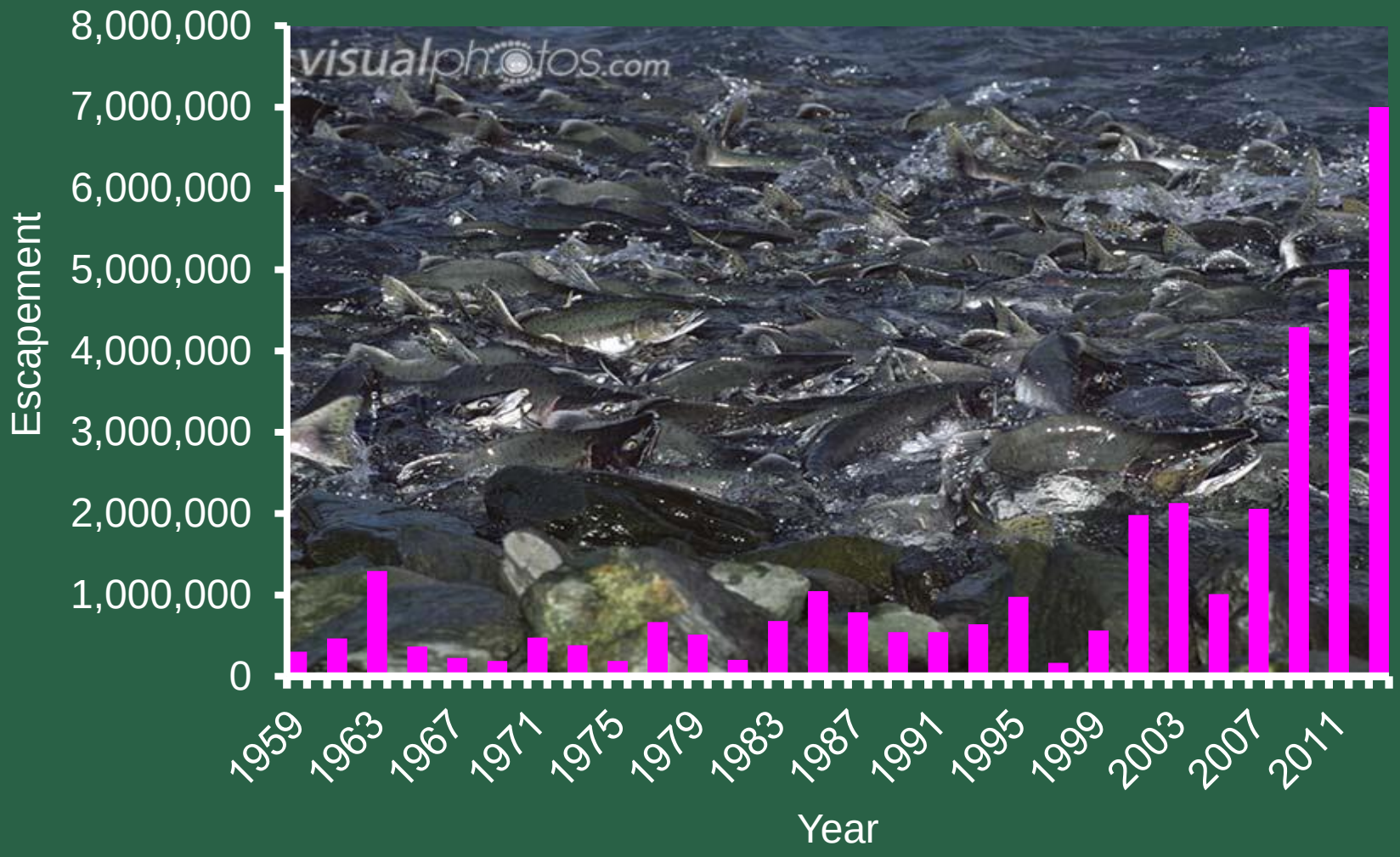
Matthew Klungle
Clayton Kinsel
Peter Topping
Joseph Anderson

POTENTIAL INFLUENCE OF PINK SALMON ON STEELHEAD SMOLTS IN PUGET SOUND

Washington Department of FISH and WILDLIFE

Steelhead Management Meeting 2014

PUGET SOUND PINK SALMON



PULSED RESOURCE SUBSIDY

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INTERSPECIFIC INTERACTION

Ruggeone and Nielsen 2004
- Puget Sound
  - Chinook
  - chum

Michael 1995
Ward and Slaney 1988
- Salish Sea
  - coho
  - steelhead

INTERSPECIFIC INTERACTION

What is the influence of pink salmon on steelhead in Puget Sound?

INTERSPECIFIC INTERACTION

HYPOTHESIZED THAT THE PINK SALMON RESOURCE SUBSIDY WOULD:

-INCREASE STEELHEAD SMOLT ABUNDANCE

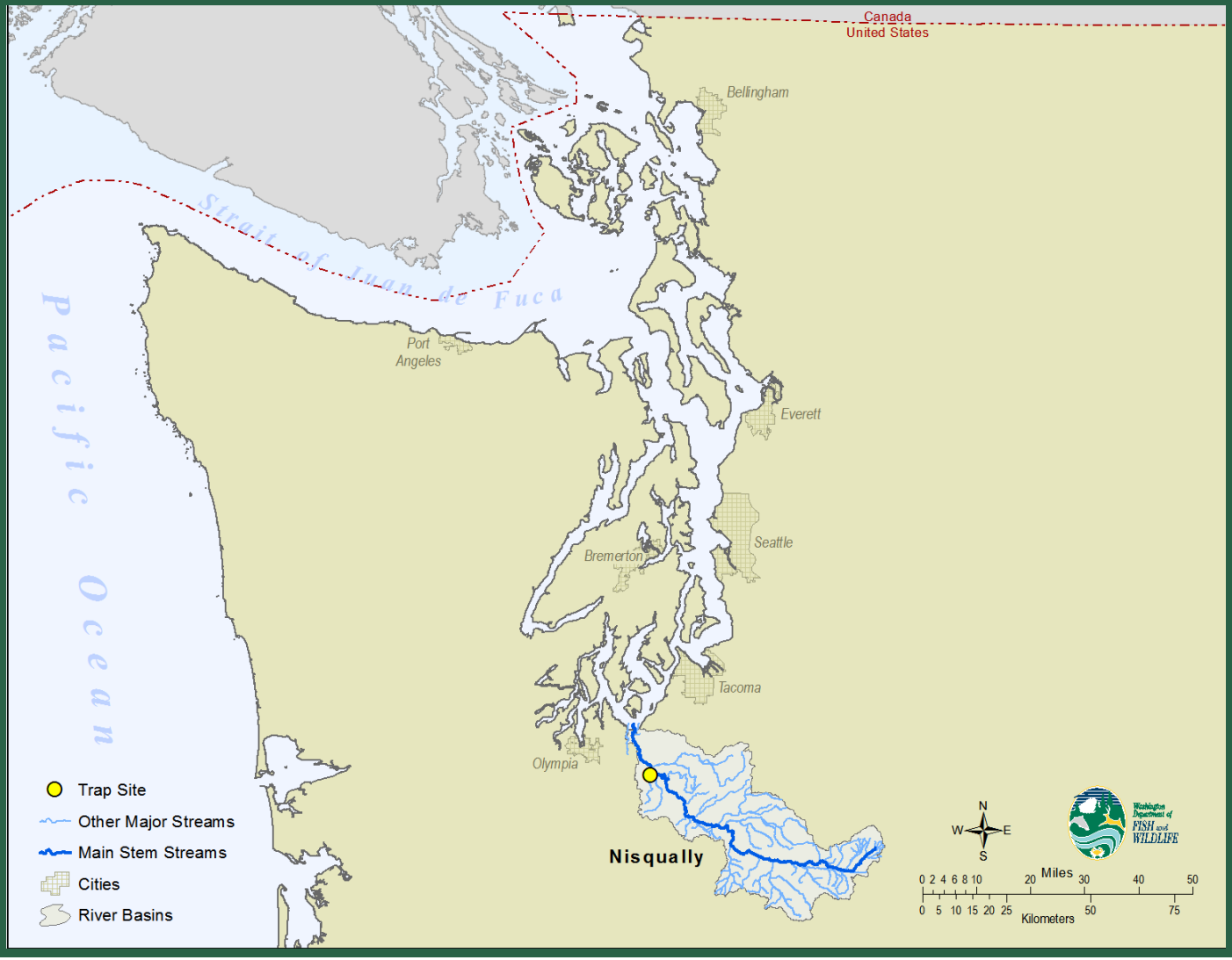
- INCREASE MEAN SMOLT LENGTH

- SHIFT THE AGE STRUCTURE TO YOUNGER

- INCREASE MEAN SMOLT LENGTH AT AGE

- ADVANCE MEDIAN RUN TIMING

NISQUALLY RIVER



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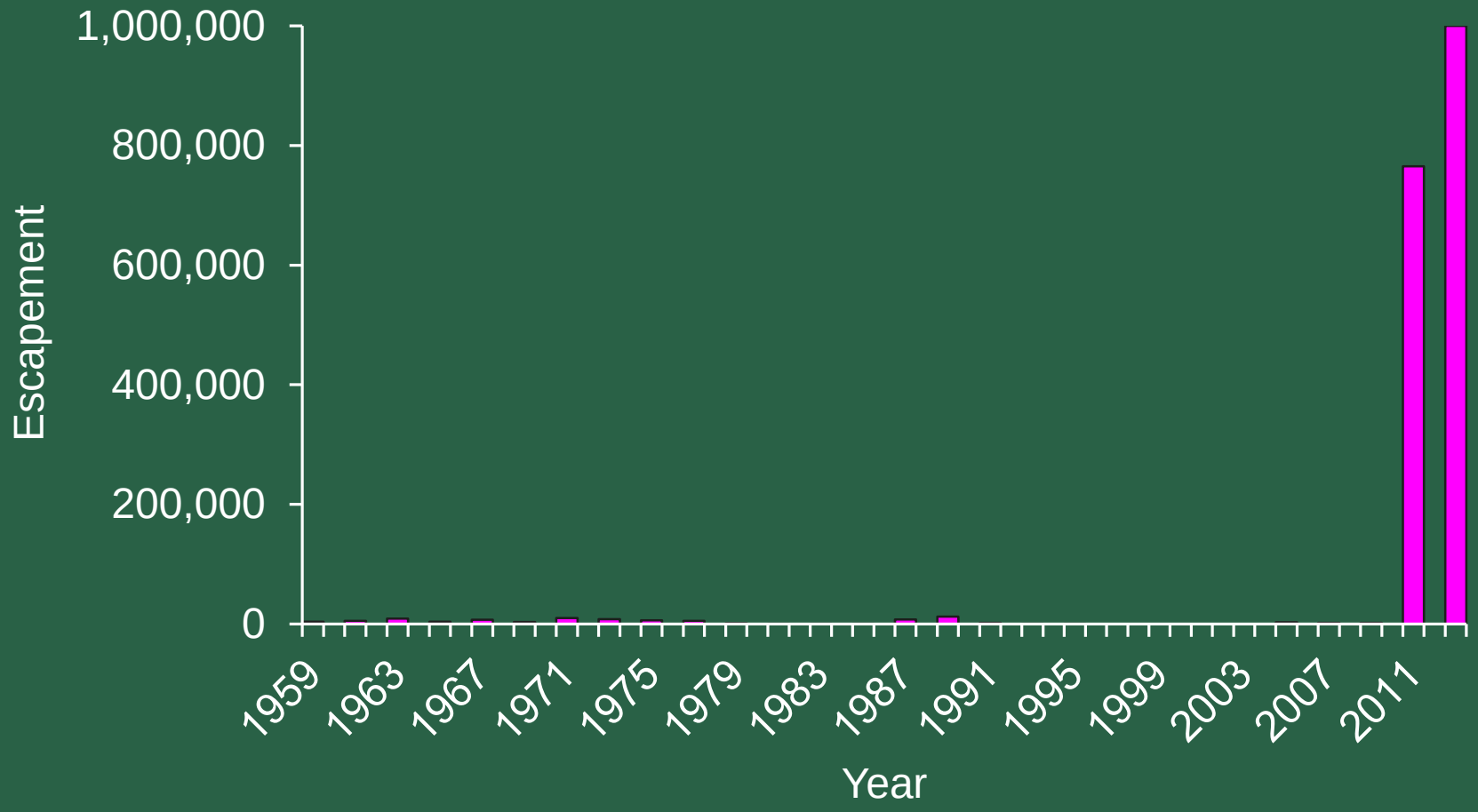
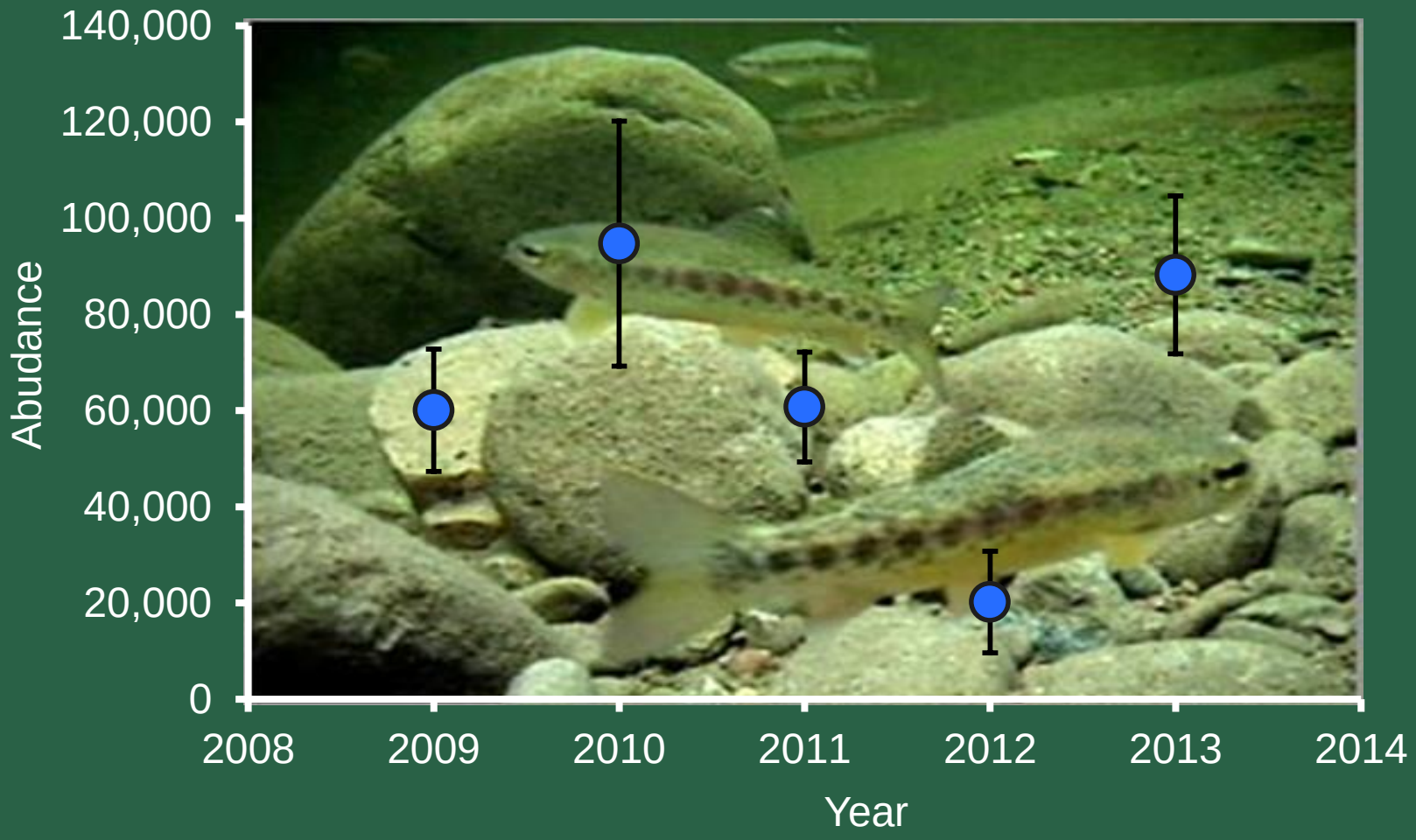
NISQUALLY RIVER
PINK SALMON



NISQUALLY RIVER STEELHEAD SMOLT ABUNDANCE



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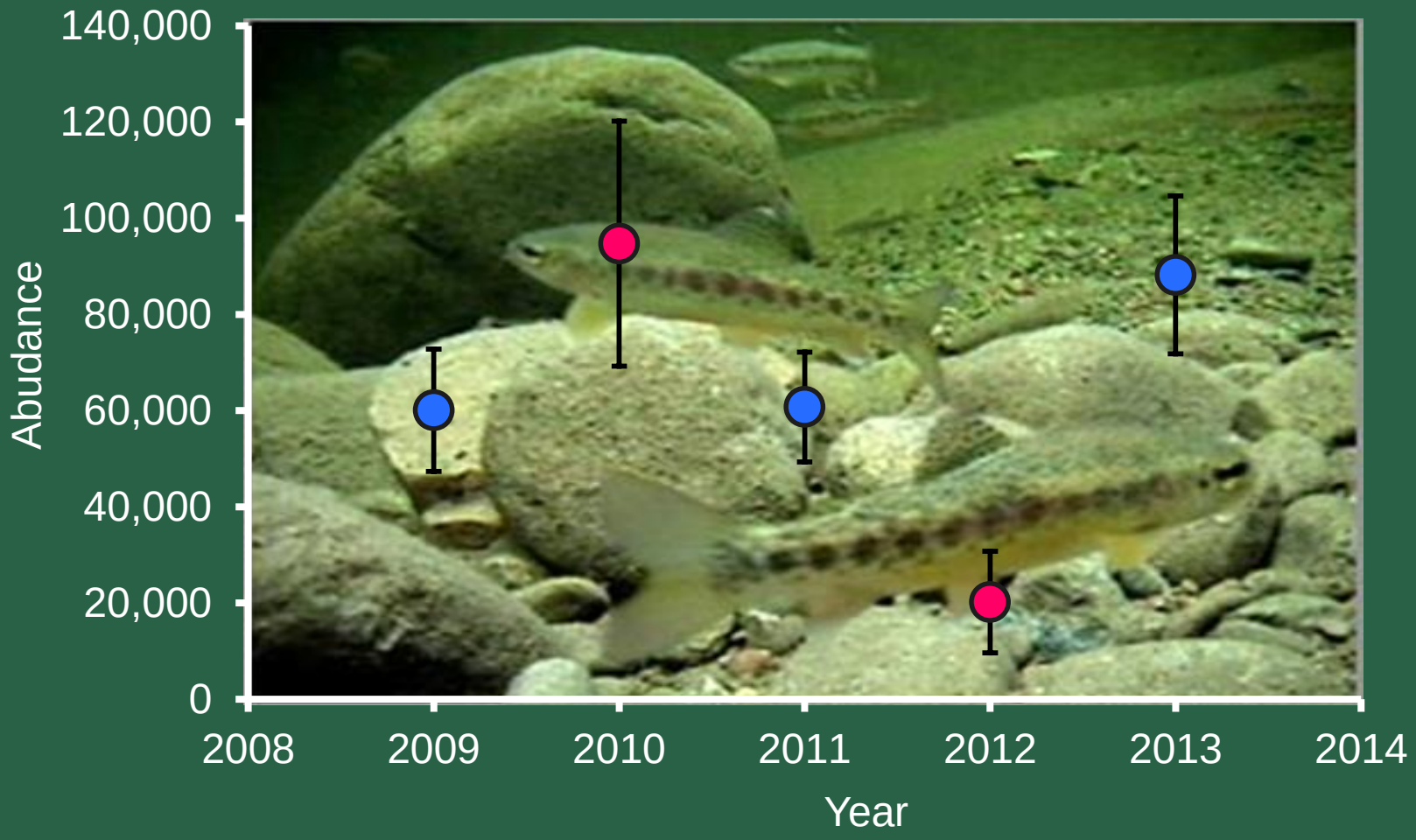

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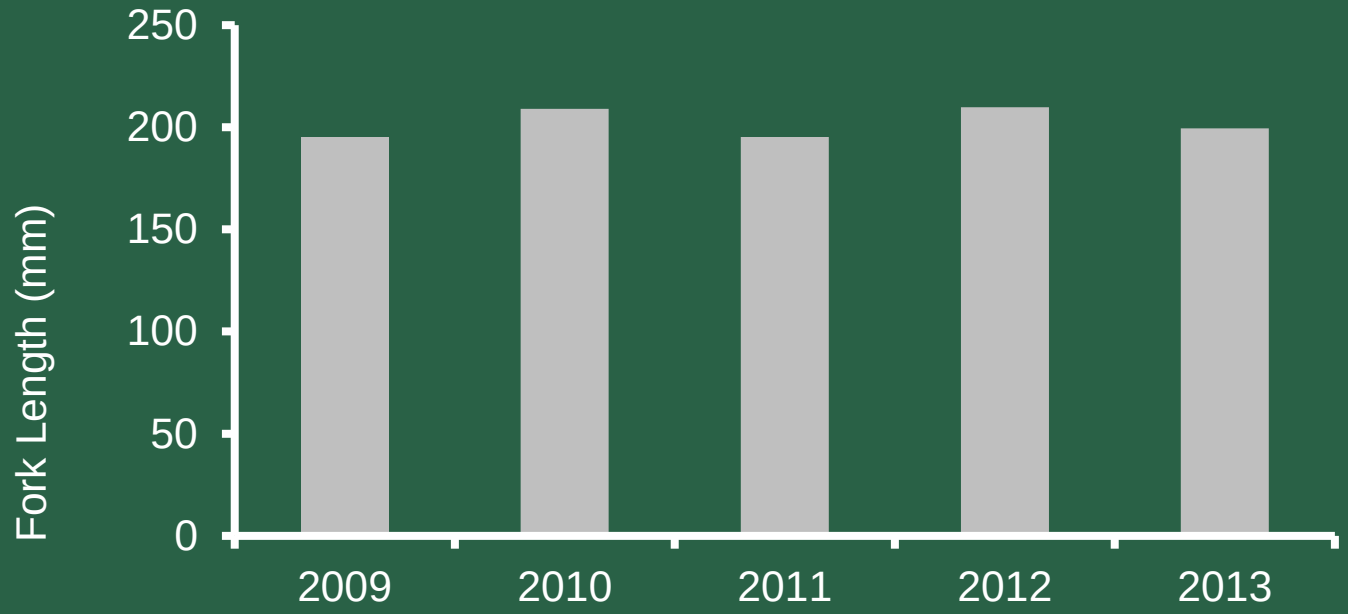
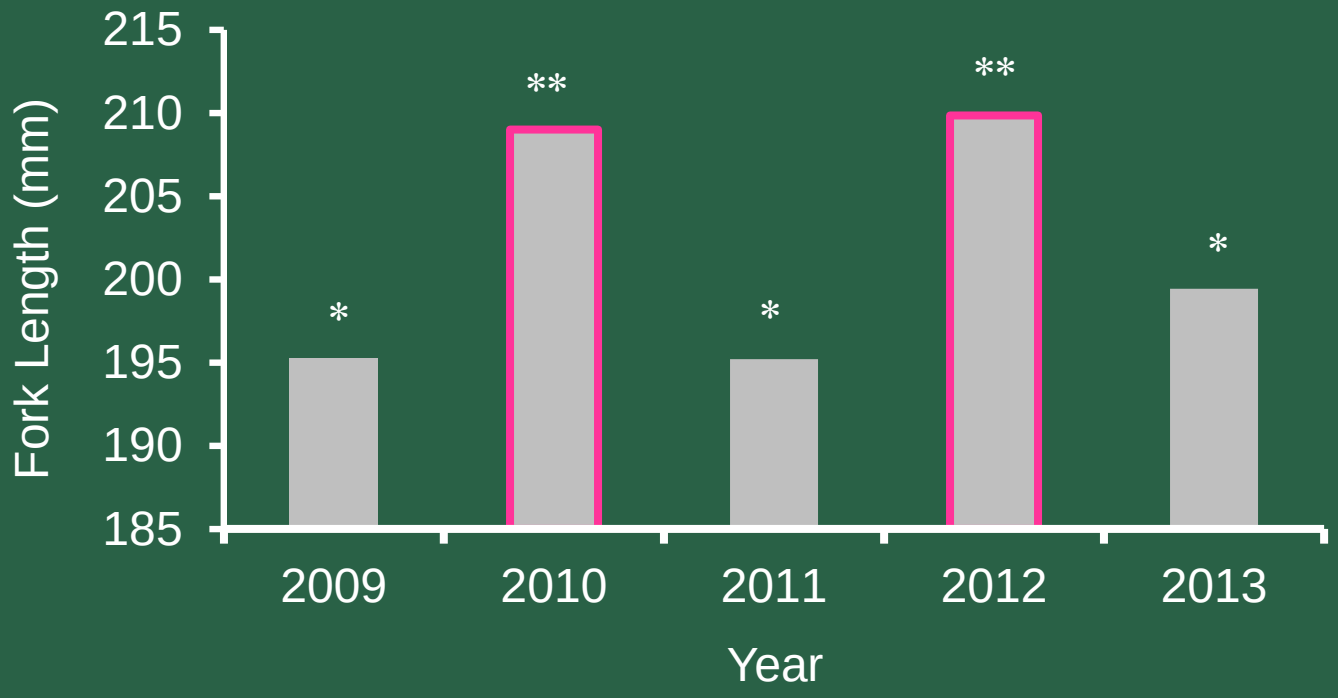
NISQUALLY RIVER STEELHEAD SMOLT SIZE STRUCTURE

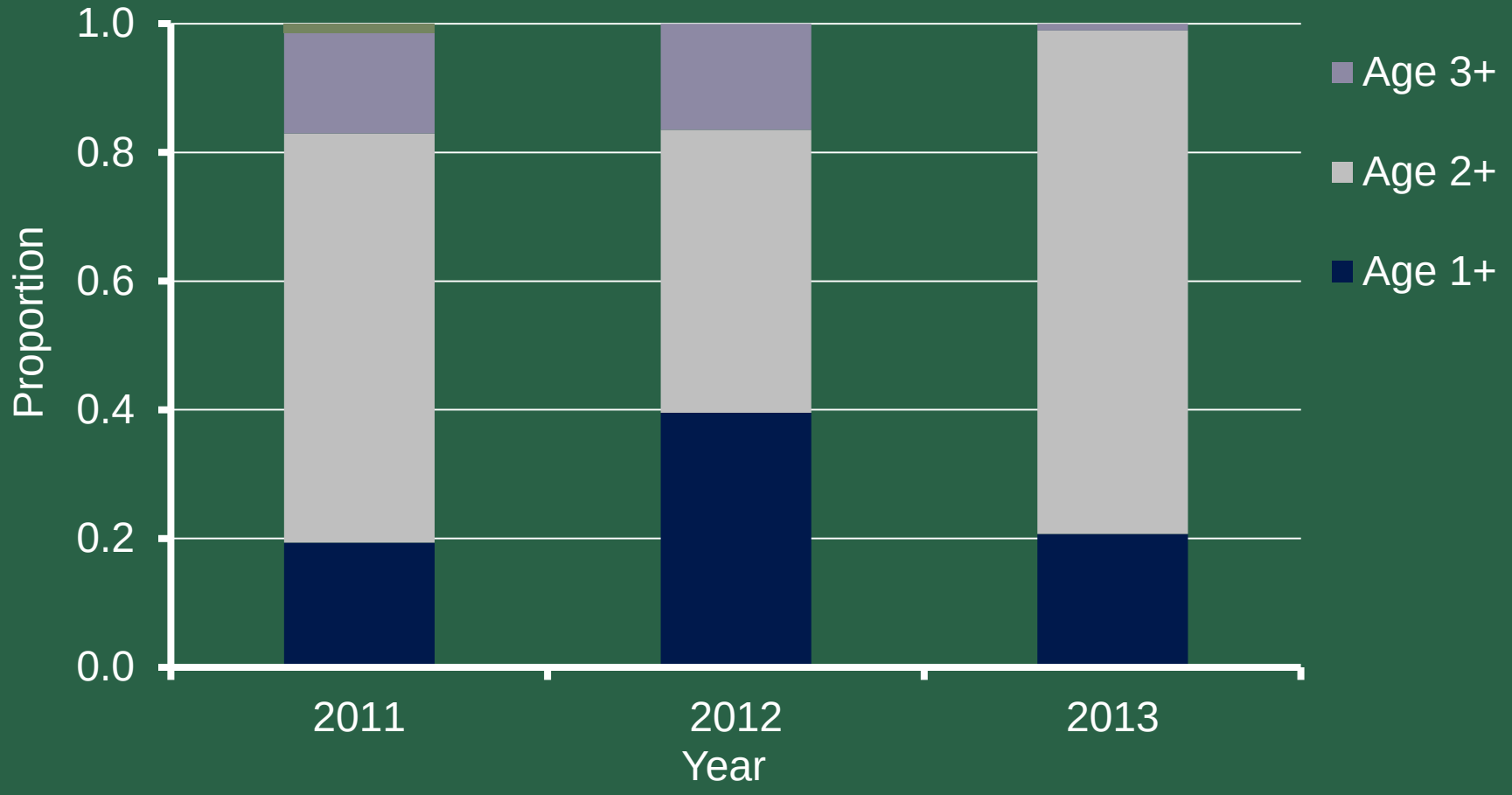


STEELHEAD SMOLT SIZE STRUCTURE

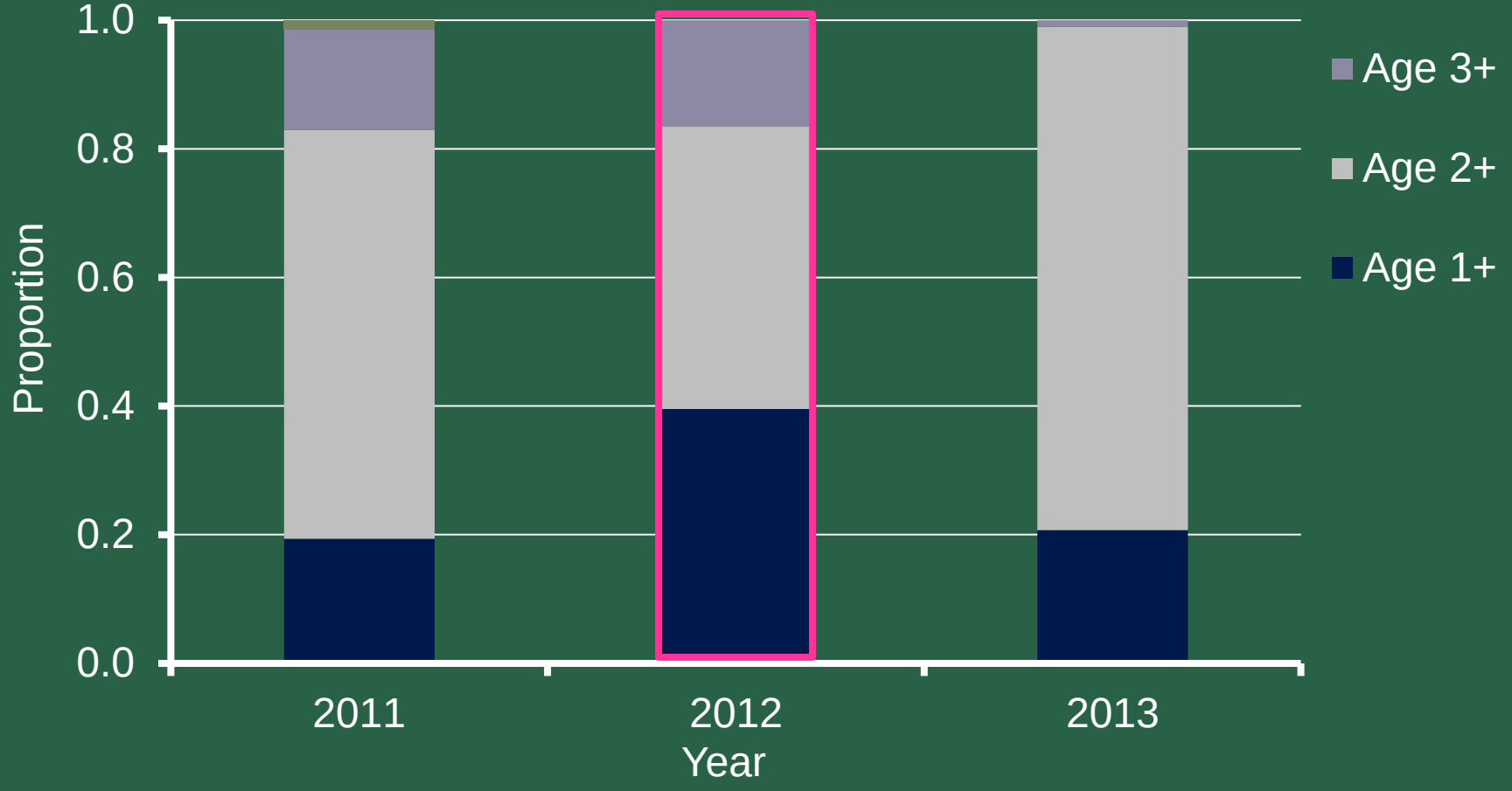
	2009	2010	2011	2012	2013
mean	195.3	209.0	195.2	209.8	199.5
S.D.	20.58	34.50	25.18	38.56	24.91



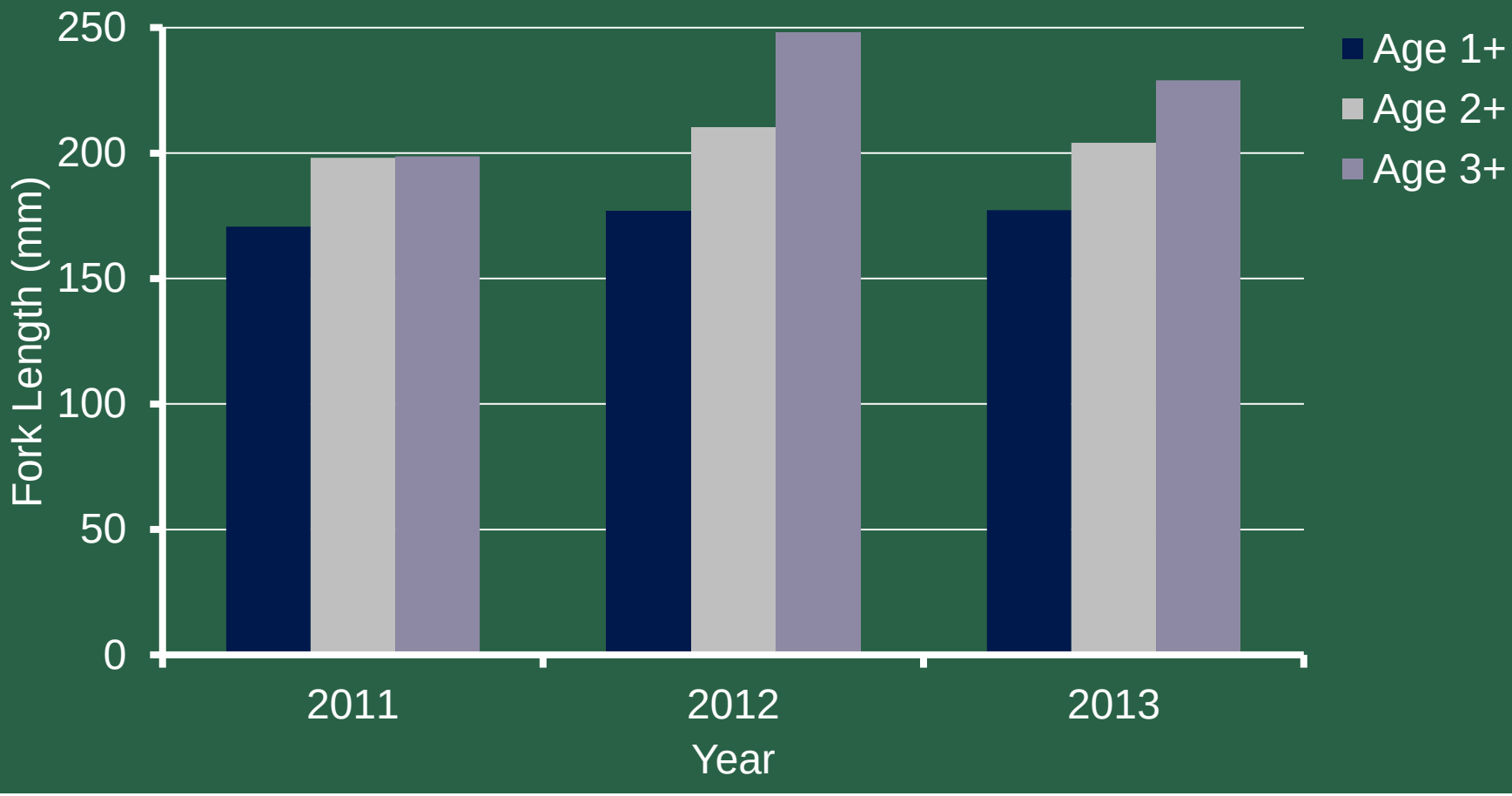
NISQUALLY RIVER STEELHEAD SMOLT AGE STRUCTURE



NISQUALLY RIVER STEELHEAD SMOLT AGE STRUCTURE

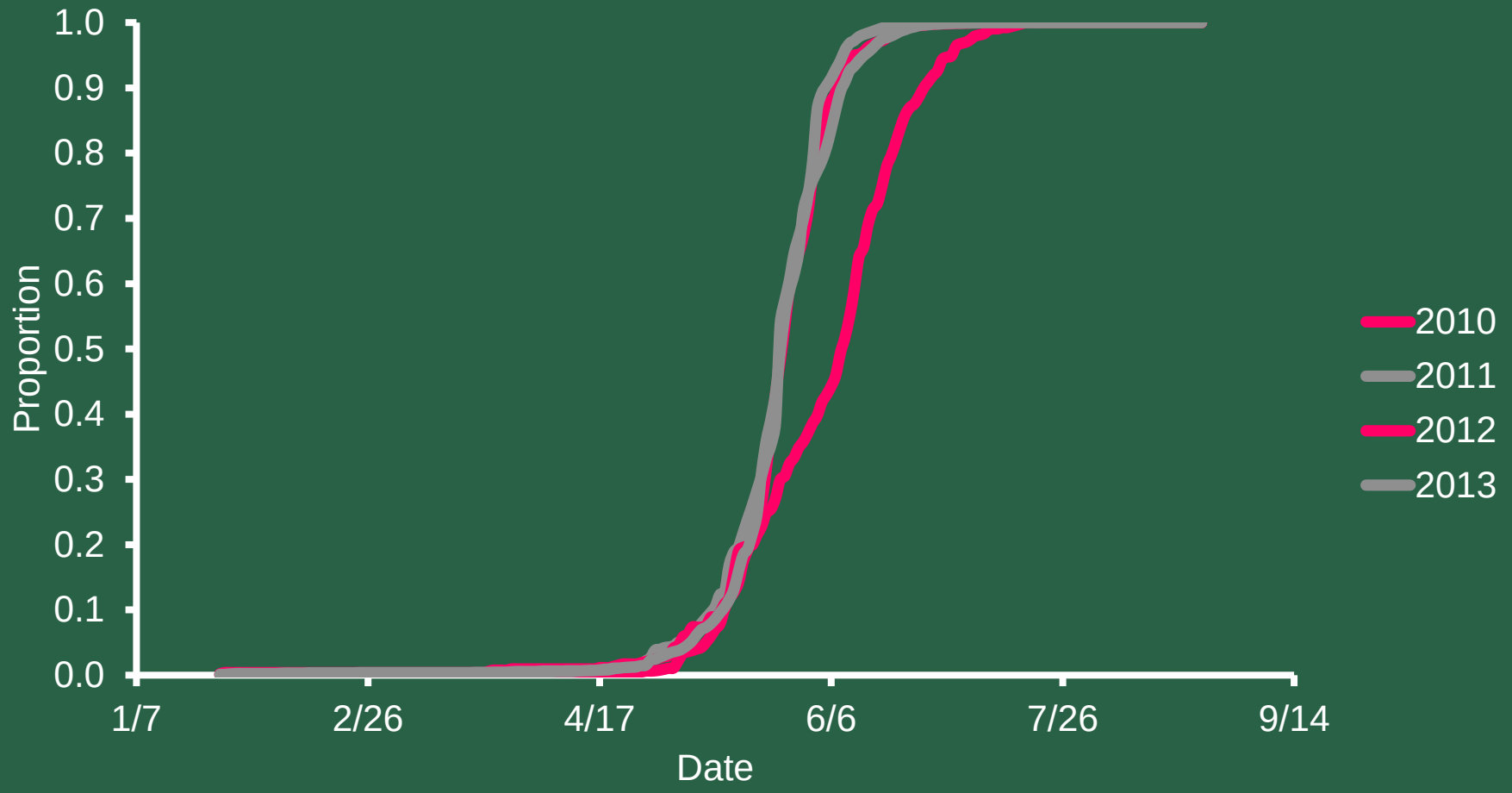


NISQUALLY RIVER
STEELHEAD SMOLT SIZE AT AGE STRUCTURE



NISQUALLY RIVER
STEELHEAD SMOLT SIZE AT AGE STRUCTURE

NISQUALLY RIVER
STEELHEAD SMOLT RUN TIMING



INTERSPECIFIC INTERACTION

HYPOTHESIZED THAT THE PINK SALMON RESOURCE SUBSIDY WOULD:

-INCREASE STEELHEAD SMOLT ABUNDANCE

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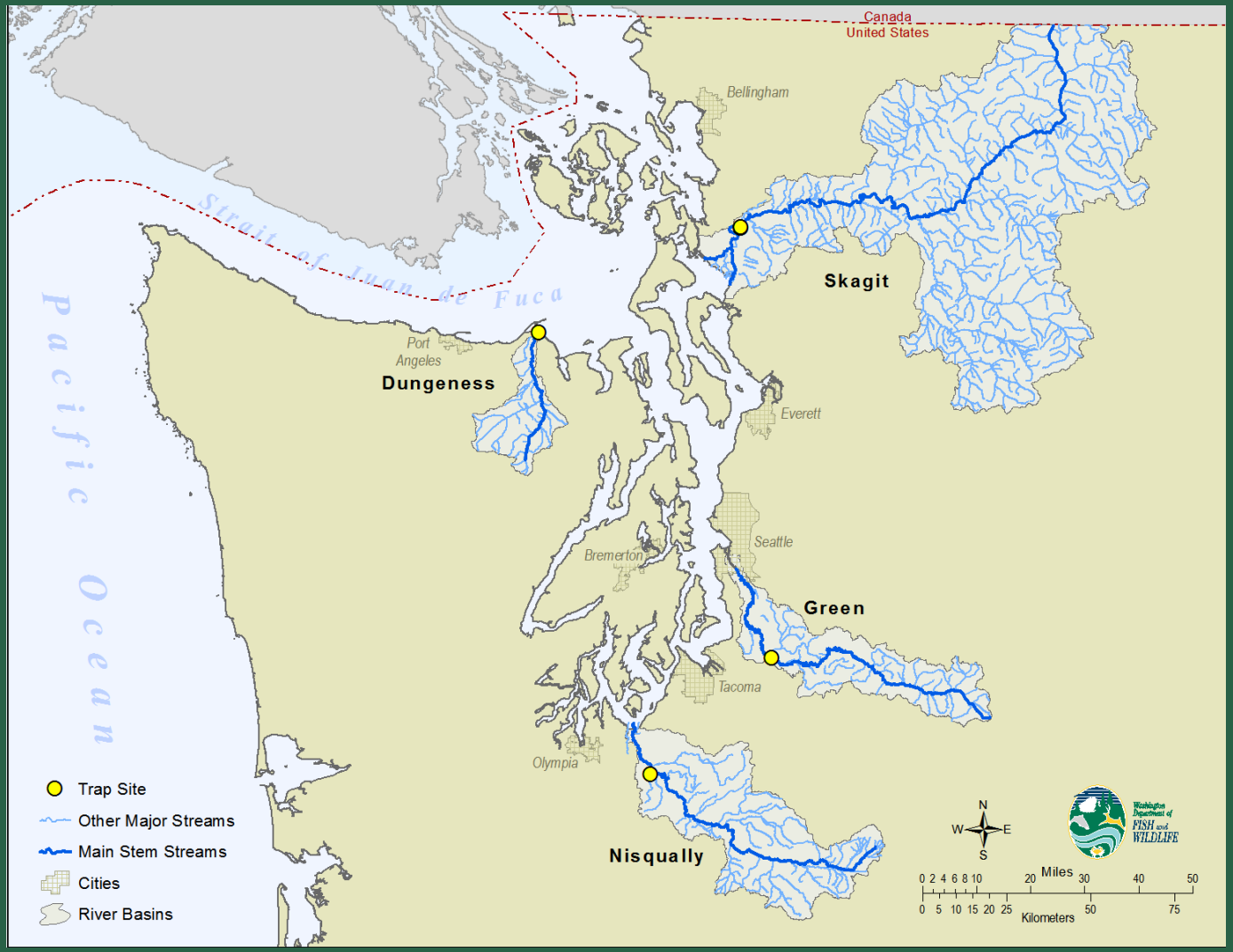
PUGET SOUND



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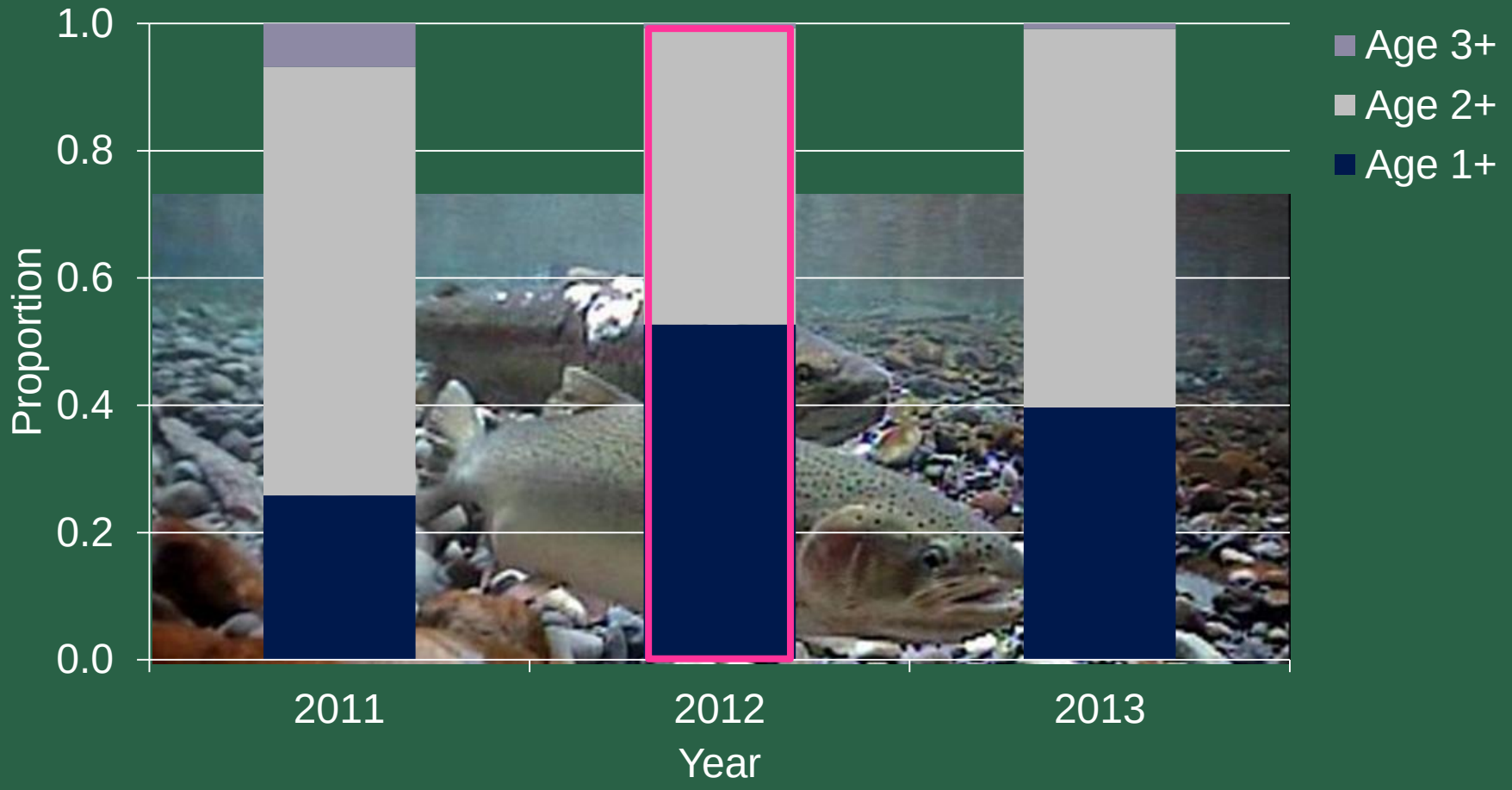
GREEN RIVER
STEELHEAD SMOLT ABUNDANCE
&
PINK ESCAPEMENT

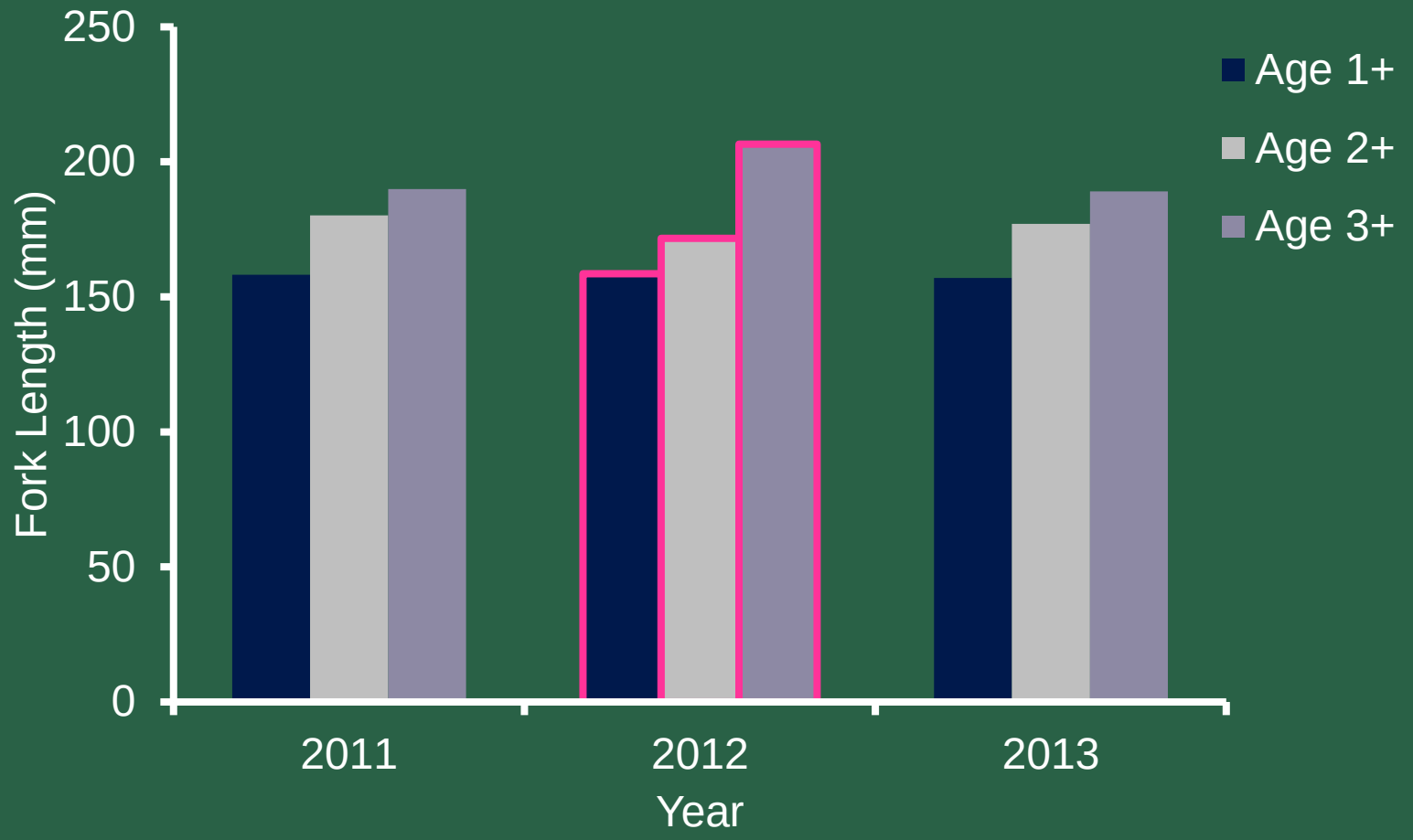
N/A

GREEN RIVER
STEELHEAD SMOLT SIZE STRUCTURE

GREEN RIVER STEELHEAD AGE STRUCTURE



GREEN RIVER
STEELHEAD SIZE AT AGE STRUCTURE



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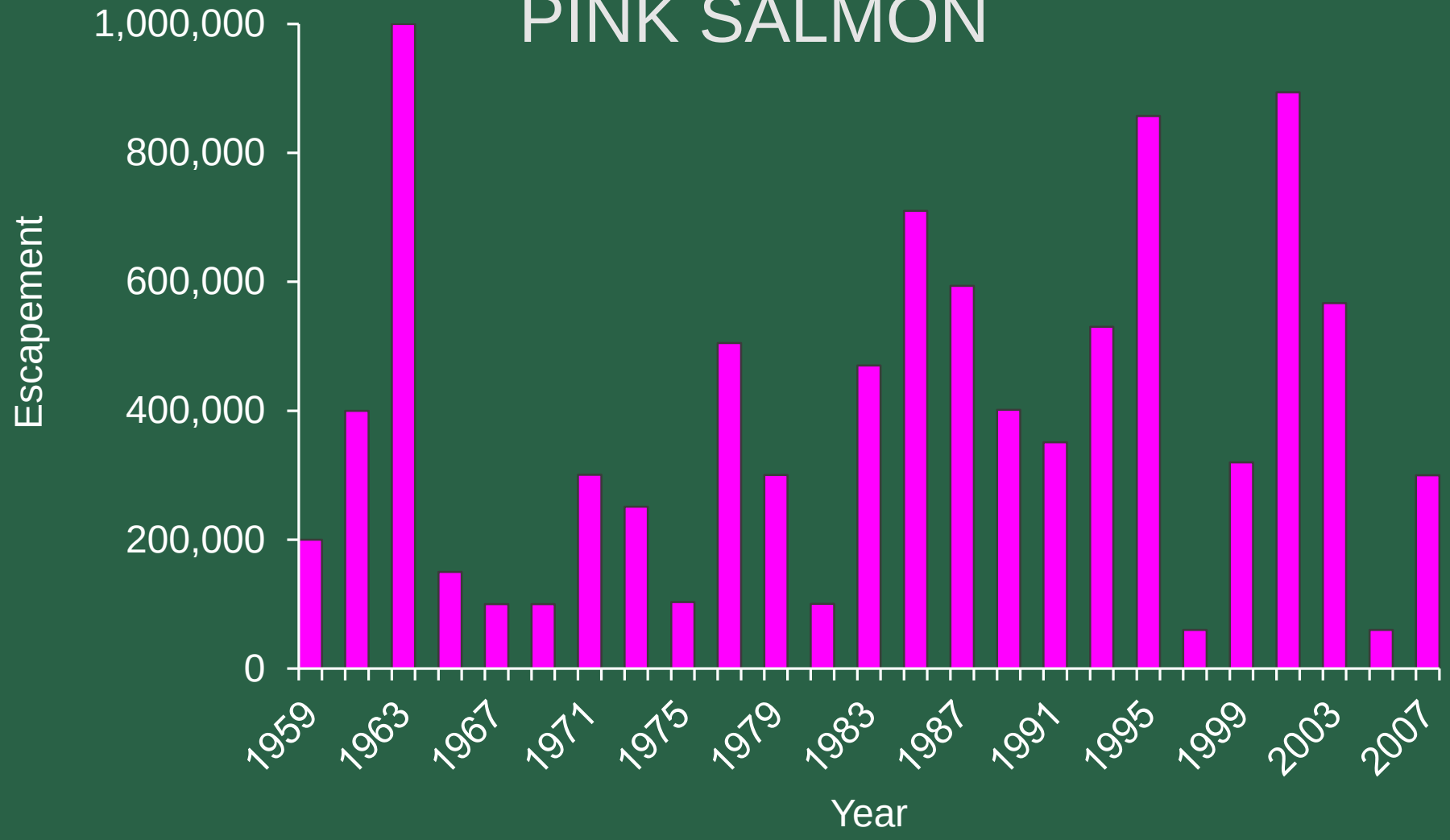
SKAGIT RIVER PINK SALMON

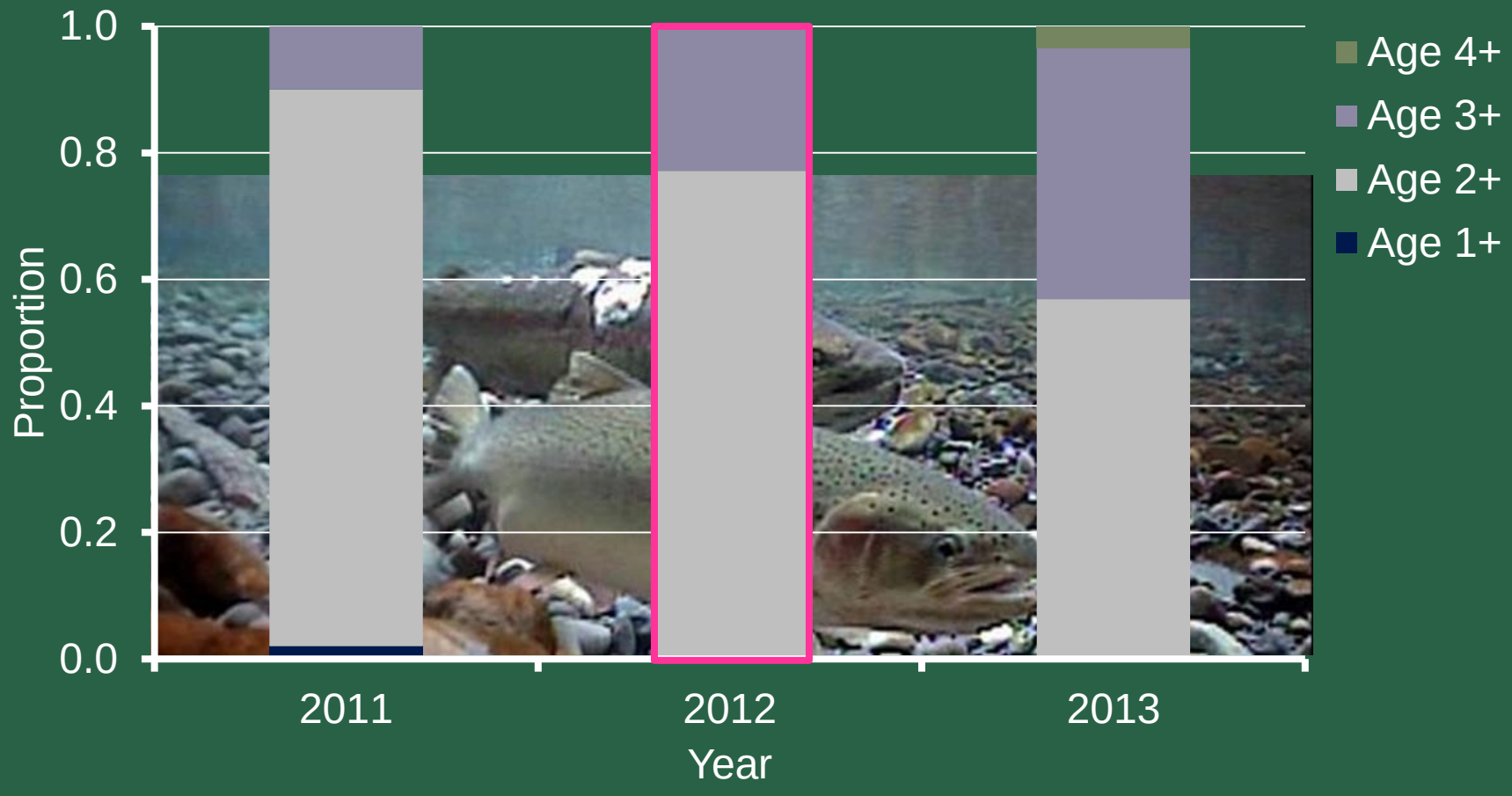


SKAGIT RIVER
STEELHEAD SMOLT ABUNDANCE

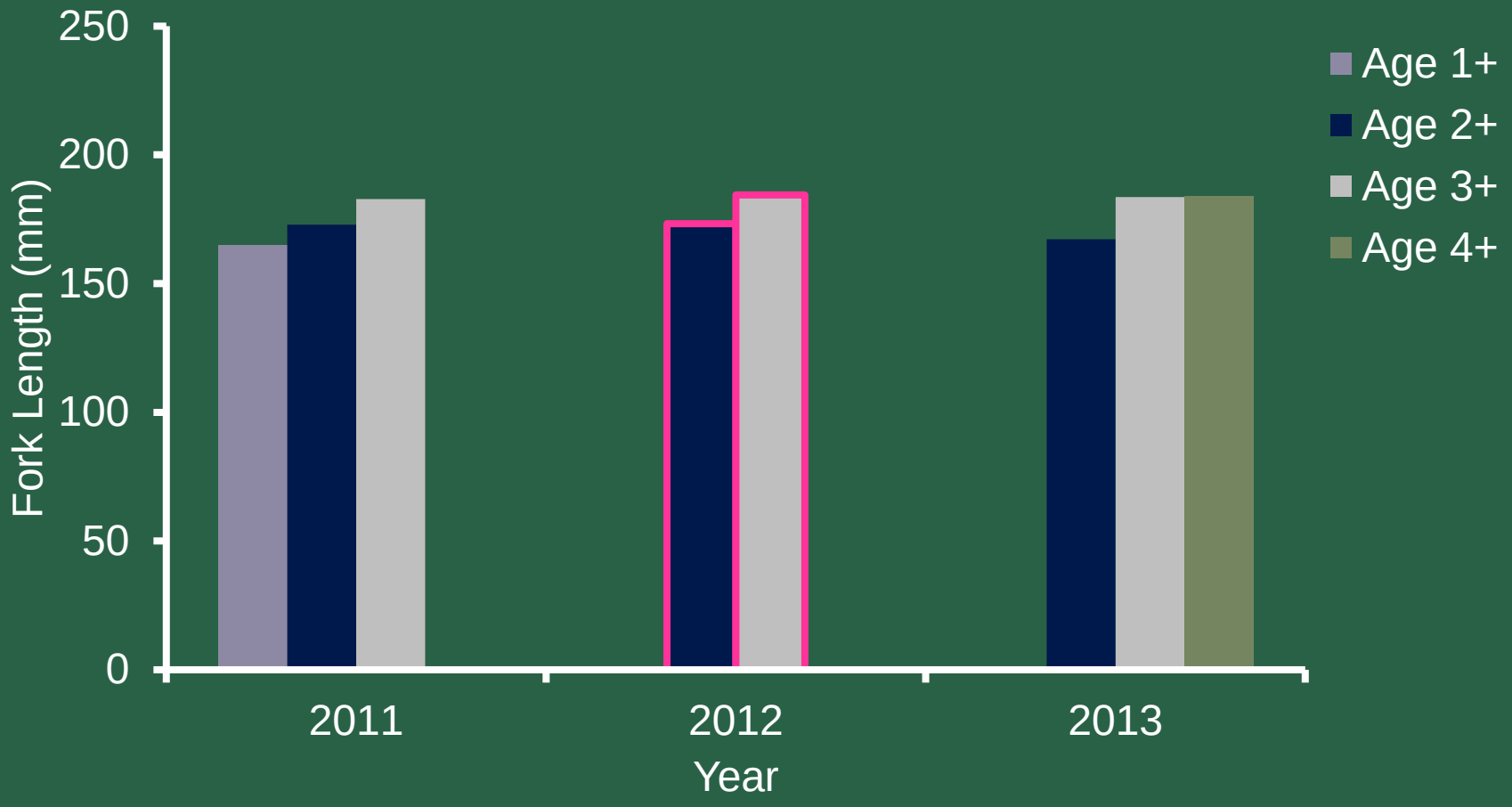
N/A

SKAGIT RIVER
STEELHEAD SMOLT SIZE STRUCTURE

SKAGIT RIVER
STEELHEAD AGE STRUCTURE



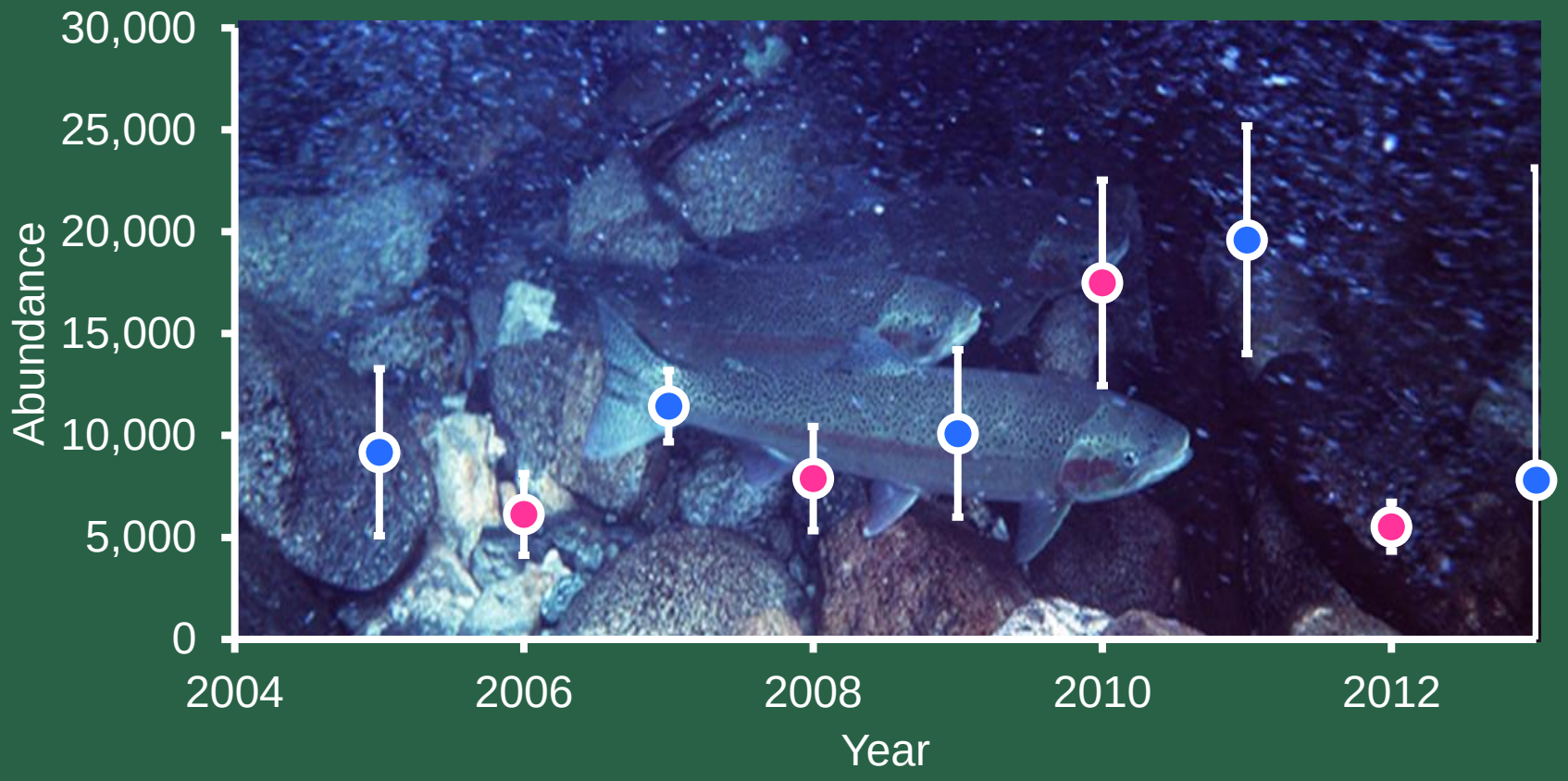
SKAGIT RIVER
STEELHEAD SIZE AT AGE STRUCTURE



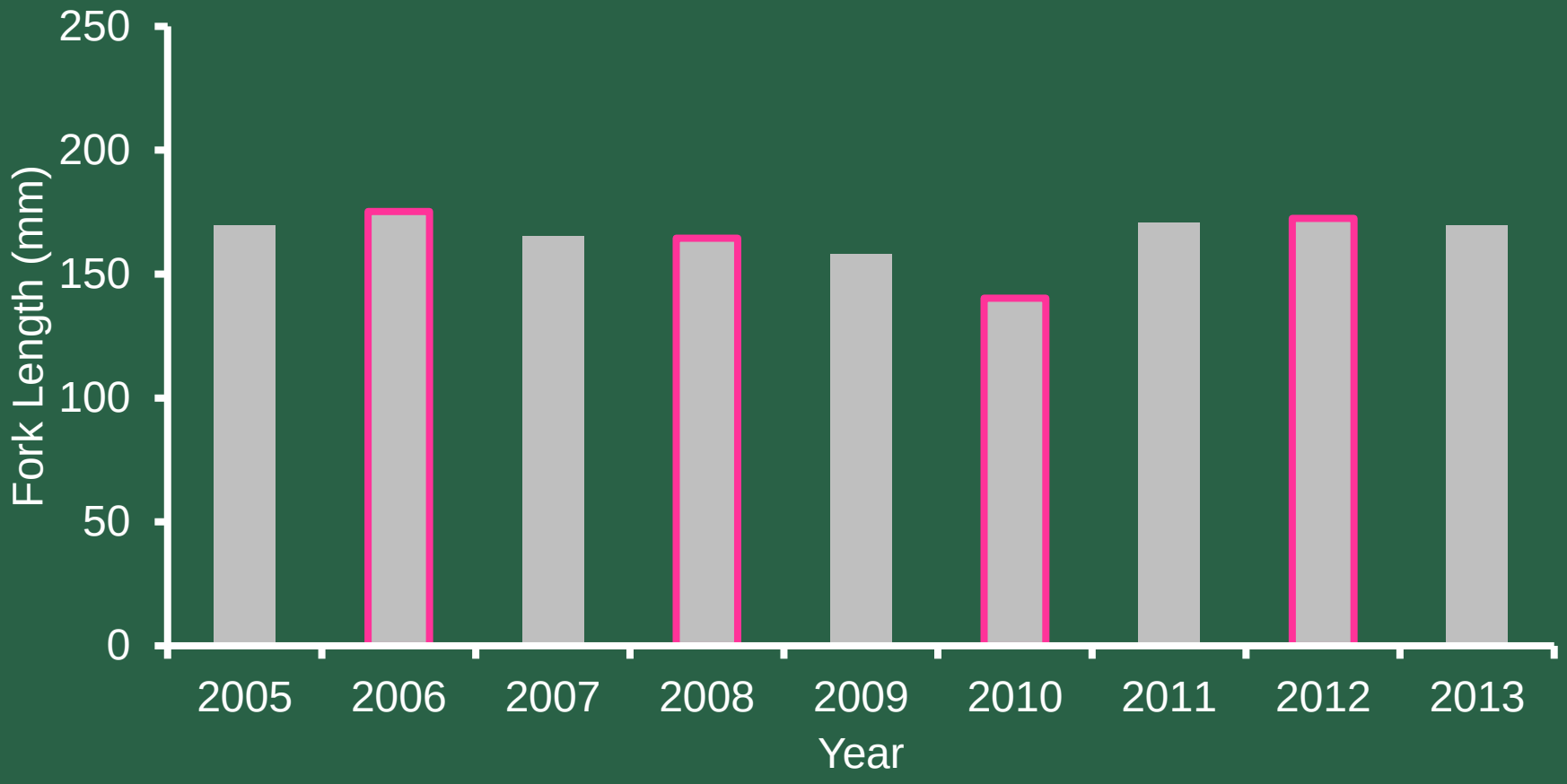
DUNGENESS RIVER PINK ESCAPMENT

N/A

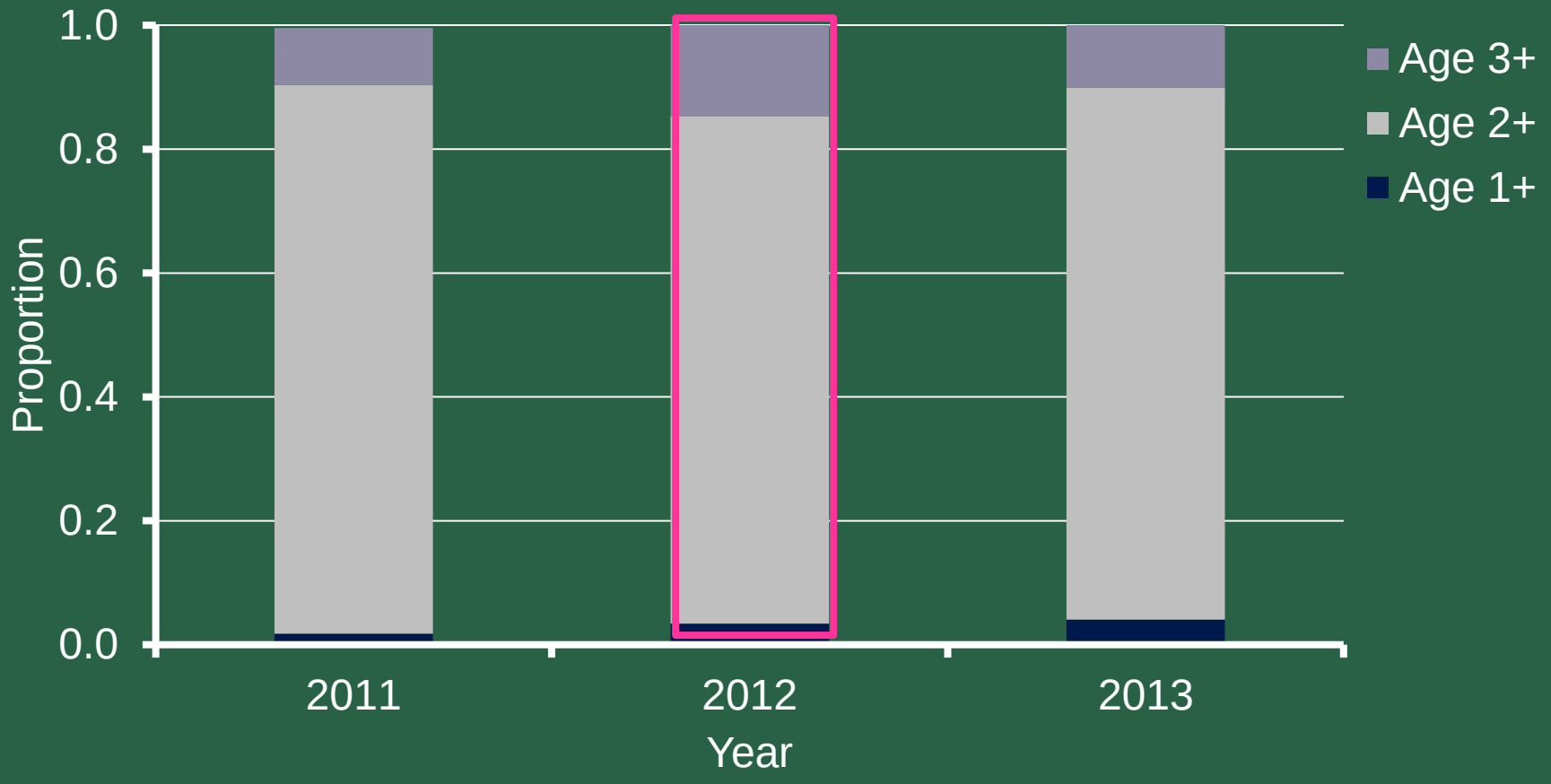
DUNGENESS RIVER STEELHEAD SMOLT ABUNDANCE



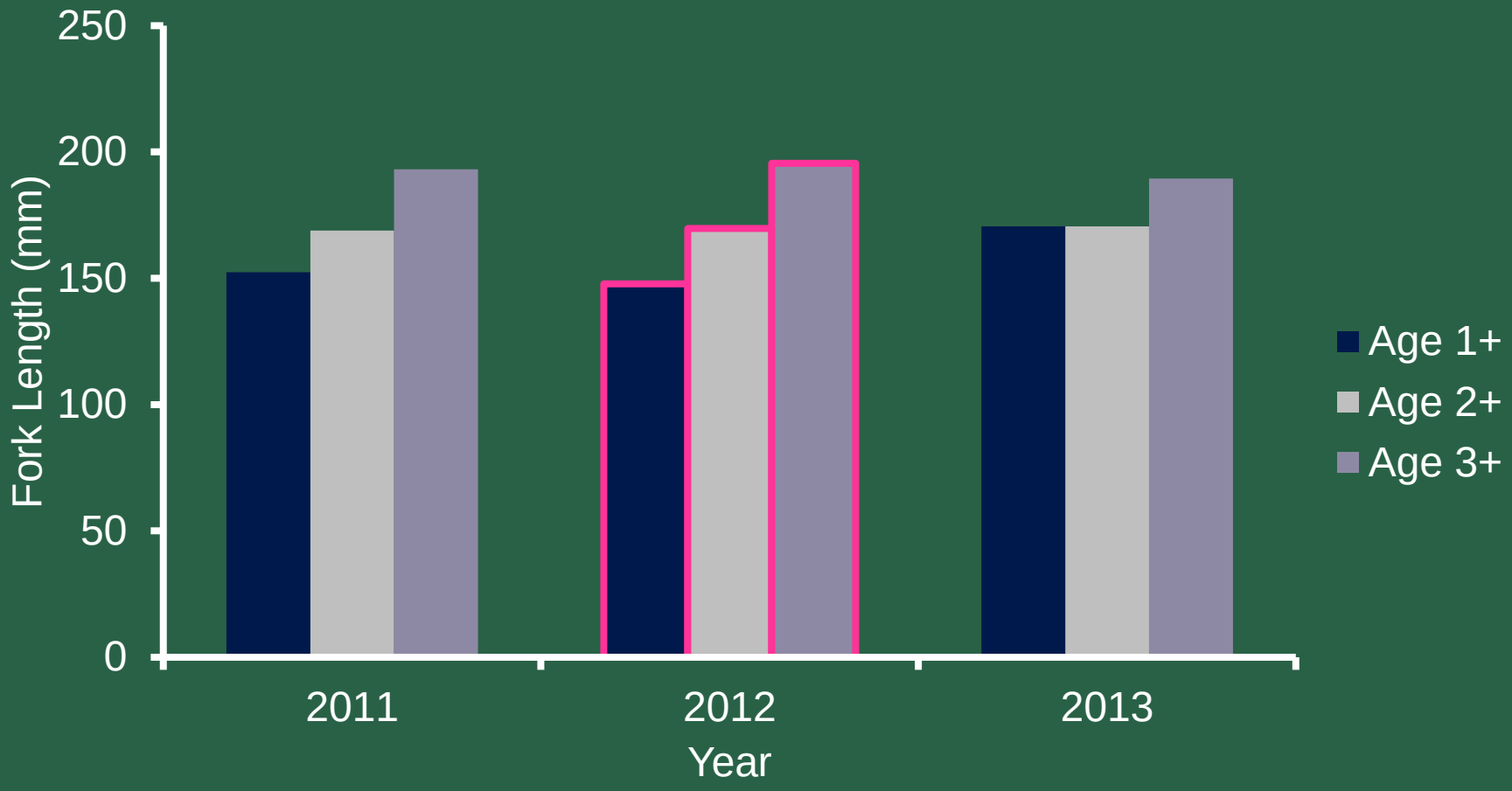
DUNGENESS RIVER
STEELHEAD SMOLT SIZE STRUCTURE



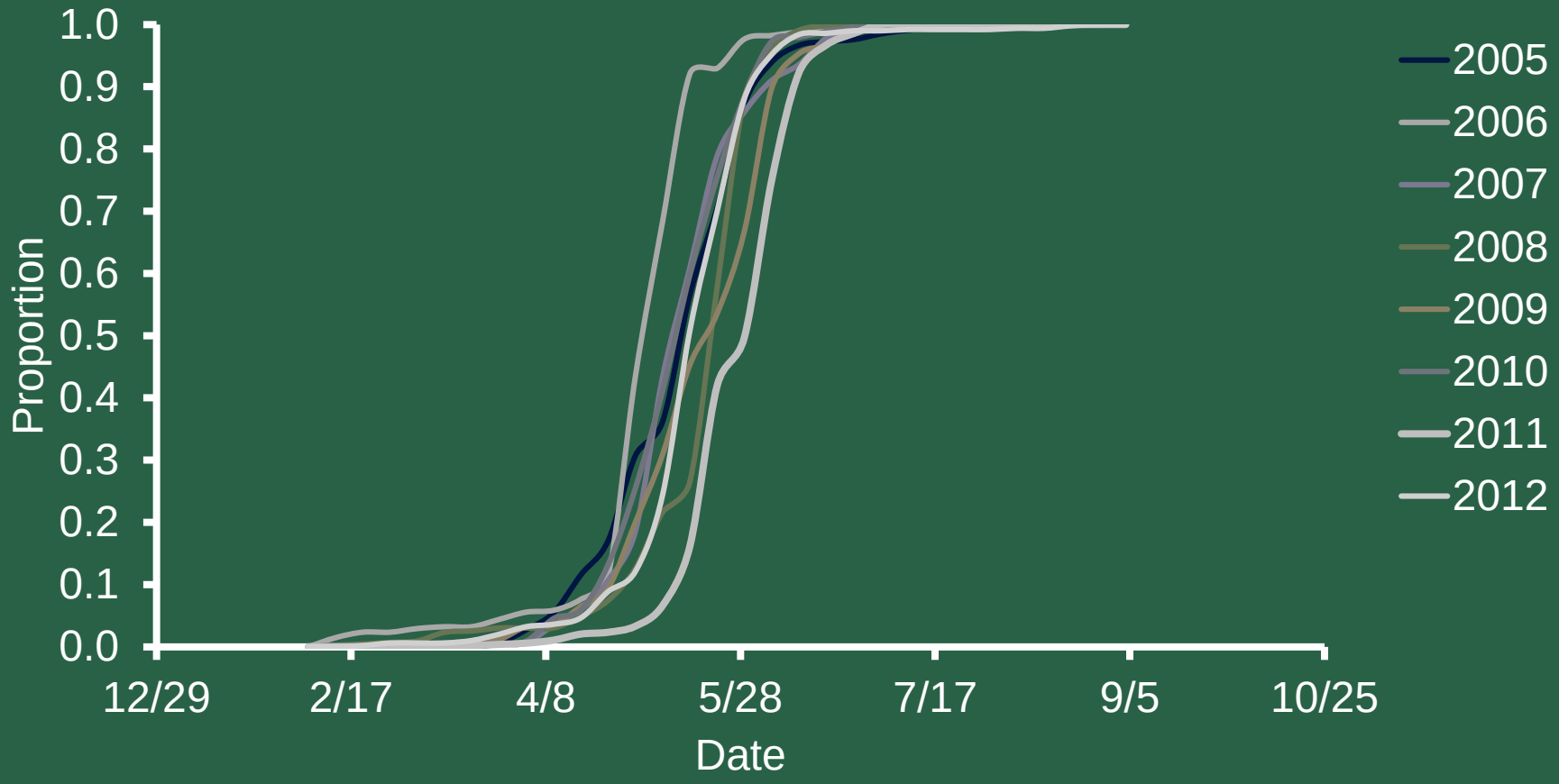
DUNGENESS RIVER
STEELHEAD SMOLT AGE STRUCTURE



DUNGENESS RIVER
STEELHEAD SIZE AT AGE STRUCTURE



DUNGENESS RIVER STEELHEAD SMOLT RUN TIMING



CONCLUSIONS

POOR RESOLUTION WITHIN PUGET SOUND

PULSED RESOURCE SUBSIDY INFLUENCE:

- LENGTH
- AGE STRUCTURE
- LENGTH AT AGE
- RUN TIMING

IMPLICATIONS

Ward and Slaney 1988

Tatara et al. yesterday

… size-dependent survival

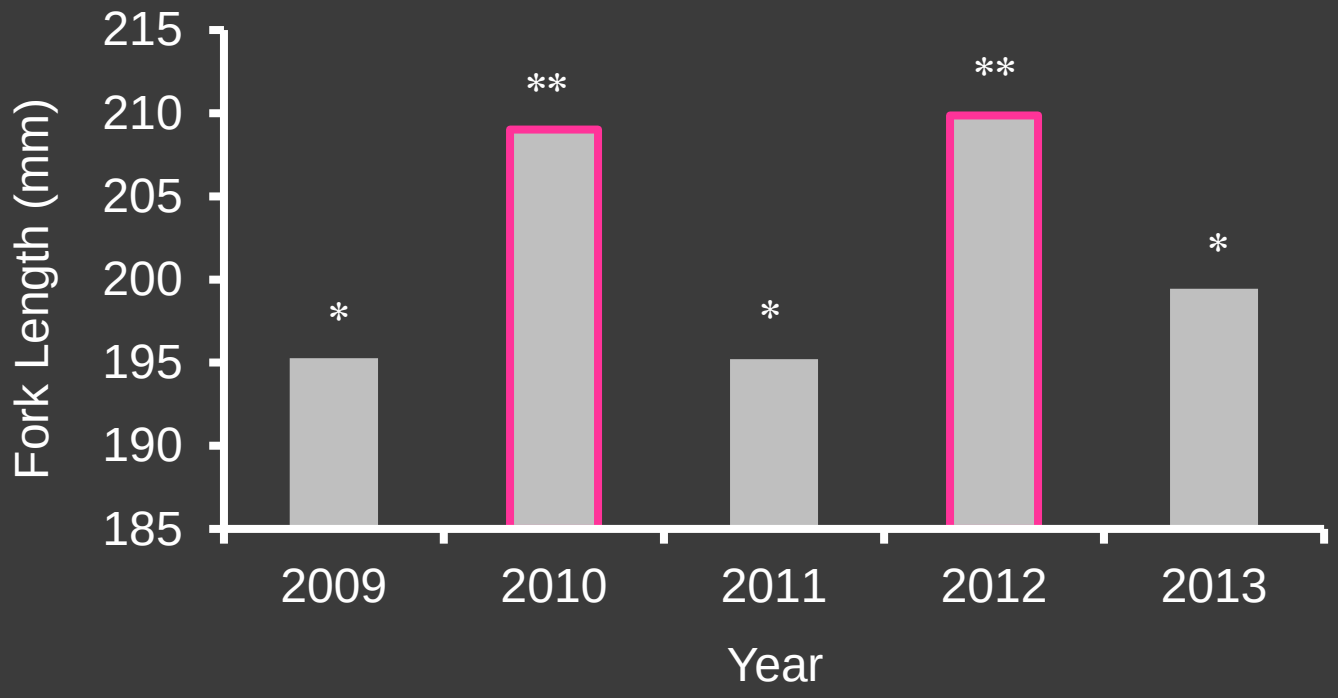
VSP parameters

- Diversity
- Productivity

THANK YOU

NISQYALLY RIVER
STEELHEAD SMOLT SIZE STRUCTURE

+13.5 mm (6.9 %) on pink outmigration years



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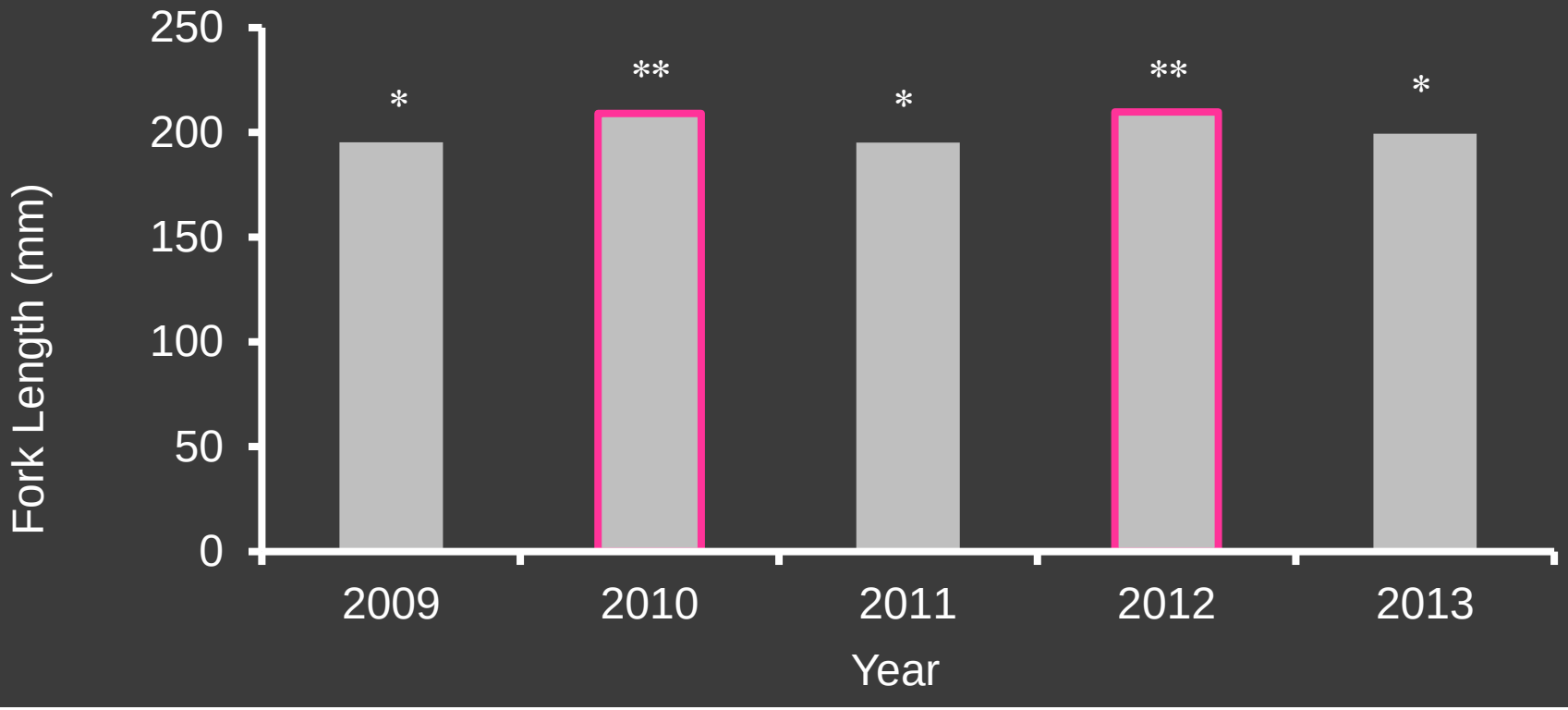
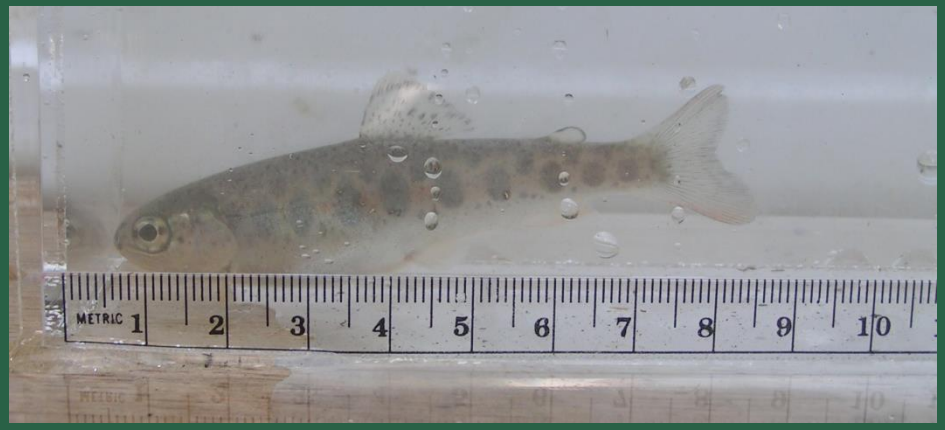


SKAGIT RIVER STEELHEAD AGE STRUCTURE

Year	Age-1	Age-2	Age-3	Age-4
2011	2.0%	88.0%	10.0%	0.0%
2012	0.0%	77.1%	22.9%	0.0%
2013	0.0%	56.9%	39.7%	3.4%



DUNGENESS RIVER STEELHEAD AGE STRUCTURE

Year	Age-1	Age-2	Age-3	Age-4
2011	1.8%	88.6%	9.2%	0.4%
2012	3.4%	82.0%	14.6%	0.0%
2013	4.0%	85.9%	10.1%	0.0%

DUNGENESS RIVER
STEELHEAD SIZE AT AGE STRUCTURE

Year	Age-1	Age-2	Age-3	Age-4
2011	152.3 (21.1)	168.9 (15.9)	193.1(15.0)	195.0 (12.5)
2012	147.8 (18.9)	169.7 (15.2)	**195.5 (36.3)**	N/A
2013	170.5 (46.5)	168.2 (17.7)	189.5 (23.5)	N/A

STEELHEAD AGE STRUCTURE

fresh water ages from Nisqually River adult scales

Year	Age-1	Age-2	Age-3	Age-4
1983	16.6%	81.8%	1.6%	0.0%
1984	27.1%	71.2%	1.7%	0.0%
1985	**35.2%**	**64.3%**	**0.5%**	**0.0%**
1986	29.1%	69.8%	1.1%	0.0%
1987	No age data			
1988	No age data			
1989	18.3%	81.1%	0.6%	0.0%
1990	17.8%	81.1%	1.1%	0.0%

SKAGIT RIVER
STEELHEAD SIZE AT AGE STRUCTURE

Year	Age-1	Age-2	Age-3	Age-4
2011	N/A	172.9 (23.9)	182.8 (32.8)	N/A
2012	N/A	173.3 (19.7)	184.4 (24.4)	N/A
2013	N/A	167.2 (15.0)	183.6 (17.0)	184.0 (15.6)

IMPLICATIONS

VIABLE SALMONID POPULATION (VSP) CRITERIA:

ABUNDANCE – No
PRODUCTIVITY – Yes
DISTRIBUTION – Not measured
DIVERSITY – Yes

IMPLICATIONS

MANAGEMENT:

pink fisheries

- recent commercial
- liberal sport creel

NEXT STEPS

CONTINUE MONITORING

- 2014 pink outmigration

INCORPORATE ADULT AGE DATA

- biased

ACKNOWLEDGMENTS

James Losee
Neala Kendall
Joe Anderson
Pete Topping

Washington-British Columbia Chapter of AFS

Serving AFS Members of Washington State and British Columbia

WA-BC Annual General Meeting

Vancouver Convention Center

Vancouver, Washington

March 24 – 27, 2014

Call for Symposia and Abstracts

Current Topics:

- social media and fisheries
- eulachon
- green sturgeon
- e-DNA

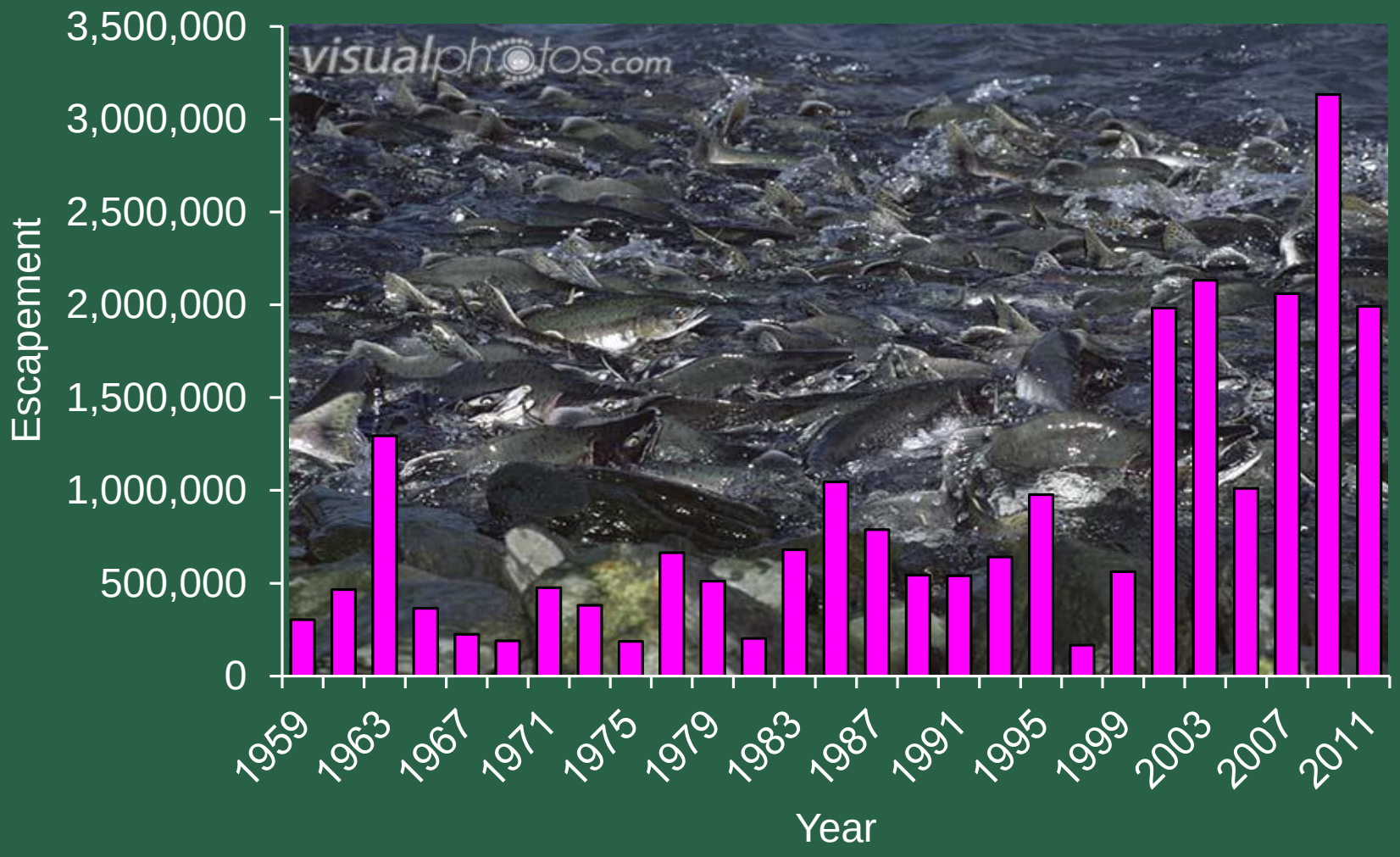
Continuing Education:

- Introduction to R for fisheries scientists
- social media and fisheries

If interested in organizing a symposium please contact Matt Klungle at: Matthew.Klungle@dfw.wa.gov or (360) 902-2742

Further details on symposia submissions can be found at (http://wabc-afs.org/)

PUGET SOUND PINK SALMON



PULSED RESOURCE SUBSIDIES

VIABLE SALMONID POPULATION (VSP) CRITERIA:

ABUNDANCE
PRODUCTIVITY
DISTRIBUTION
DIVERSITY

PULSED RESOURCE SUBSIDIES

INTERSPECIFIC INTERACTION

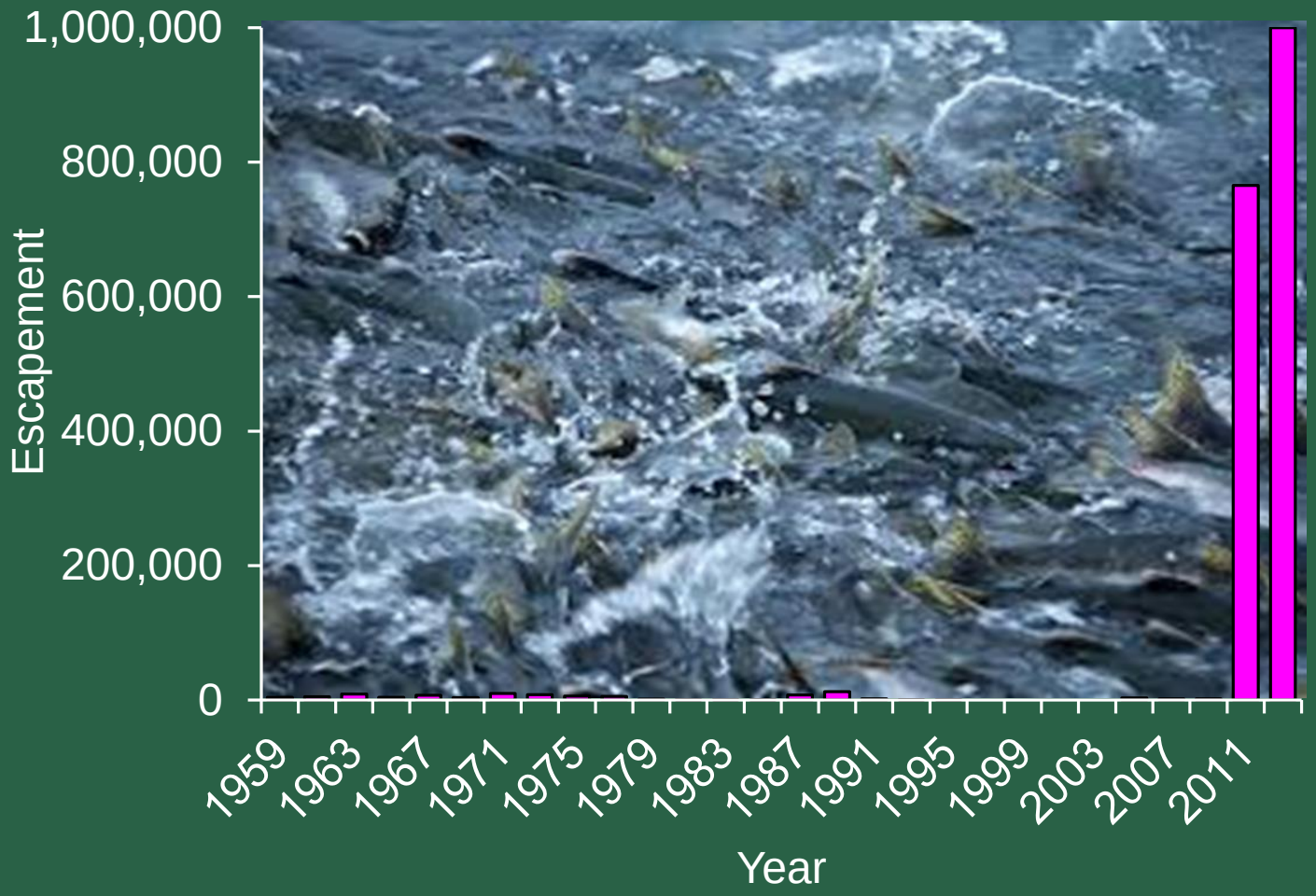
What is the influence of pink salmon on steelhead?

$$H_o: \overline{FL_p} > \overline{FL_{np}}$$

$$H_a: \overline{FL_p} = \overline{FL_{np}}$$

Something about younger fish as well?
Set this up as hypothesis driven based on findings from Ward and Stanley (Keogh River)
-what was their percent increase in size?
- " " " " change in age?
- " " " " change in size at age?

NISQUALLY RIVER PINK SALMON



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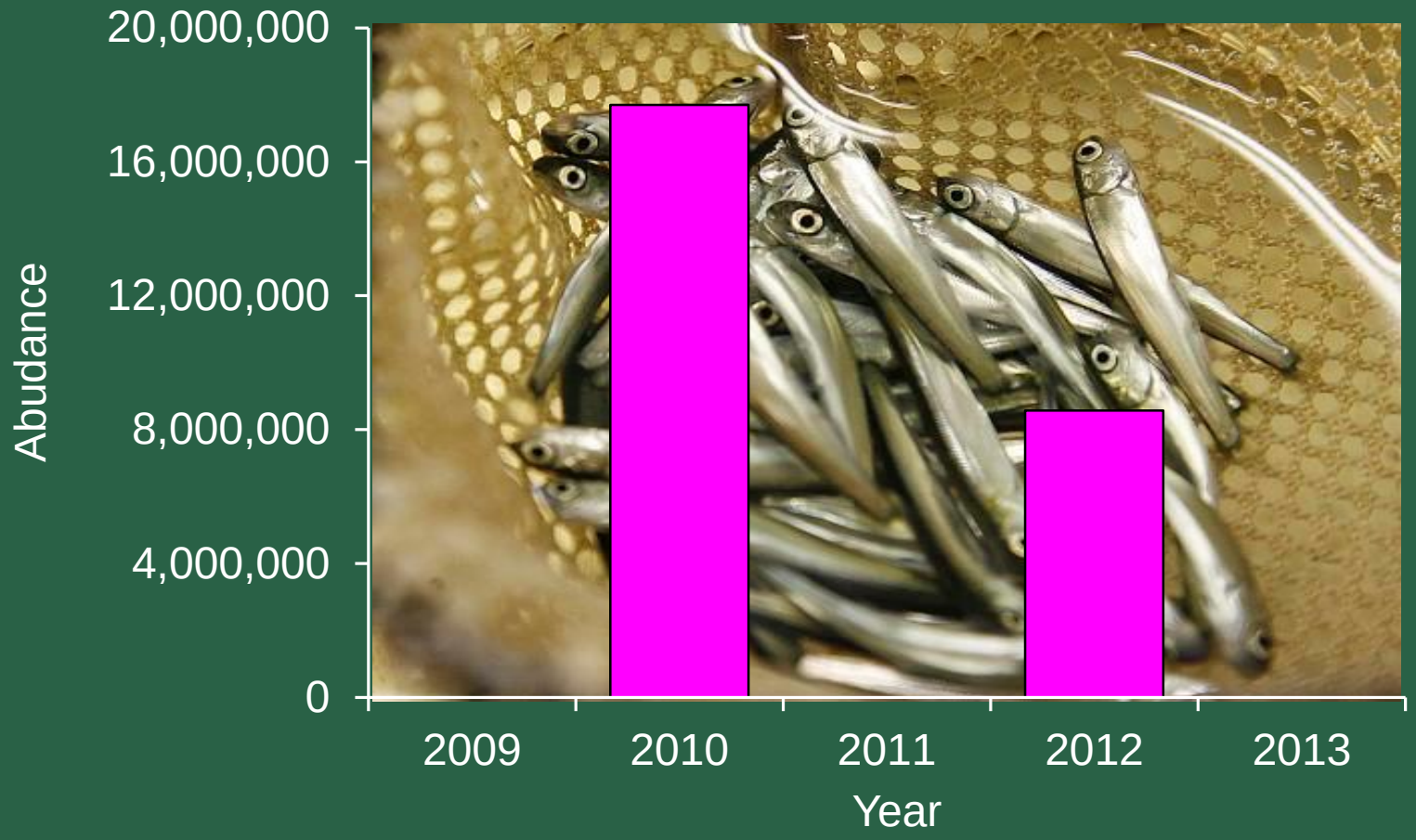
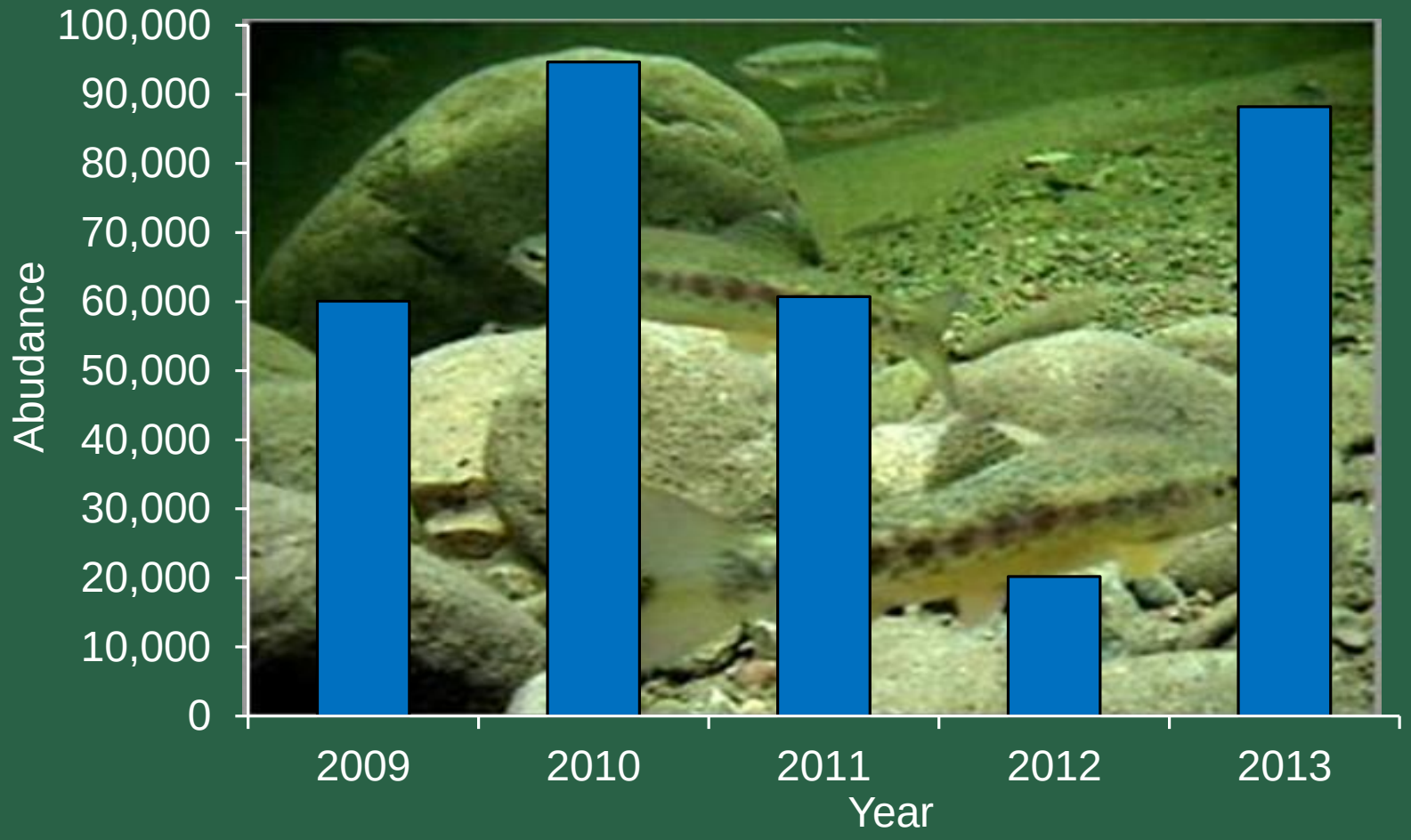
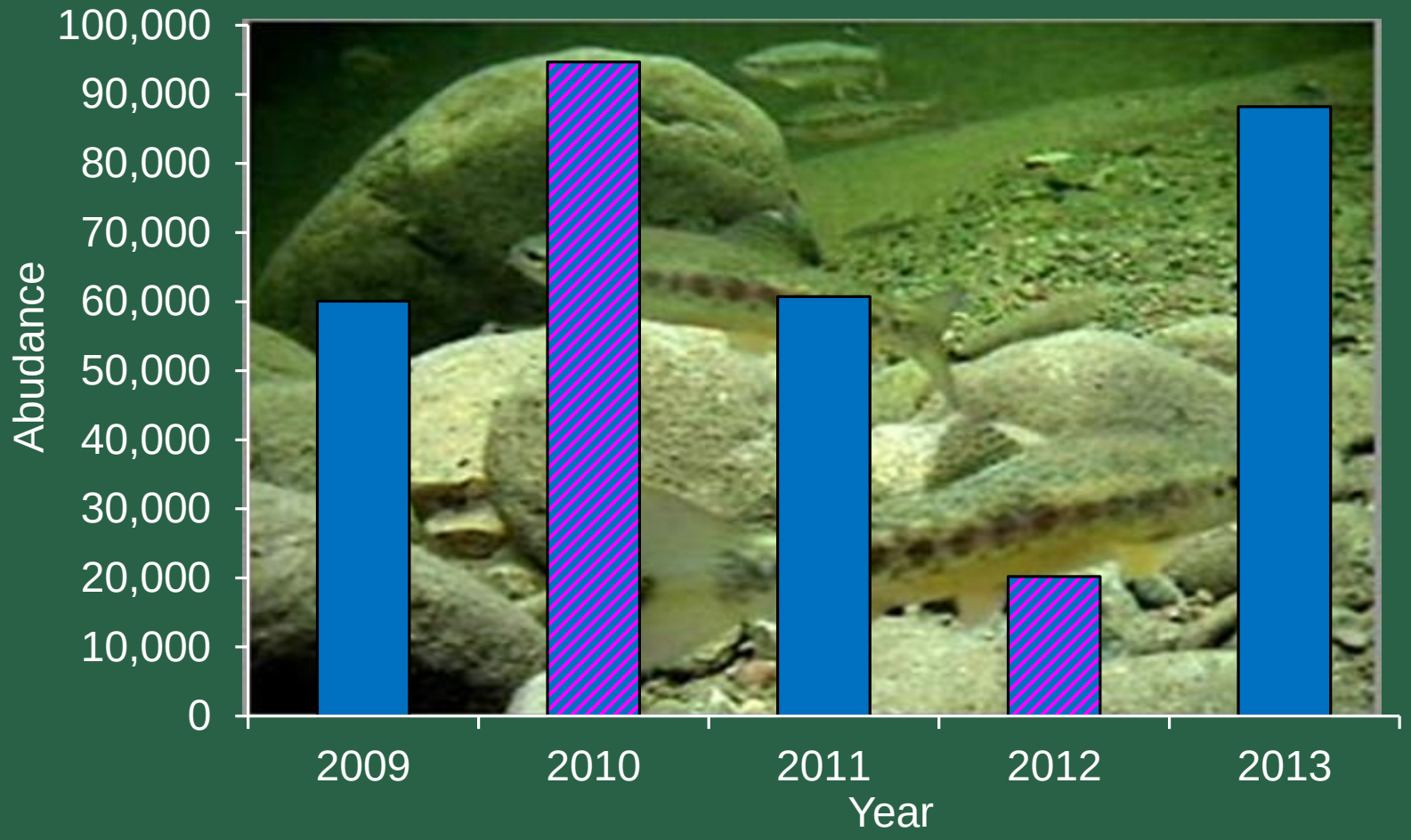


NISQUALLY RIVER STEELHEAD



NISQUALLY RIVER STEELHEAD



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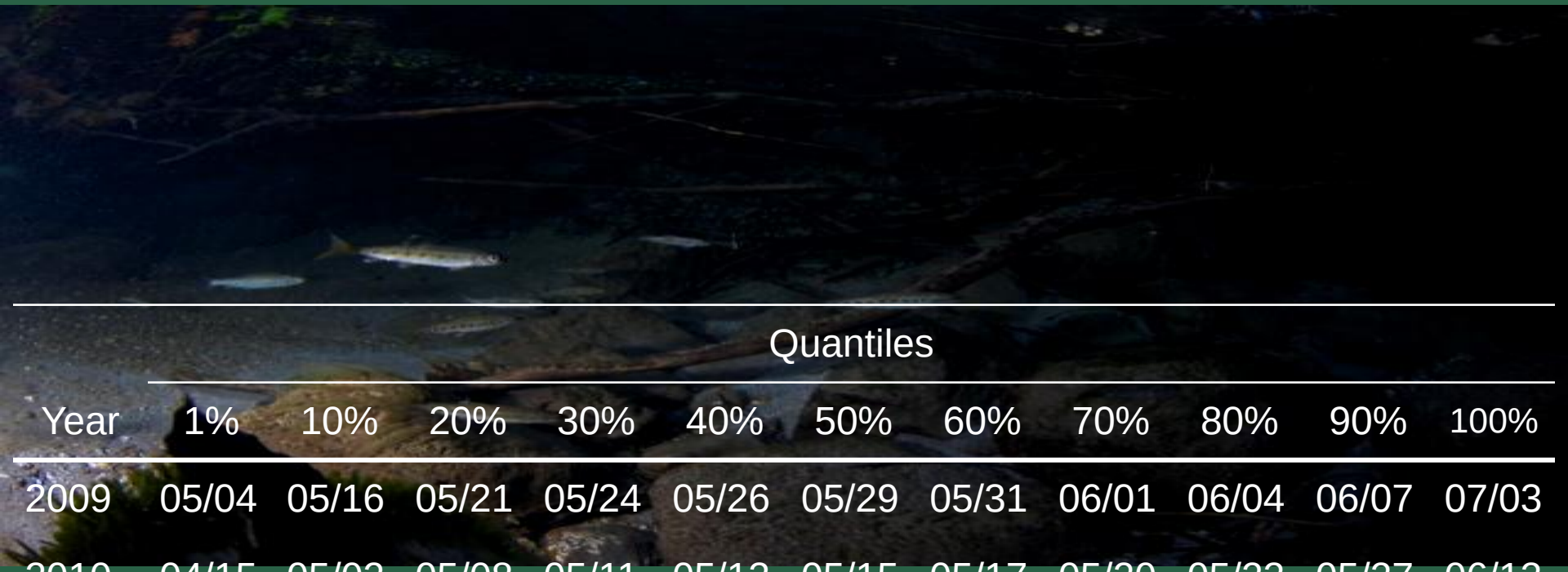
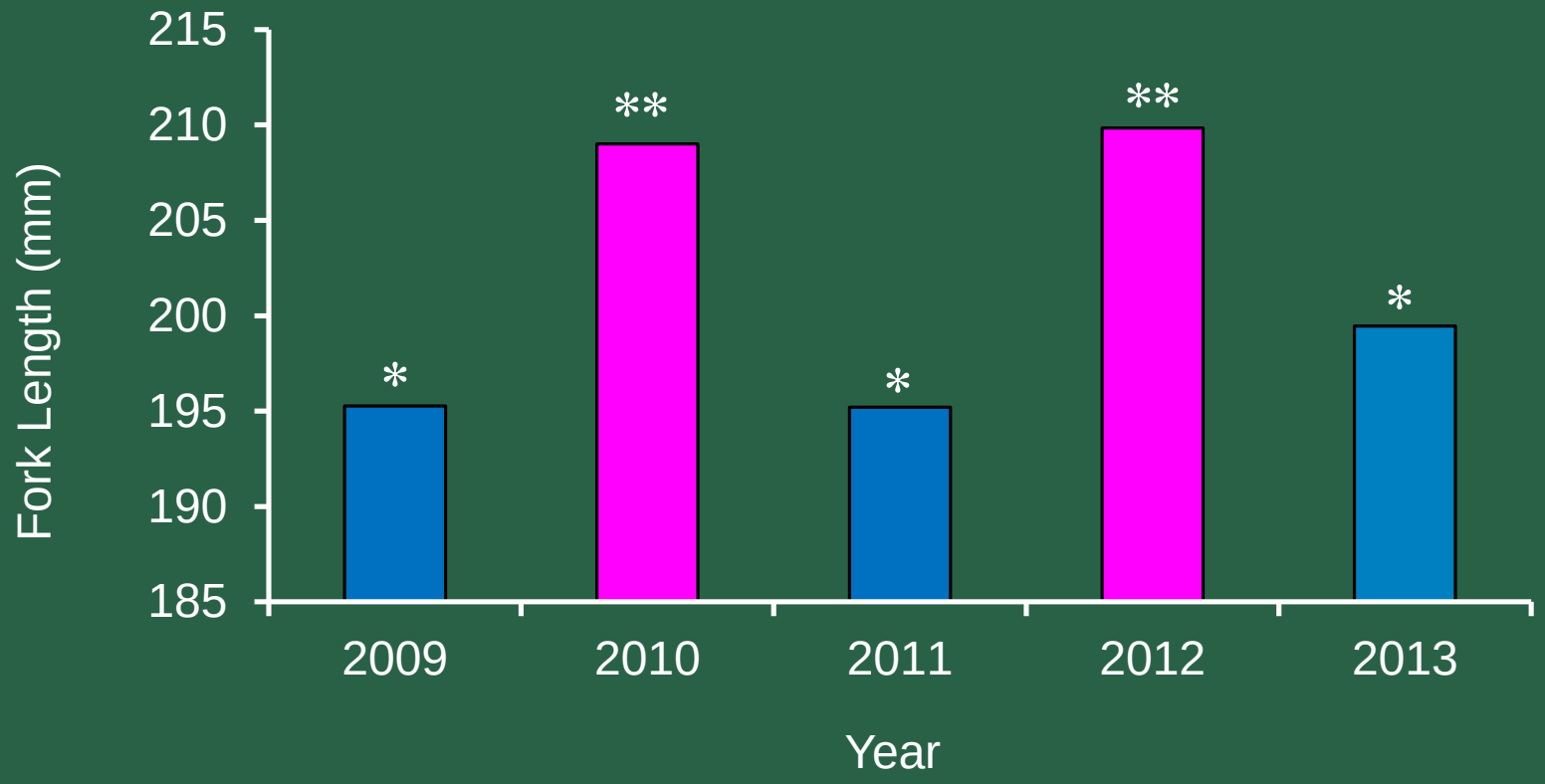
STEELHEAD RUN TIMING



	Quantiles										
Year	1%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2009	05/04	05/16	05/21	05/24	05/26	05/29	05/31	06/01	06/04	06/07	07/03
2010	04/15	05/02	05/08	05/11	05/13	05/15	05/17	05/20	05/23	05/27	06/13
2011	04/21	05/12	05/18	05/22	05/25	05/26	05/28	06/01	06/03	06/05	07/22
2012	04/05	05/02	05/09	05/15	05/23	05/28	05/31	06/03	06/08	06/14	07/06
2013	03/21	05/05	05/12	05/14	05/17	05/19	05/21	05/23	05/28	06/01	06/17

STEELHEAD SIZE STRUCTURE



AGE STRUCTURE

fresh water ages from Nisqually River adult scales

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1983	16.6%	81.8%	1.6%	0.0%
1984	27.1%	71.2%	1.7%	0.0%
1985	35.2%	64.3%	0.5%	0.0%
1986	29.1%	69.8%	1.1%	0.0%
1987	No age data			
1988	No age data			
1989	18.3%	81.1%	0.6%	0.0%
1990	17.8%	81.1%	1.1%	0.0%

AGE STRUCTURE

fresh water ages from Skagit River adult scales

Year	Age-1	Age-2	Age-3	Age-4
2009	3.5%	77.8%	18.1%	0.6%
2010	2.2%	77.8%	20.0%	0.0%
2011	0.3%	76.6%	21.3%	1.8%
2012	3.4%	60.4%	34.1%	2.1%

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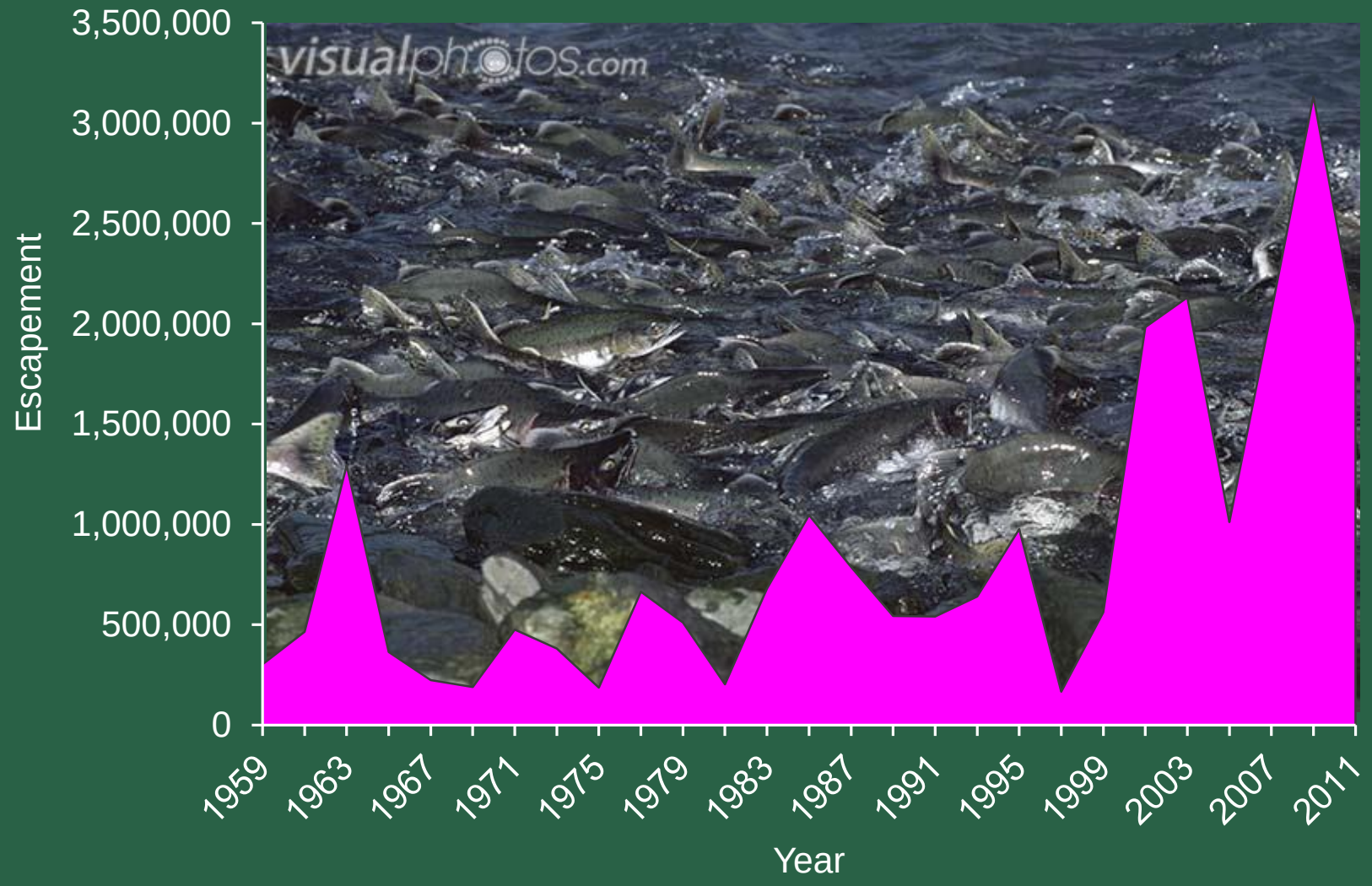
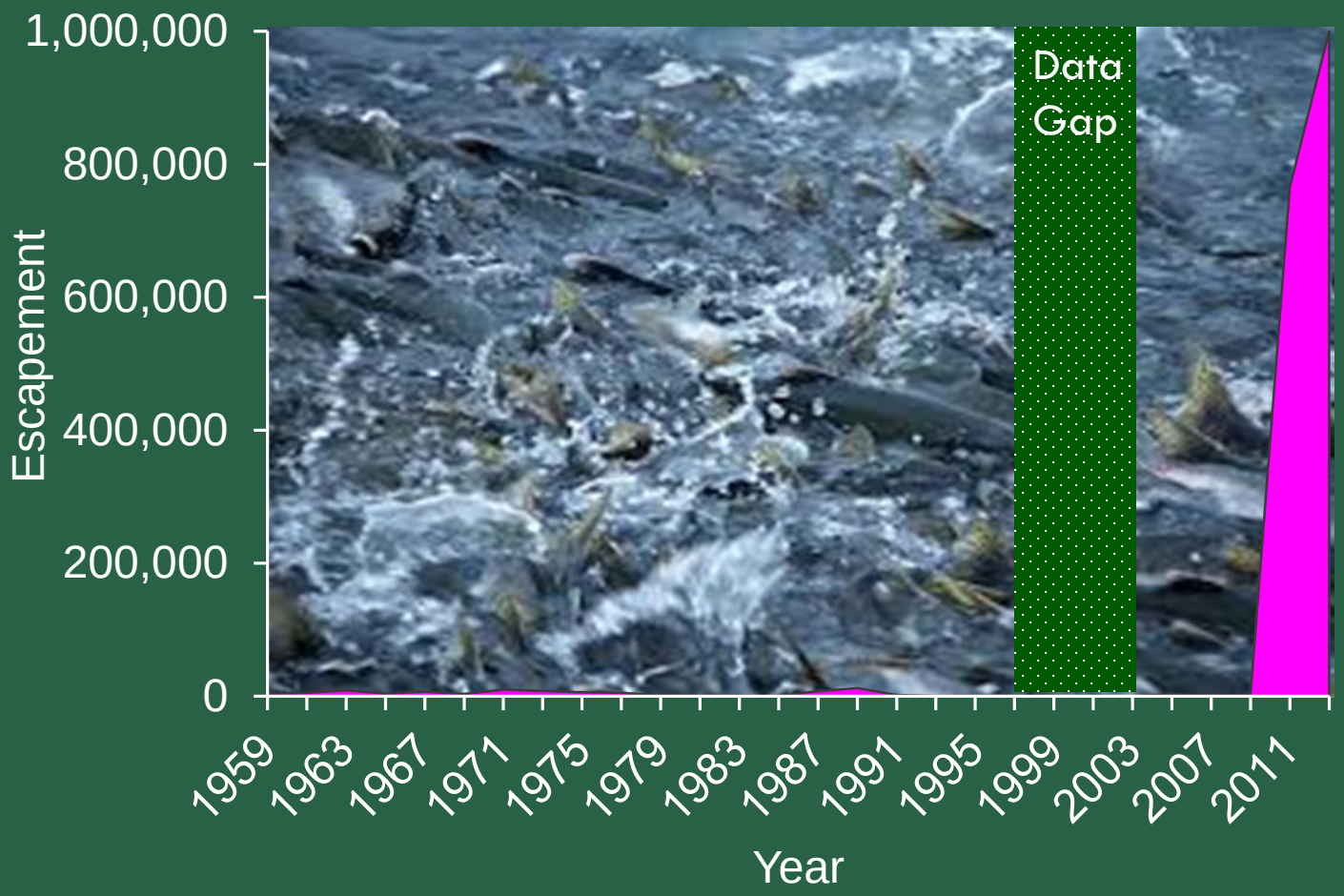
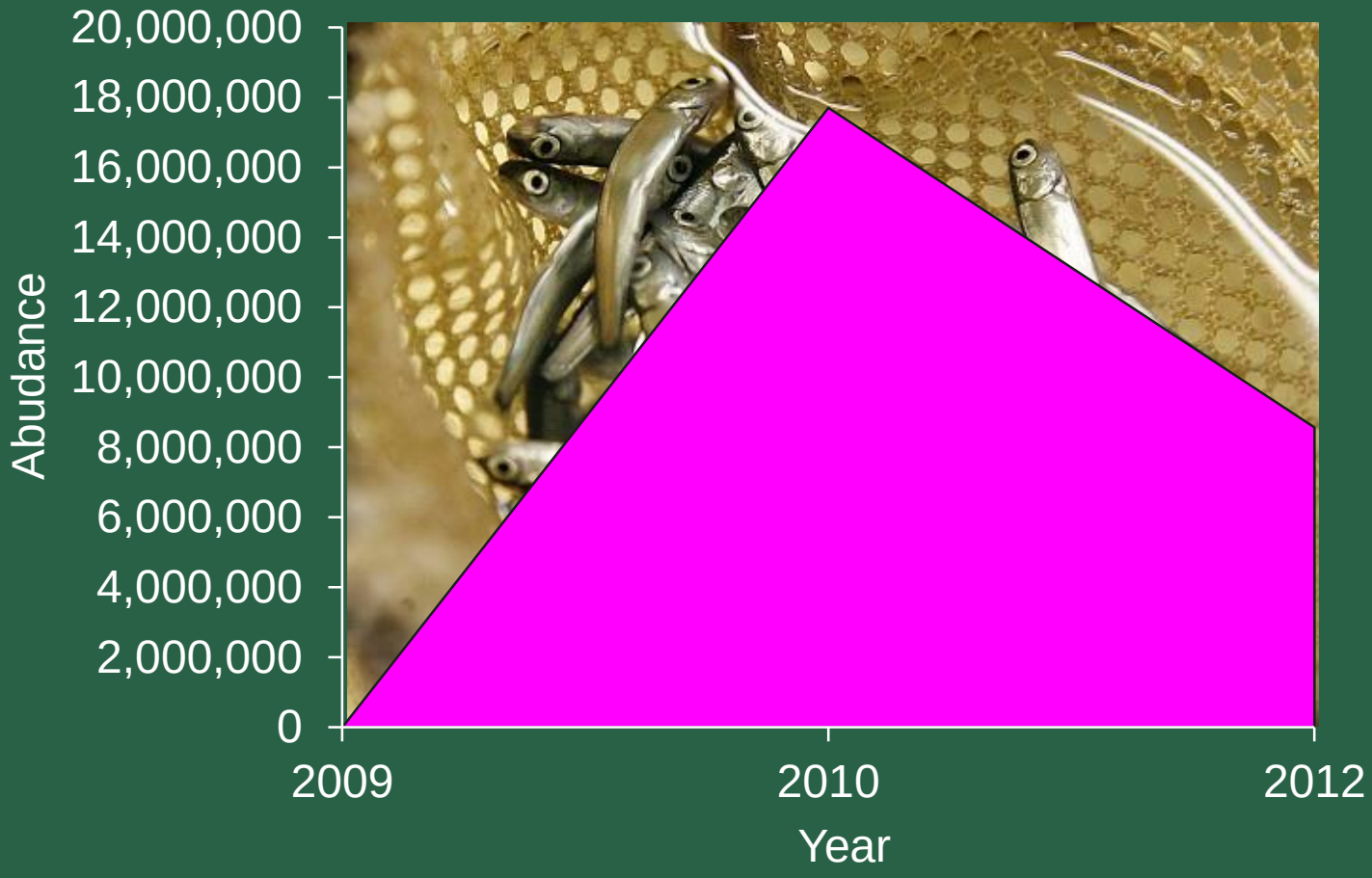
PUGET SOUND PINK SALMON



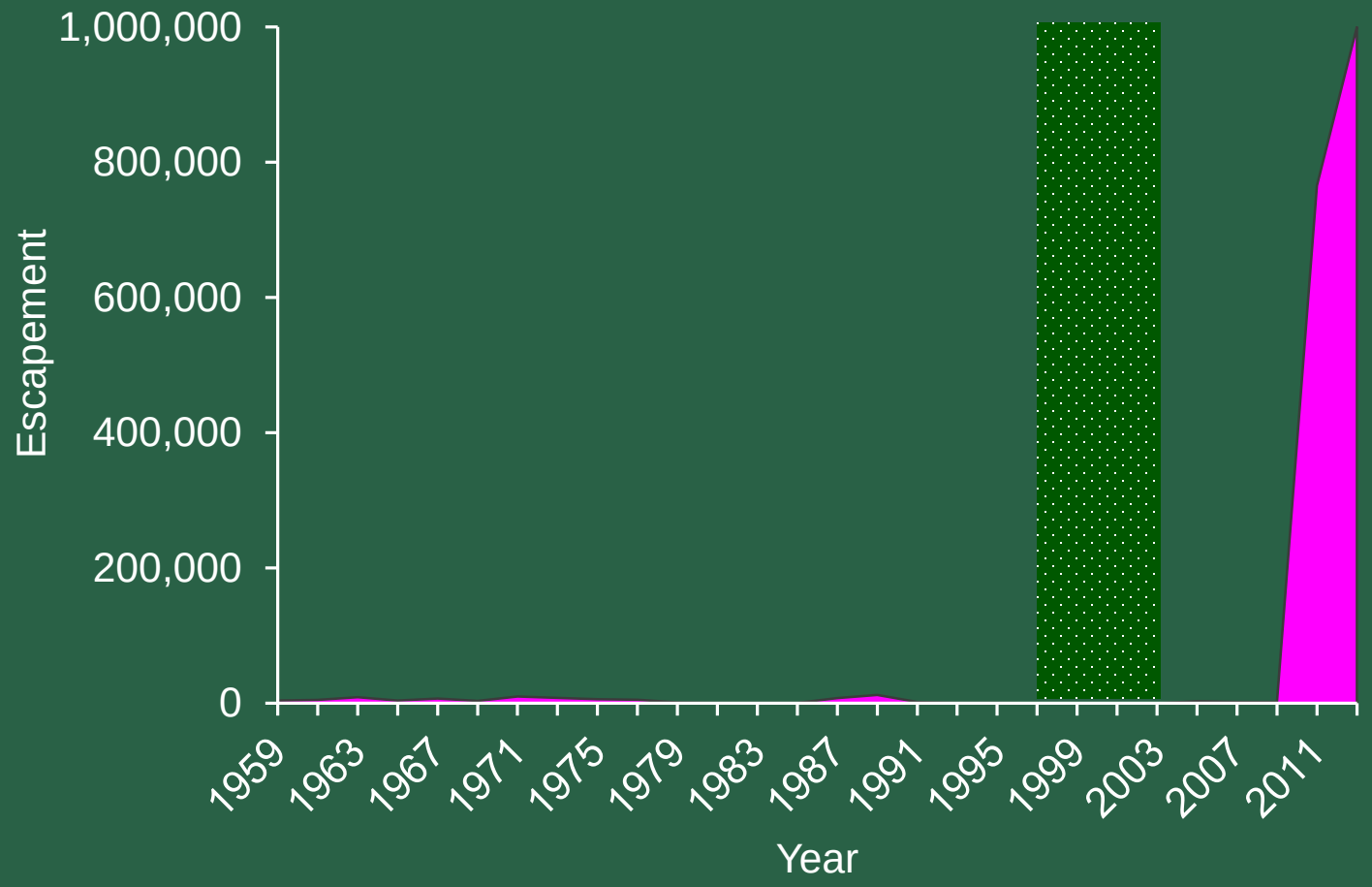
NISQUALLY RIVER PINK SALMON



NISQUALLY RIVER PINK SALMON

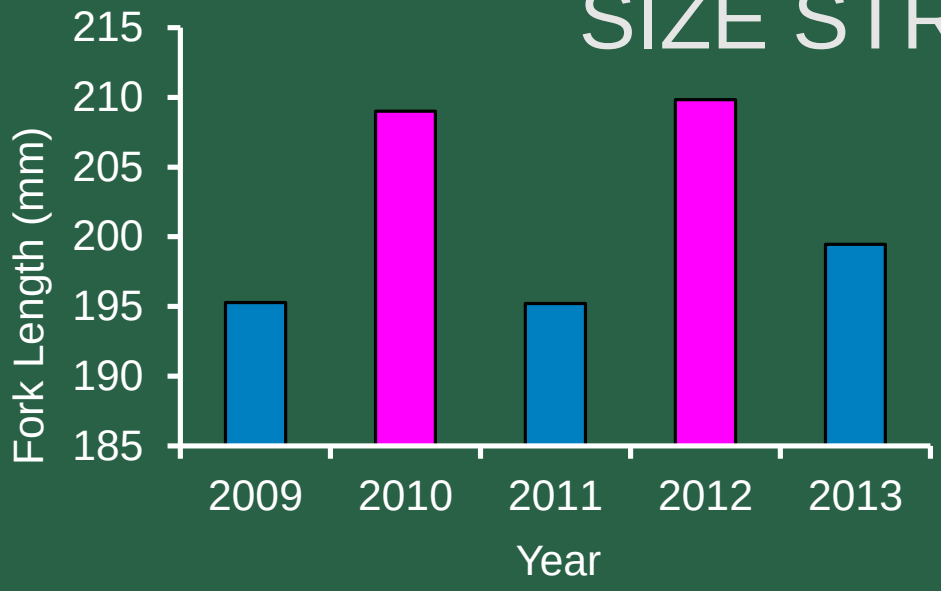


NISQUALLY RIVER PINK SALMON



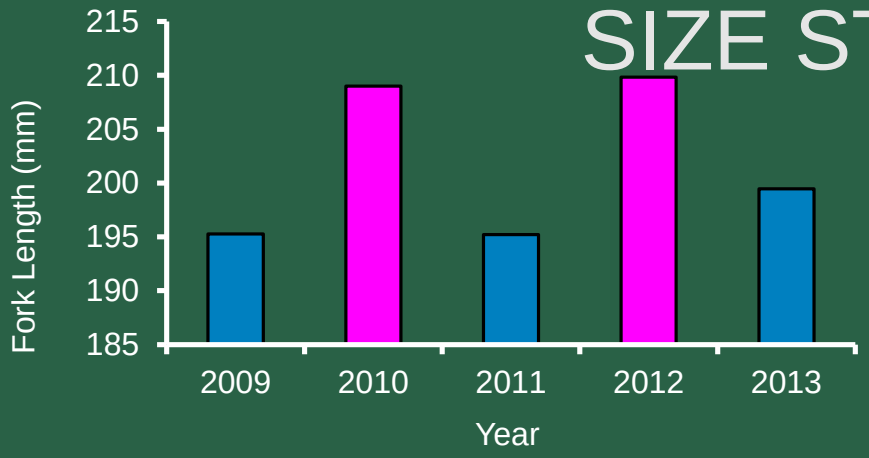
ABUNDANCE

SIZE STRUCTURE



	df	Sum of Squares	Mean Square	*F*-value	*p*-value
Year	4	80,641	20,160.3	34.08	<0.001
Residuals	3,185	1,884,249	591.6		

SIZE STRUCTURE



	Difference (abs)	Std. Error	*t*-value	*p*-value
2009-2010	**13.7**	1.38	9.902	**<0.001**
2009-2011	0.1	1.59	-0.042	1.00
2009-2012	**14.6**	2.17	6.702	**<0.001**
2009-2013	4.2	1.44	2.893	0.0288
2010-2011	**13.8**	1.97	-7.003	**<0.001**
2010-2012	0.8	2.46	0.340	0.9968
2010-2013	**9.6**	1.86	-5.149	**<0.001**
2011-2012	**14.6**	2.59	5.661	**<0.001**
2011-2013	4.2	2.01	2.110	0.2019
2012-2013	10.4	2.50	-4.159	**<0.001**

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