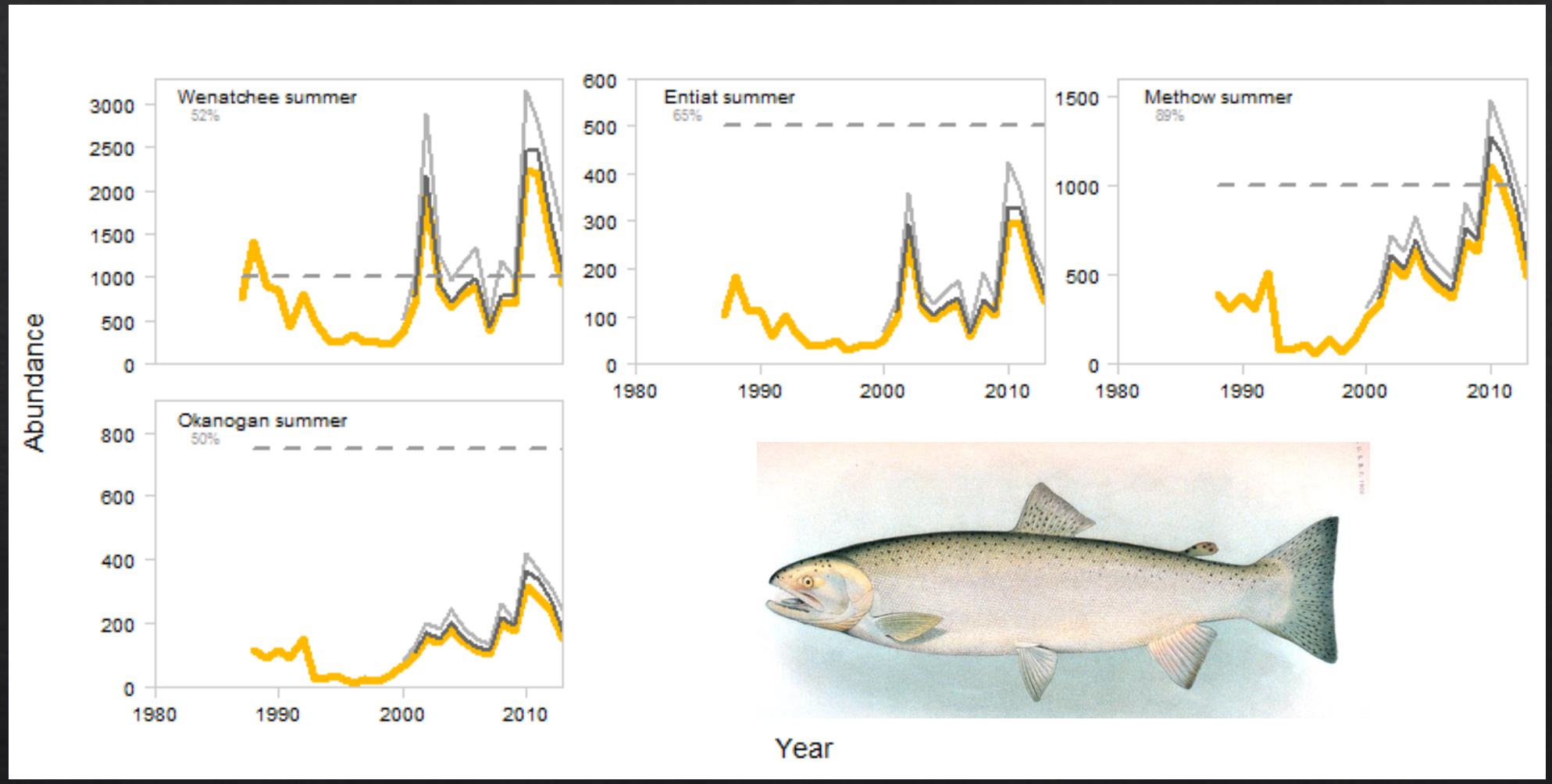
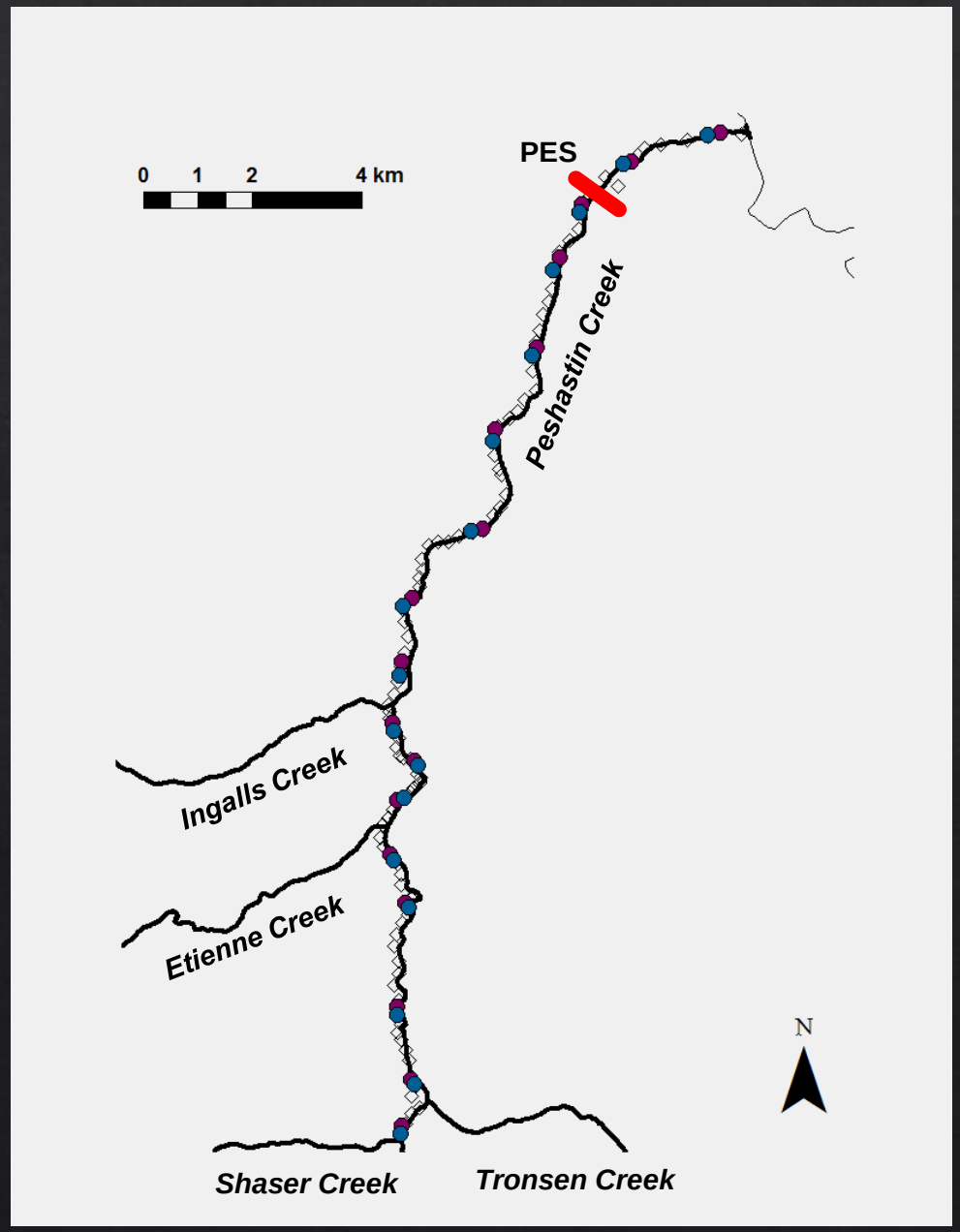
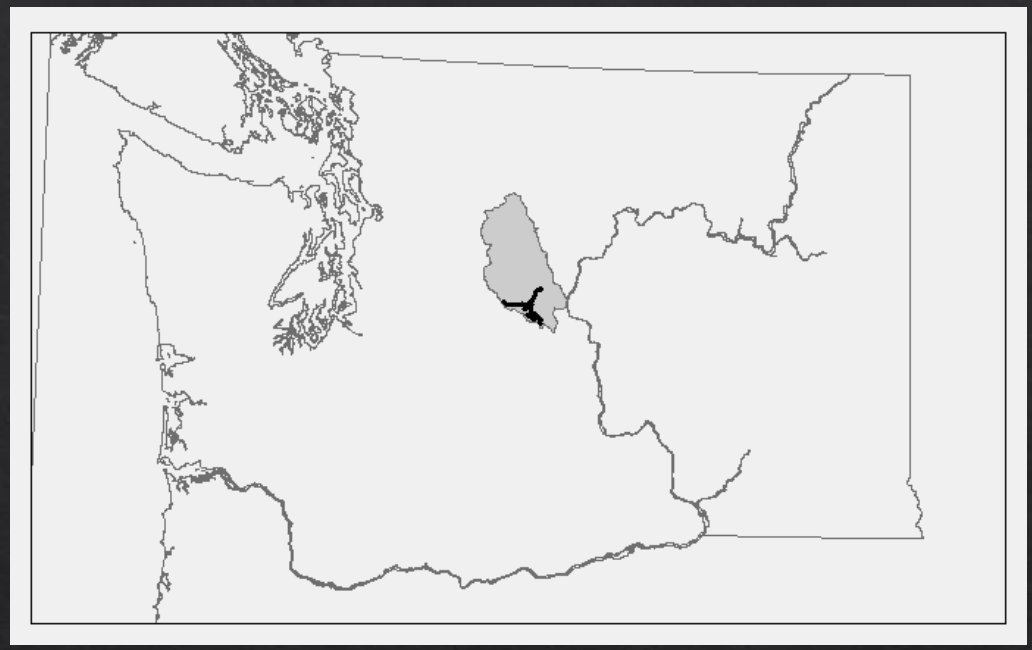
Washington Department of Fish and Wildlife

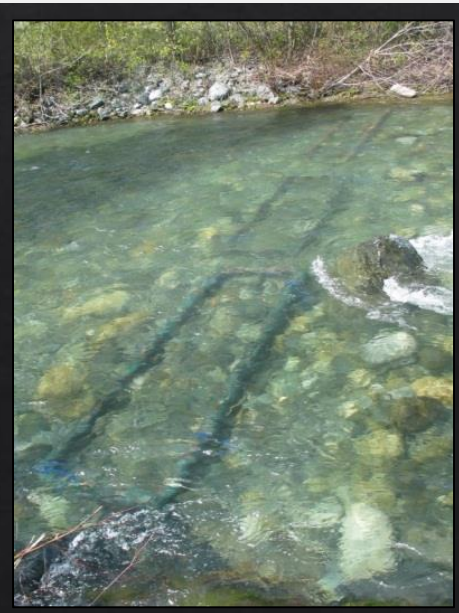
Steelhead in the Upper Columbia DPS



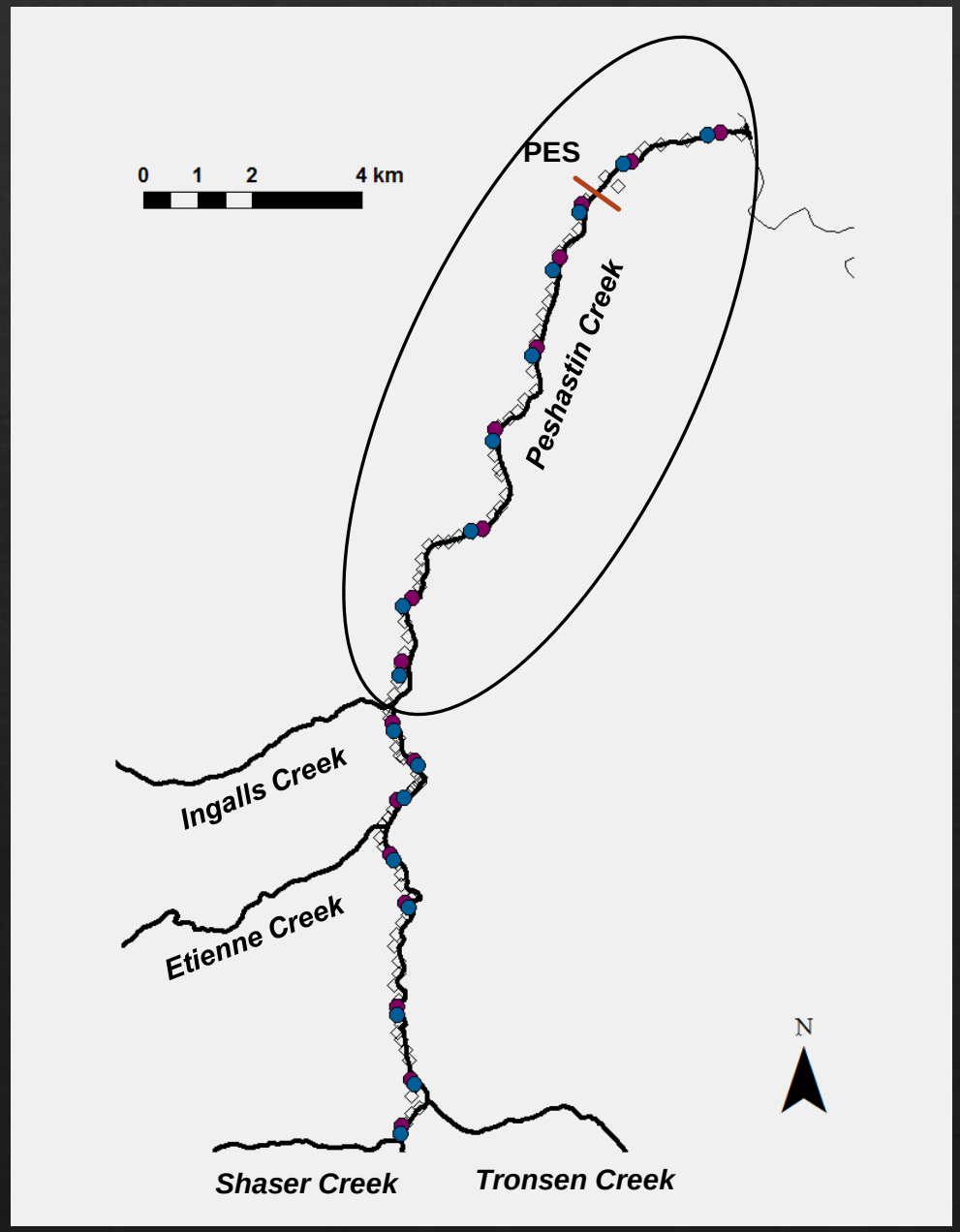
Study Area


0 1 2 4 km
PES
Peshastin Creek
Ingalls Creek
Etienne Creek
Shaser Creek
Tronsen Creek
N





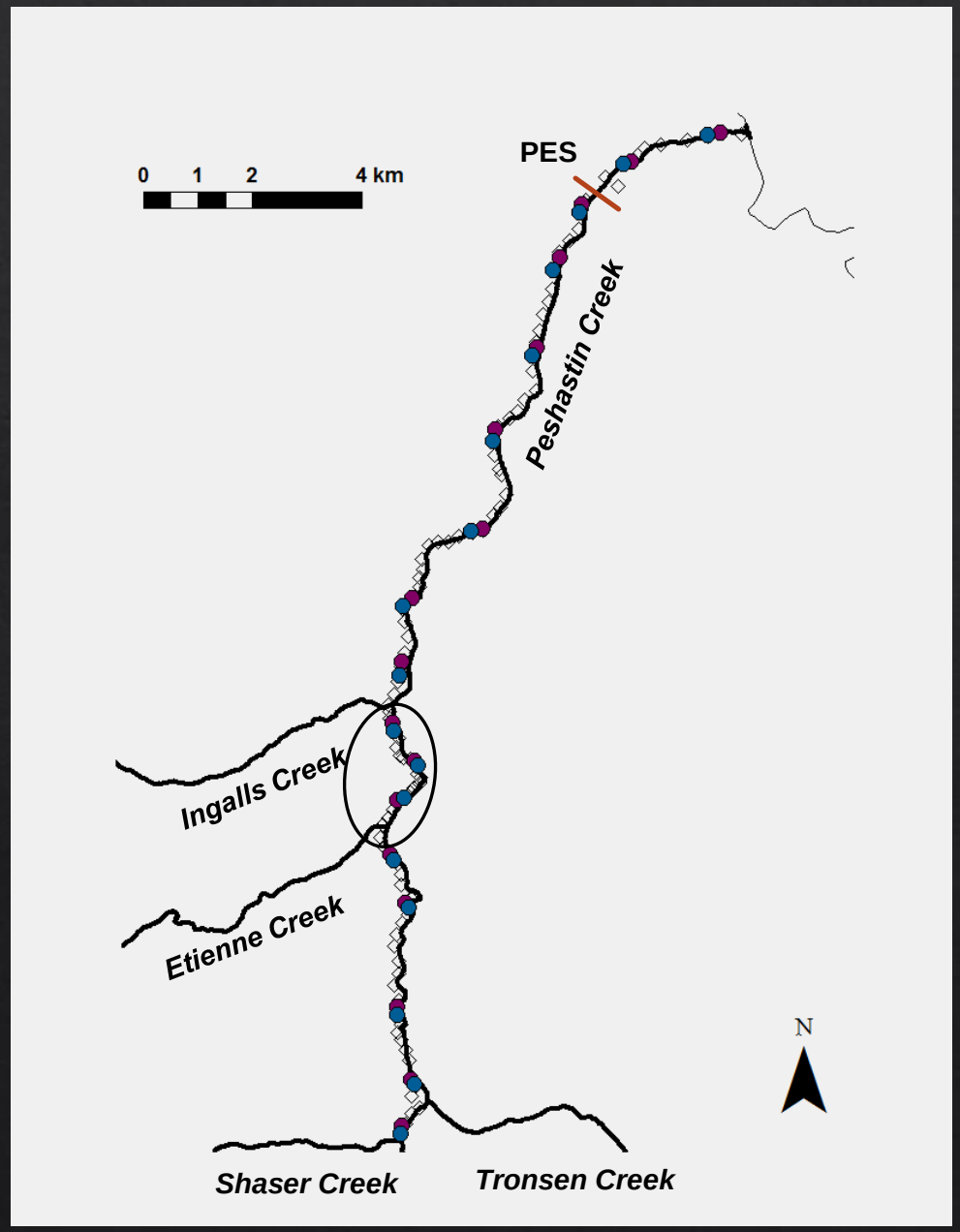
Study Area



Spatial design

Lower: Mouth to Ingalls (14.5 km)

Study Area

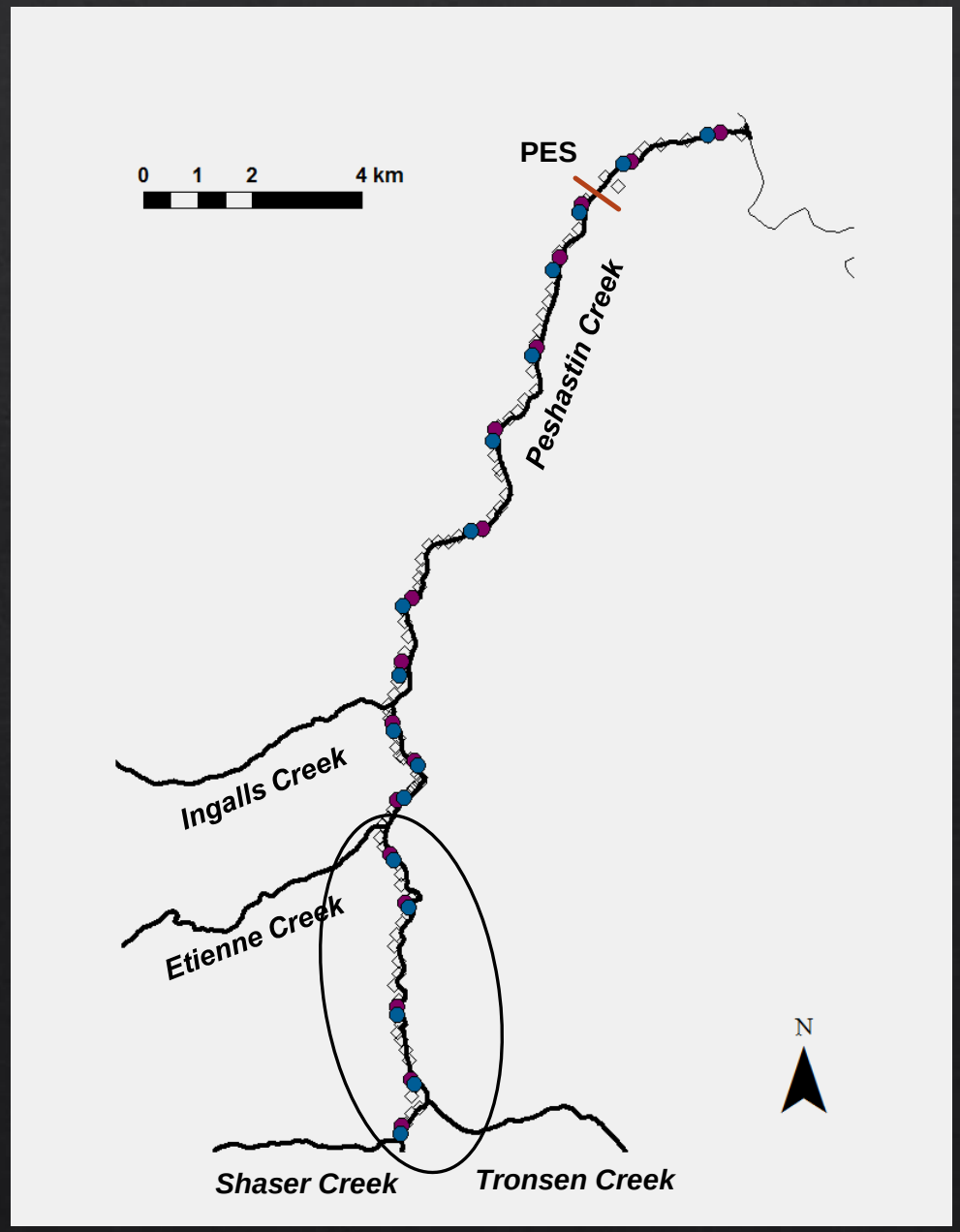


Spatial design

Lower: Mouth to Ingalls (14.5 km)

Middle: Ingalls to Etienne (3.0 km)

Study Area



Spatial design

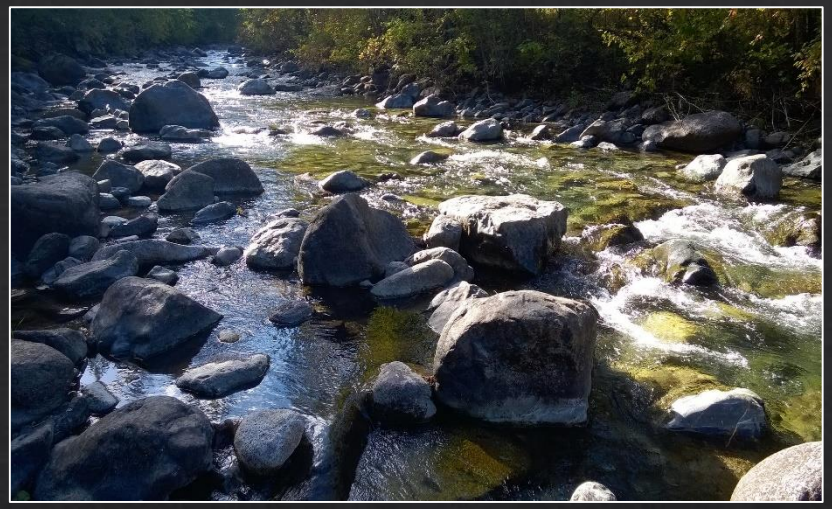
Lower: Mouth to Ingalls (14.5 km)
Middle: Ingalls to Etienne (3.0 km)
Upper: Etienne to Shaser (6.9 km)

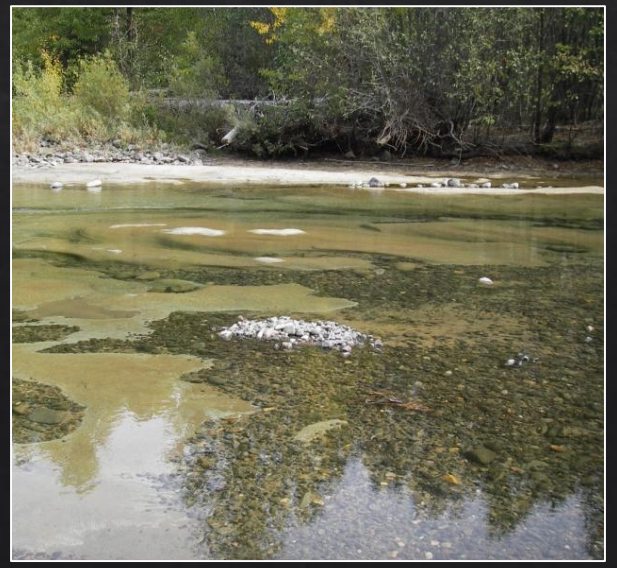
Total extent: 24.4 km

17-19 systematic recapture sites

3-6 weeks in Oct-Nov

Peshastin Creek





Project objectives

- Estimate unbiased and precise (<10% CV) abundance of age-0, age-1, and older age juvenile abundance at multiple spatial scales
- Incorporate a mixture model to assess length-at-age and age class proportions based on fork length and scale ages
- Describe patterns of movement and survival

Spatially continuous methodology

- **Fast and light tagging setup**
  - Fin clip all, PIT-tag a subset
  - Measure all, scales from subset
- **Recapture events**
  - 2 – 12 days
  - Track recaps and new fish

Abundance and age analysis methods

- Closed population abundance model
  - Darroch (1961)
- Mixture model
  - All fish have lengths, subset with scale ages
- Movement was monitored during recapture events and at PES
- Related parr abundance to brood year egg deposition to estimate survival

Spatially continuous marking results

	Steelhead	Chinook Salmon	Coho Salmon	Bull trout
2015				
captured	25,583	56	692	21
PIT-tagged	2,946	35	86	21
2016				
captured	20,794	1	0	20
PIT-tagged	2,821	1	0	20

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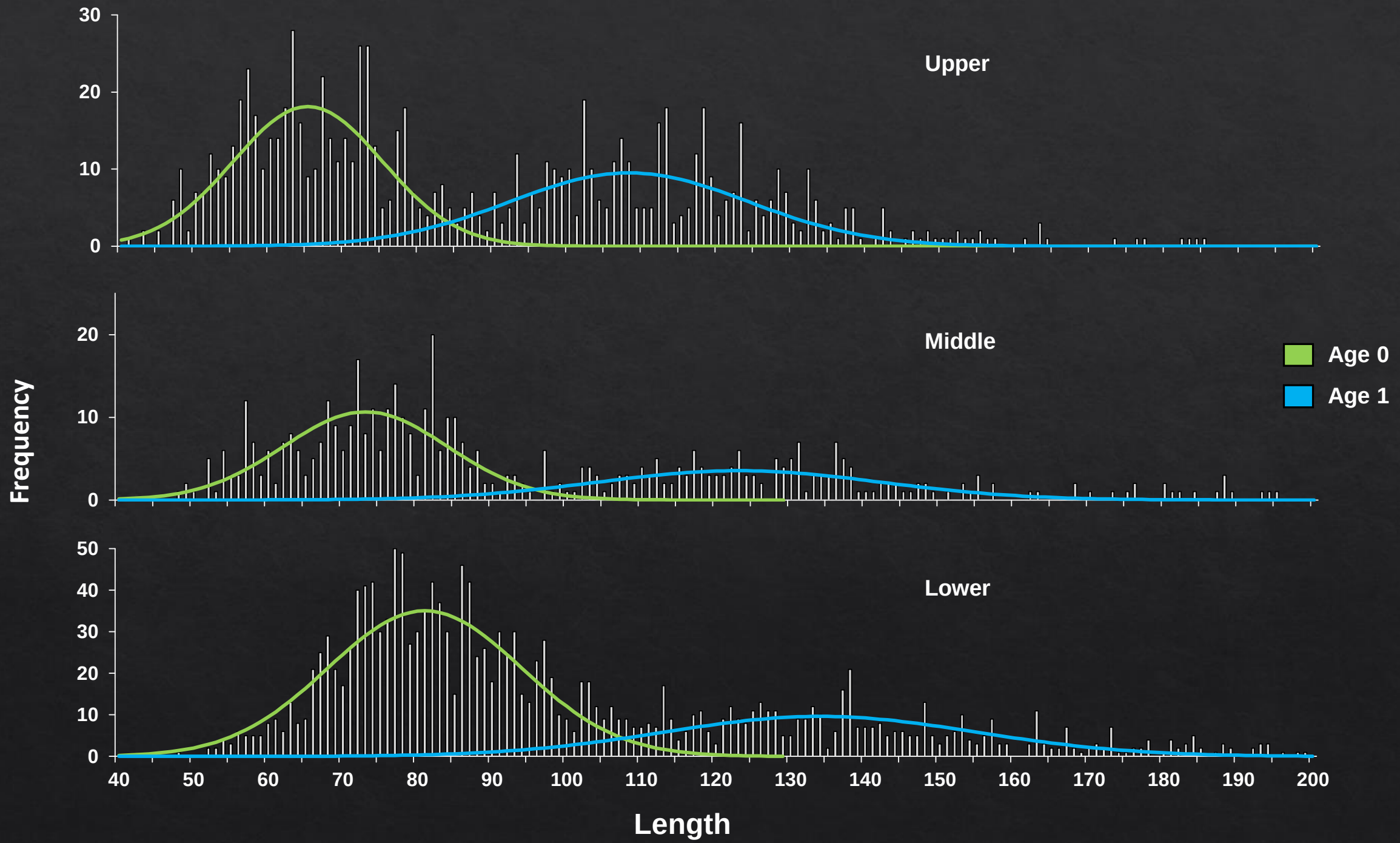
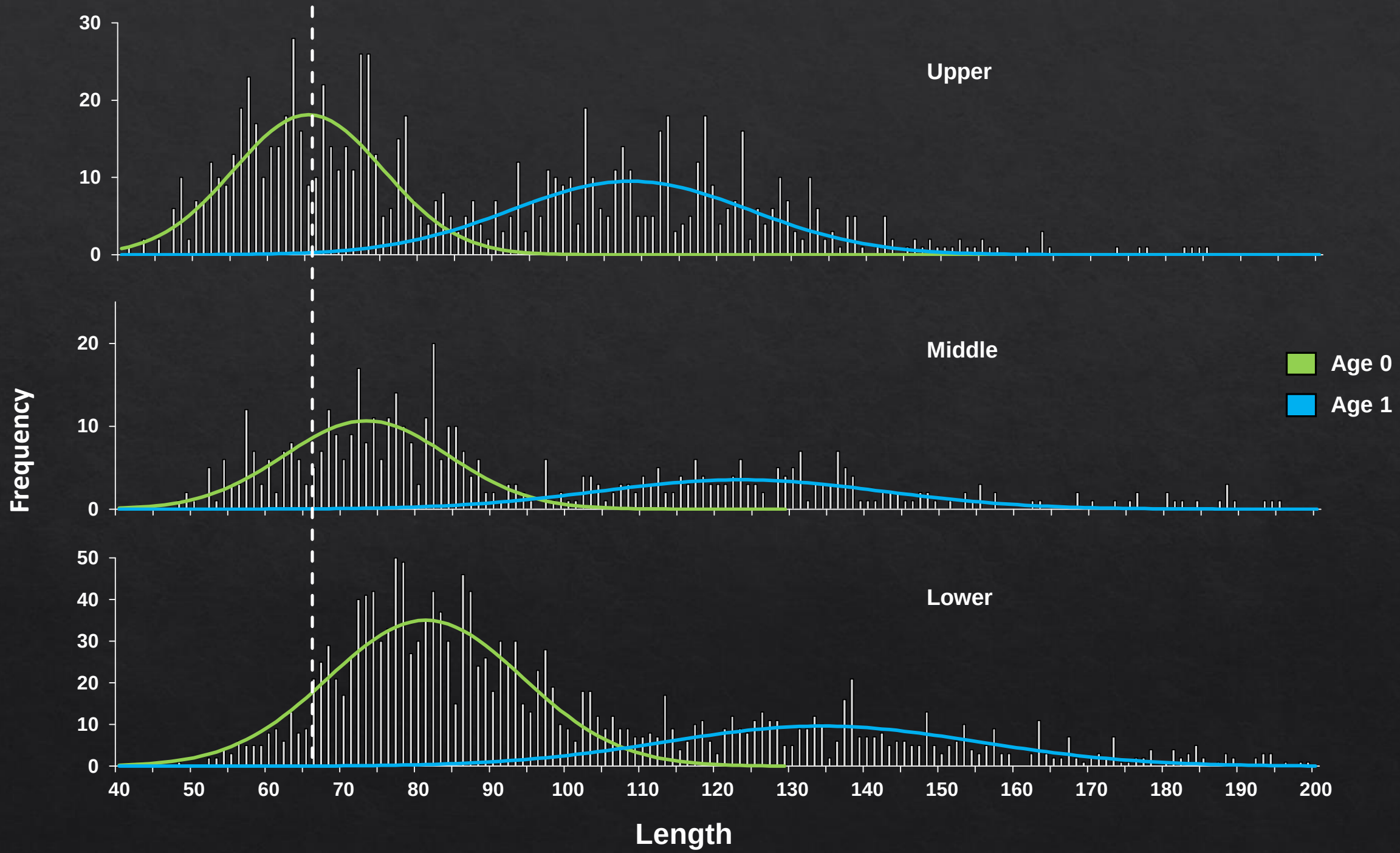
Year	Abundance	SD	95% CI	CV
2015	70,151	2,588	65,287 – 75,555	3.7%
2016	57,978	2,376	53,518 – 62,858	4.1%


Upper
Middle
Lower
Age 0
Age 1
Frequency
Length
30
20
10
0
20
10
0
50
40
30
20
10
0
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200


Upper
Middle
Lower
Age 0
Age 1
Frequency
Length
0
10
20
30
0
10
20
0
10
20
30
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60
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90
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110
120
130
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170
180
190
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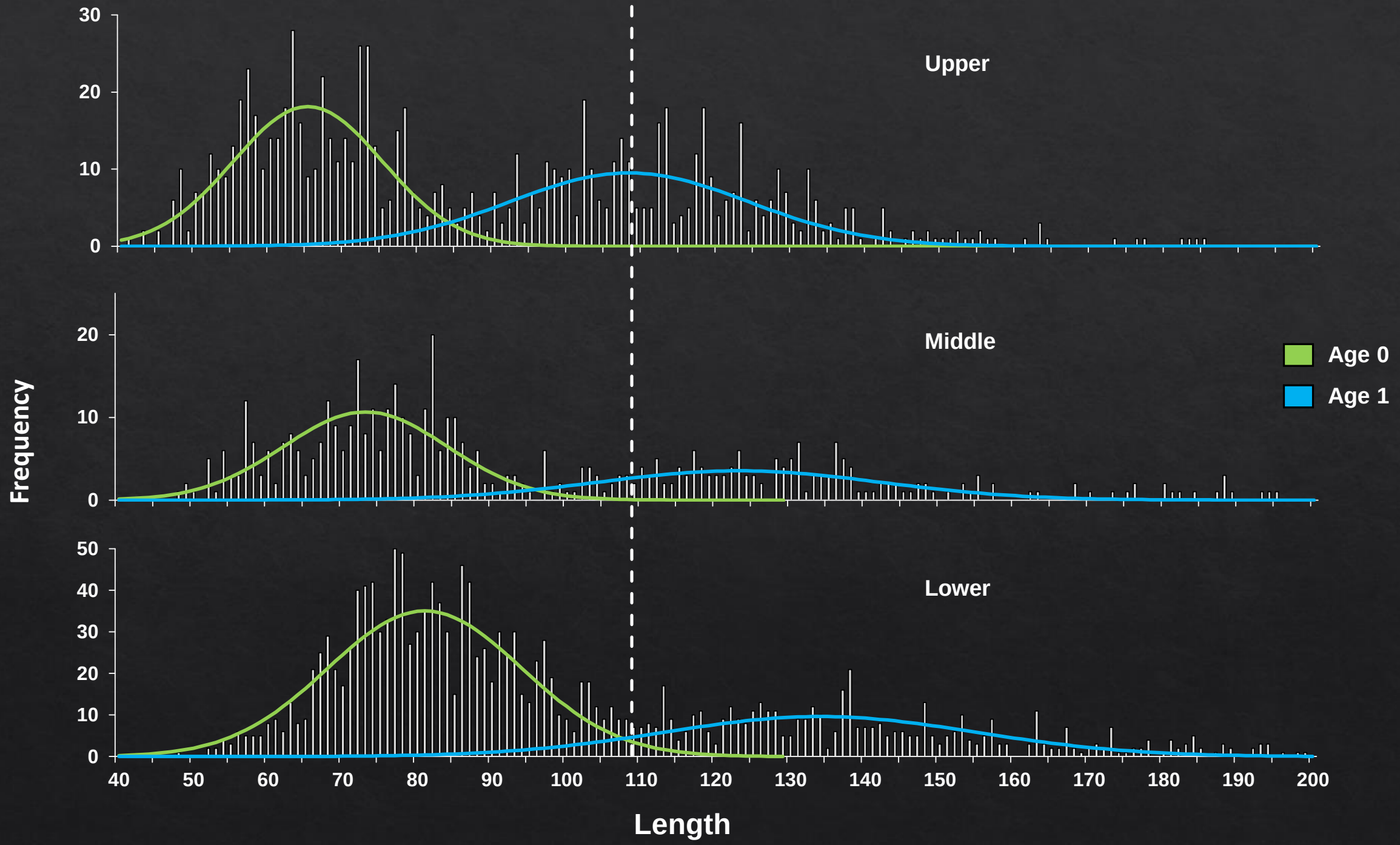
Upper
Middle
Lower
Age 0
Age 1
Frequency
Length
30
20
10
0
20
10
0
50
40
30
20
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40
50
60
70
80
90
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120
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140
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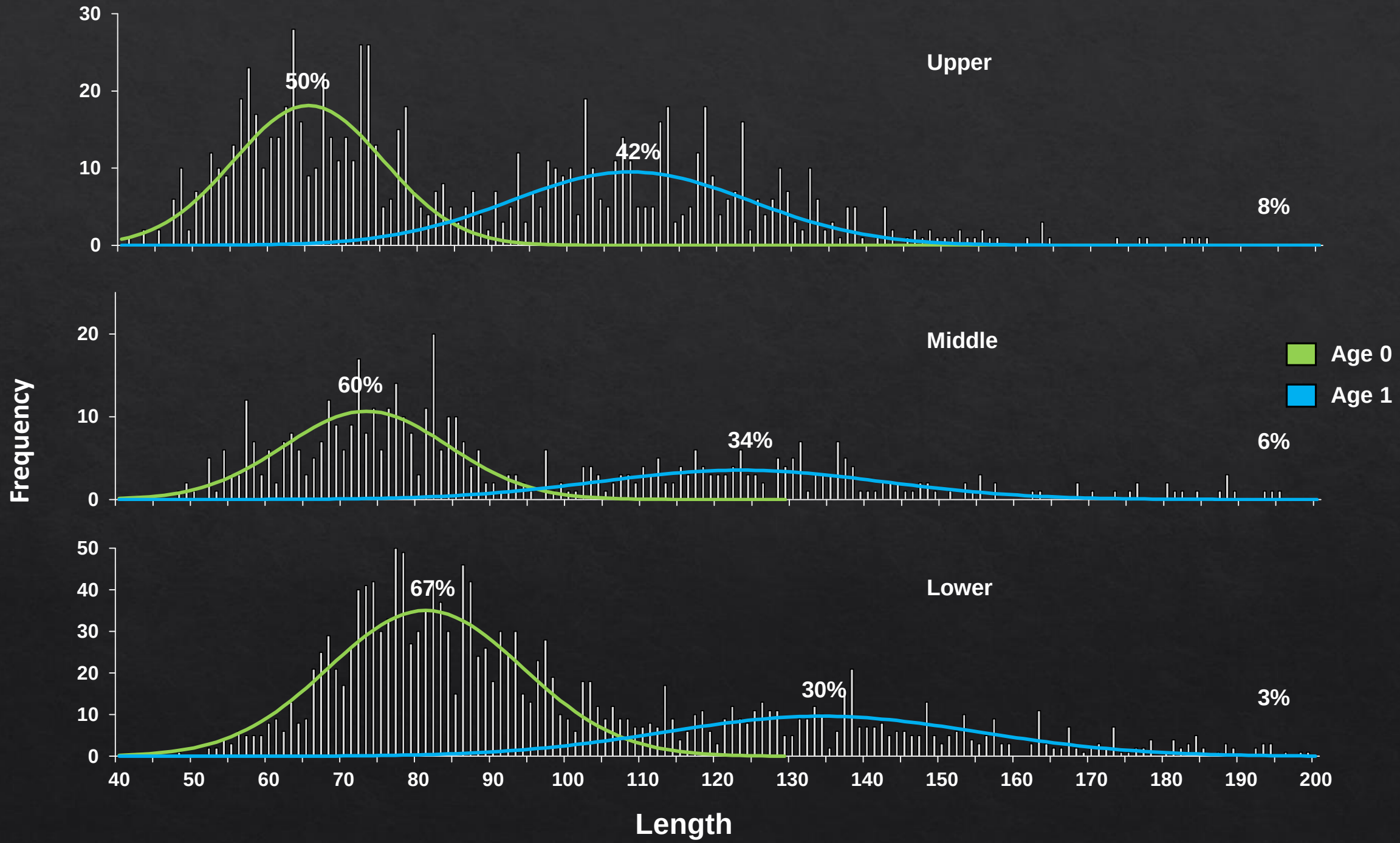
170
180
190
200


Upper
50%
42%
8%
Middle
60%
34%
6%
Lower
67%
30%
3%
Age 0
Age 1
Frequency
Length
0
10
20
30
40
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100
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120
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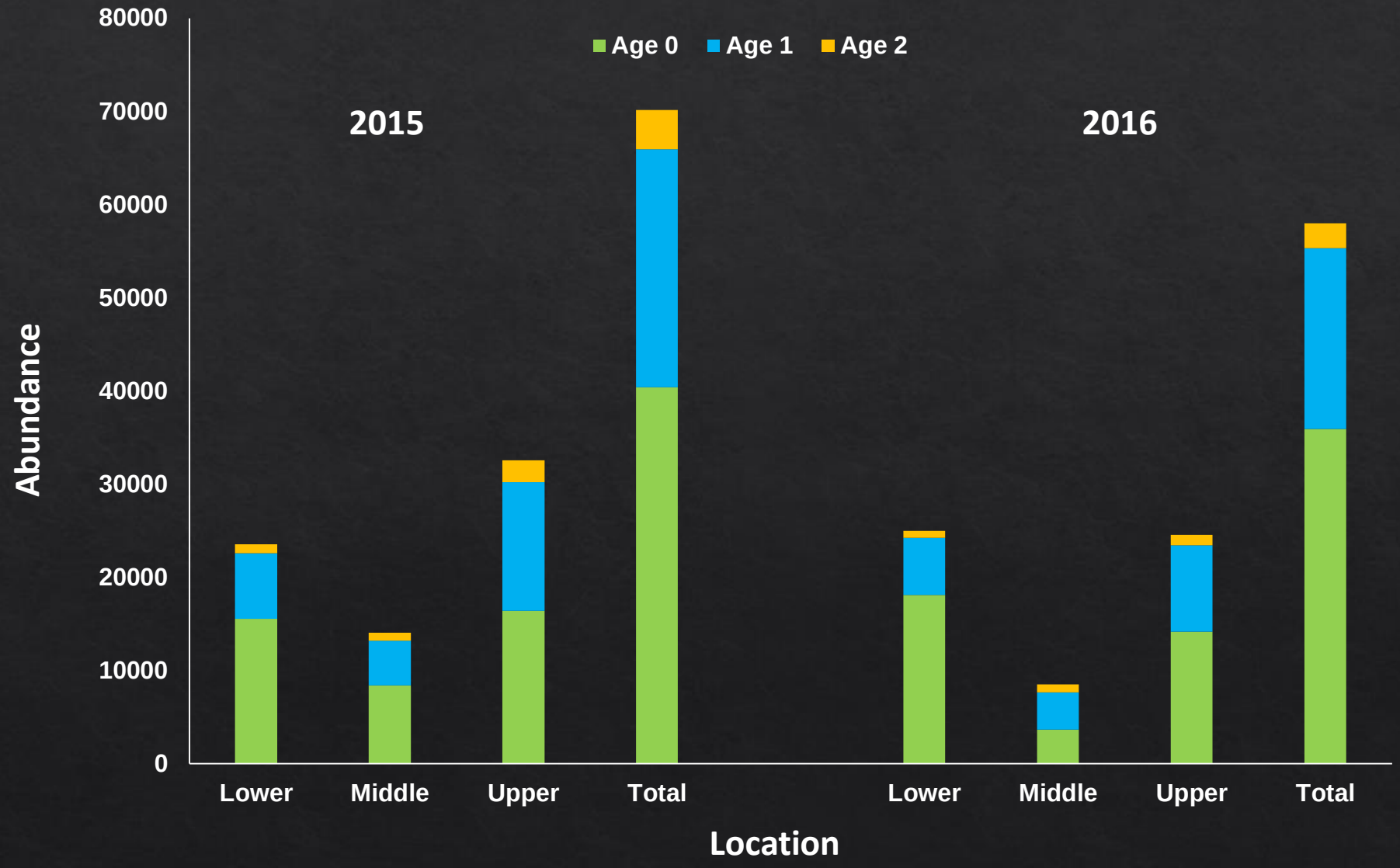
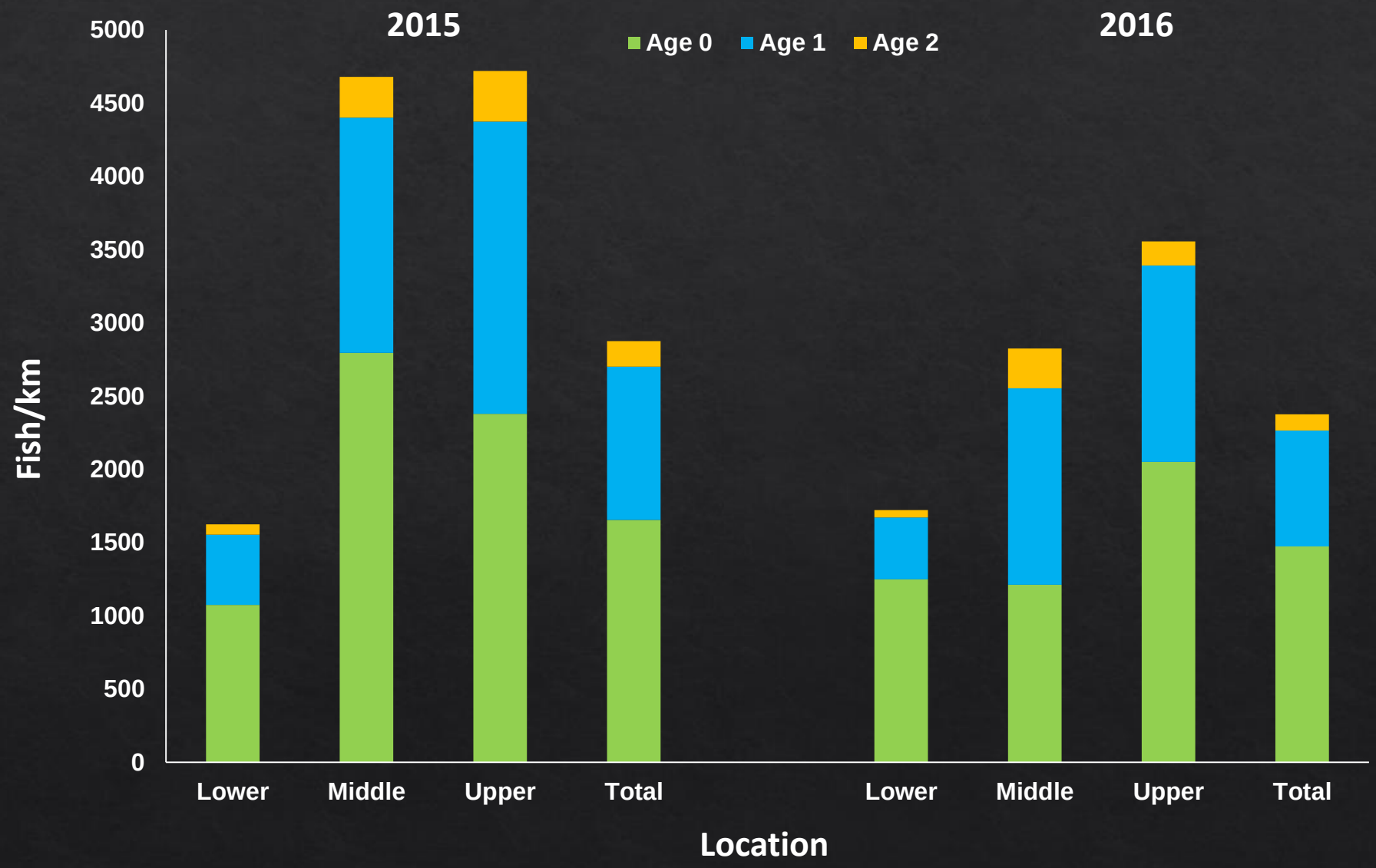
140
150
160
170
180
190
200

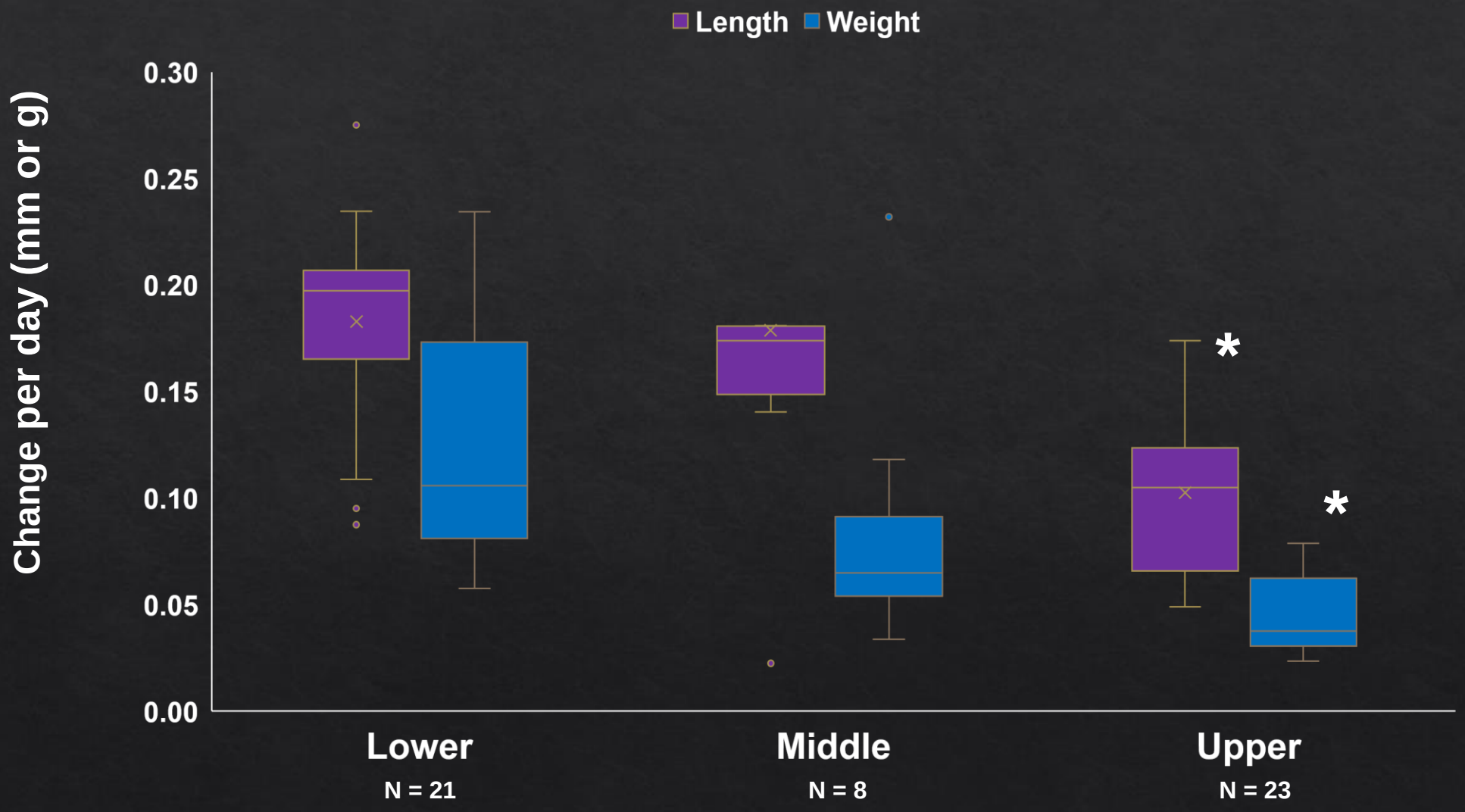
Juvenile abundance and age class results



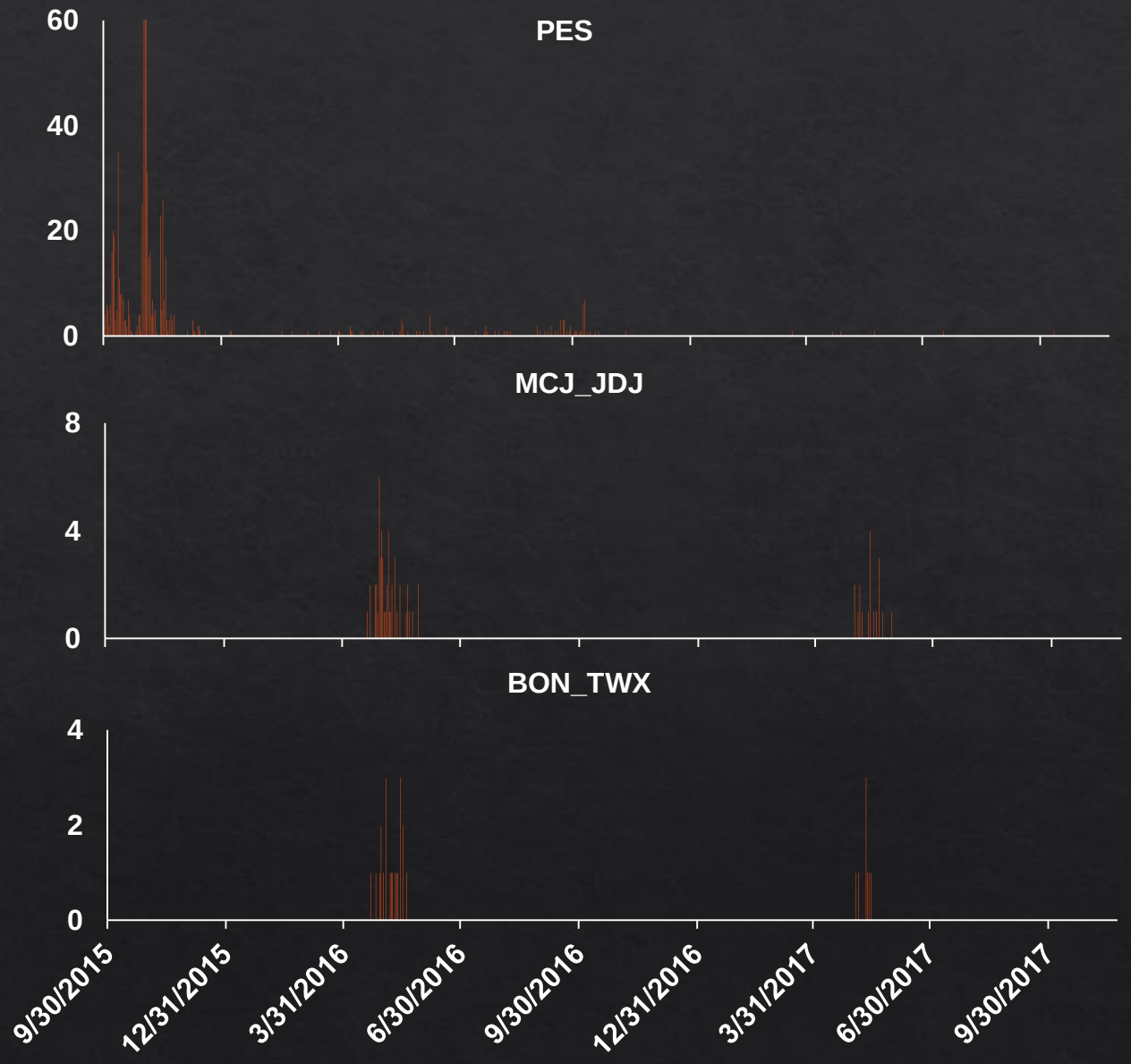
Juvenile density and age class results



Growth from 2015 to 2016



Emigration patterns



Estimating egg-to-parr survival

Brood Year	Origin	Estimate	SE	Fecundity	Eggs	Age 0	Age 1	Age 2
2013	Natural	147	31.2	5749	482,569			**0.9%**
	Hatchery	12	9.8	5770				
2014	Natural	209	36.4	5831	524,058		**4.9%**	**0.5%**
	Hatchery	11	8.8	5847				
2015	Natural	200	32.9	6220	479,184	**8.4%**	**4.0%**	
	Hatchery	36	14.1	5532				
2016	Natural	153	30	5392	428,727	**8.4%**		
	Hatchery	4	5	4956				

Spatially continuous mark-recapture summary and next steps

- Effective for estimating population demographics
  - Strata help account for longitudinal patterns in growth, size-at-age, etc.
  - Can be dynamically adjusted given sufficient recaputures
- Emphasis on fall parr informs critical juvenile life stages (e.g., egg-to-parr, overwinter)
- Longterm monitoring – resident/anadromy, stock-recruit models
- Can also be linked to river habitat at multiple spatial scales

Acknowledgements

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