20 years of monitoring brook trout and American eels in Blue Ridge Mountain streams

more research is needed…..

Mountain Streams Symposium II
James Madison University
September 2013

USDA

Southern Research Station

CENTER FOR AQUATIC TECHNOLOGY TRANSFER CATT

NATIONAL PARK SERVICE

Virginia Tech

UNIVERSITY OF VIRGINIA 1819

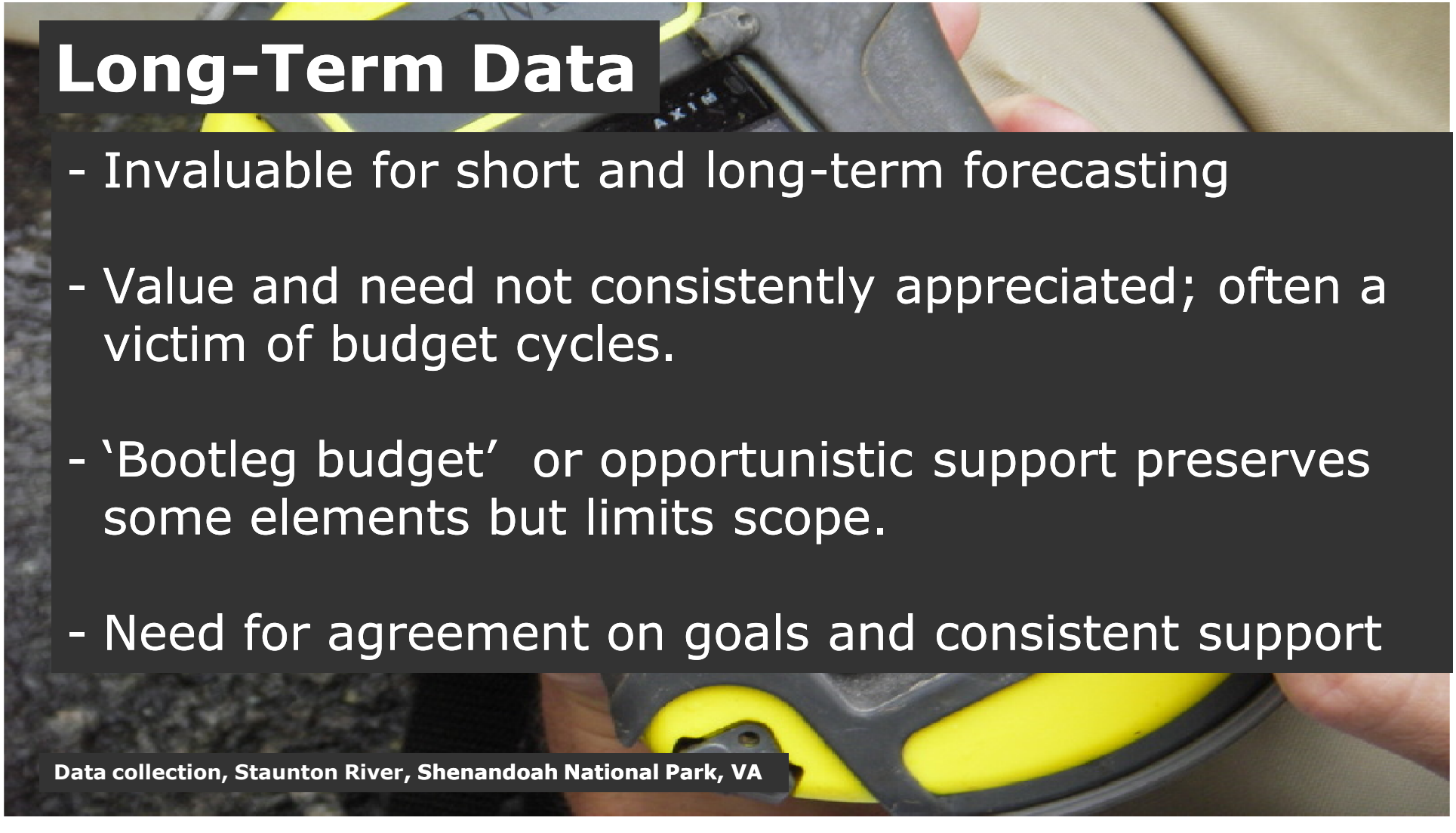
Long-Term Data

- Invaluable for short and long-term forecasting

- Value and need not consistently appreciated; often a victim of budget cycles.

- 'Bootleg budget' or opportunistic support preserves some elements but limits scope.

- Need for agreement on goals and consistent support

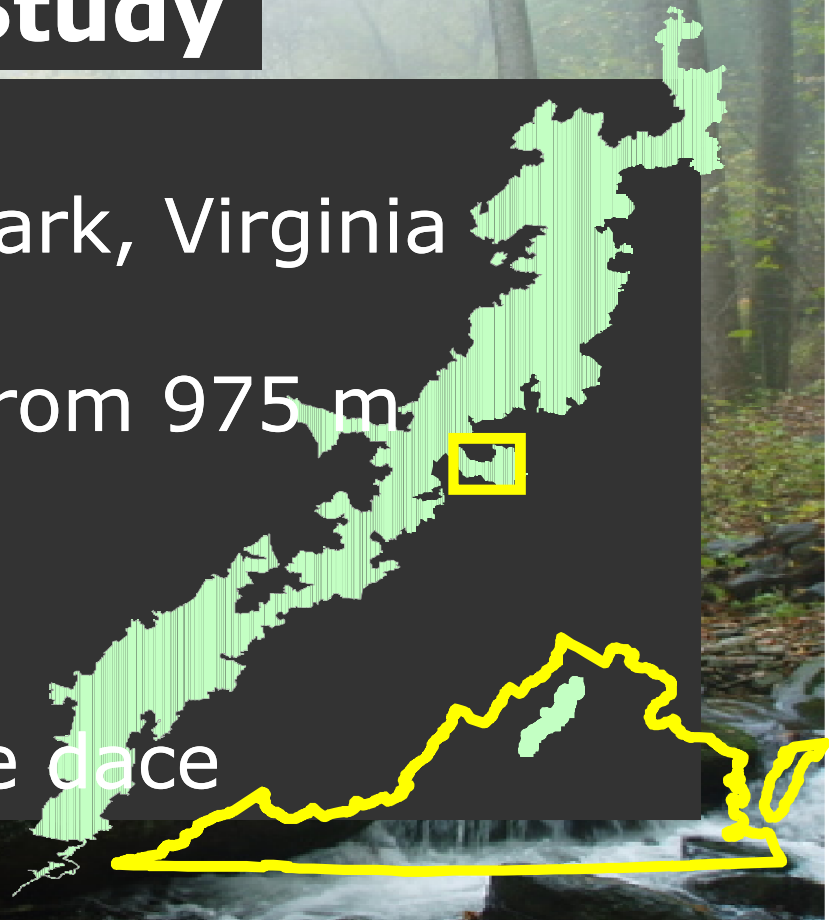


Data collection, Staunton River, Shenandoah National Park, VA

Site of "Long Term" Study

- Staunton River
  - Shenandoah National Park, Virginia

- 3rd order trib, flows east from 975 m
- Rappahannock drainage
- 6.3 km long
- 2 to 5 m wide
- Brook trout and Blacknose dace

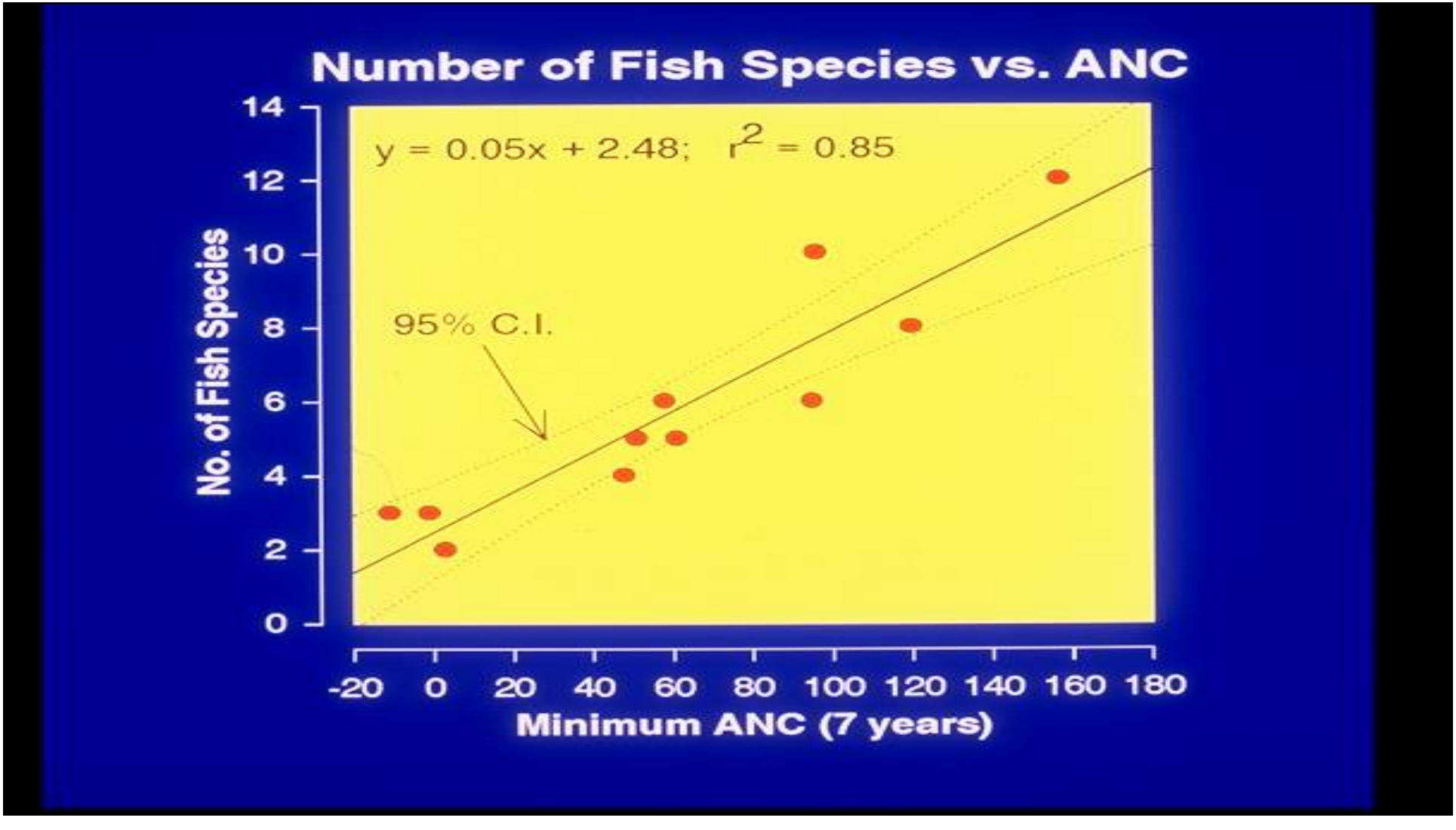


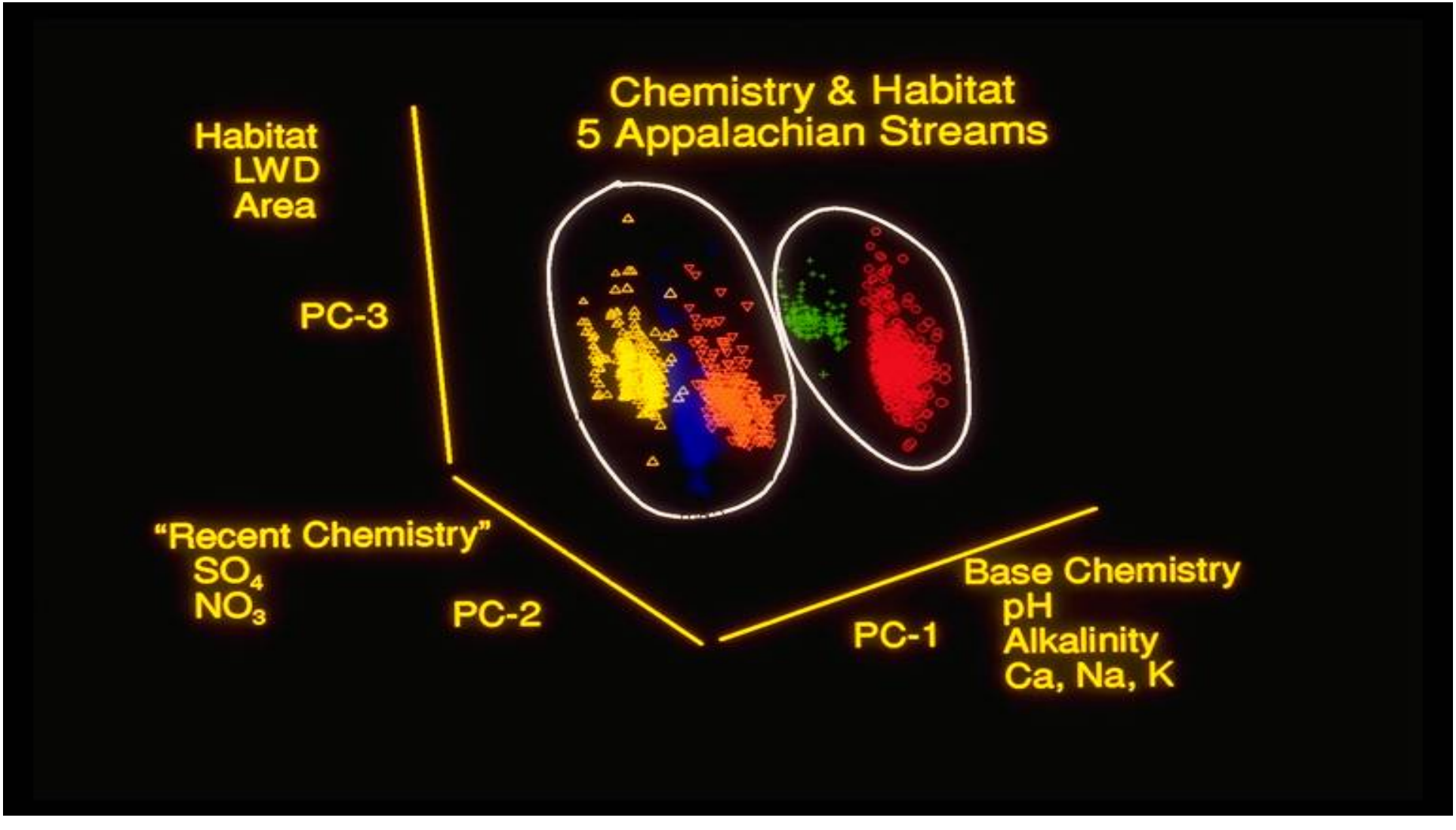
Staunton River, Shenandoah National Park, VA

Acid Rain Study 1993 - 1995

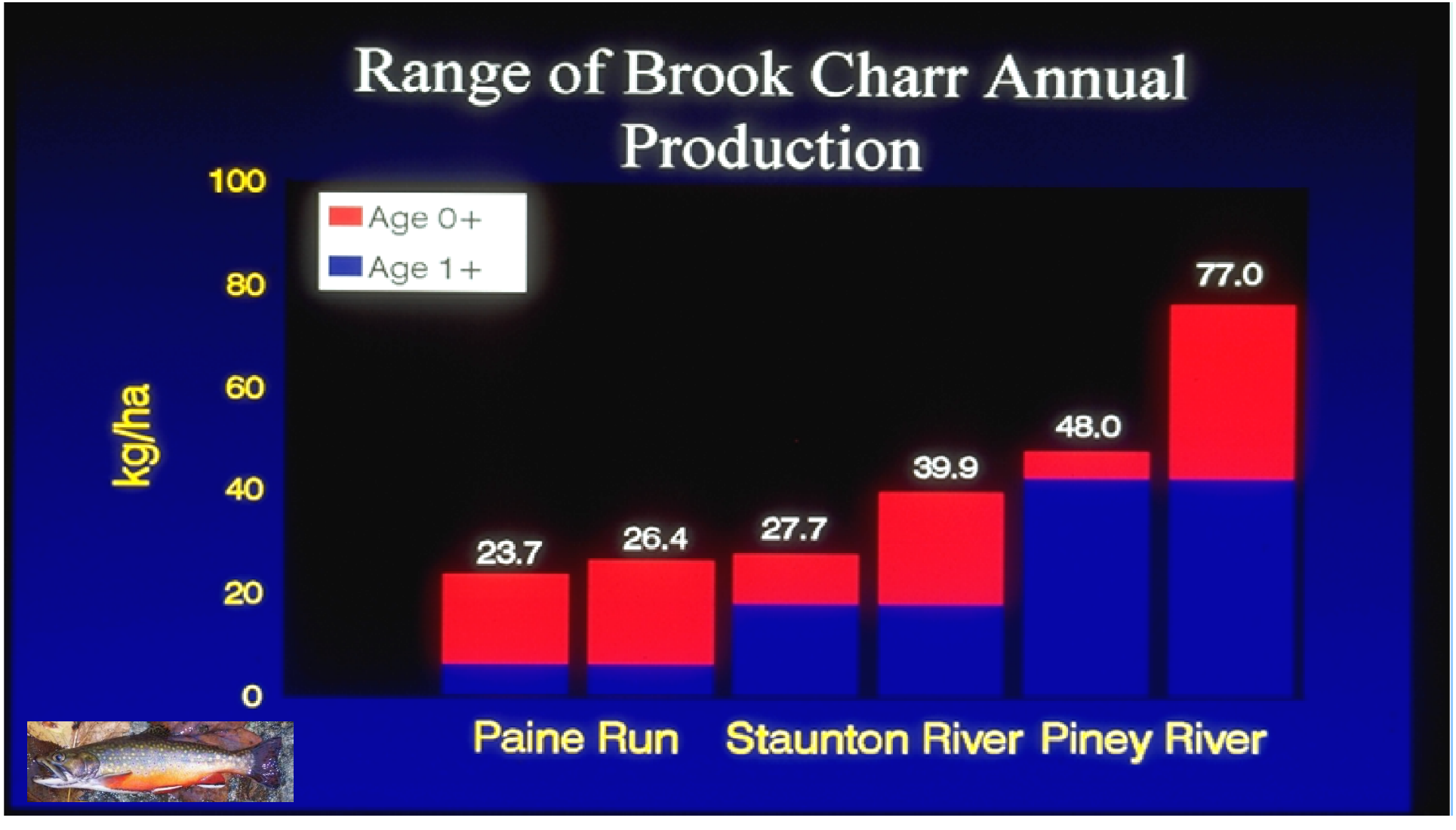
- Natural variation
  - temporal & spatial (5+3=8 streams)
- Water quality
  - continuous & episodic
- Habitat
  - type, substrate, large wood
- Fish fauna
  - diversity, distribution, production

Master's Thesis, Kurt Newman, 1995, Virginia Tech


Number of Fish Species vs. ANC
y = 0.05x + 2.48; r2 = 0.85
95% C.I.
No. of Fish Species
0
2
4
6
8
10
12
14
-20
0
20
40
60
80
100
120
140
160
180
Minimum ANC (7 years)


Chemistry & Habitat
5 Appalachian Streams
Habitat
LWD
Area
PC-3
"Recent Chemistry"
SO_4
NO_3
PC-2
PC-1
Base Chemistry
pH
Alkalinity
Ca, Na, K

Range of Brook Charr Annual Production



Catastrophic Event

Before

After

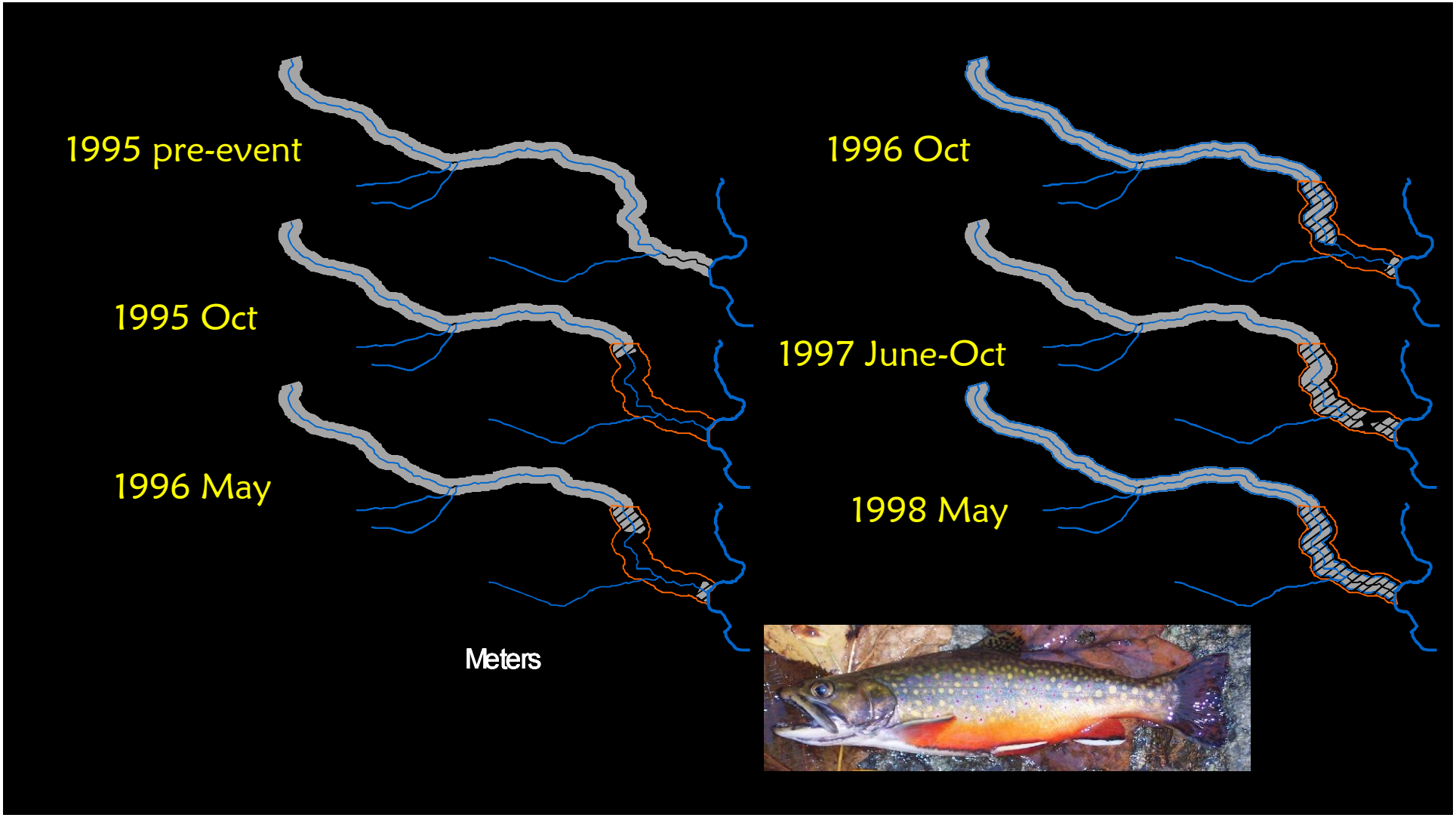
Millenial flood & debris flow

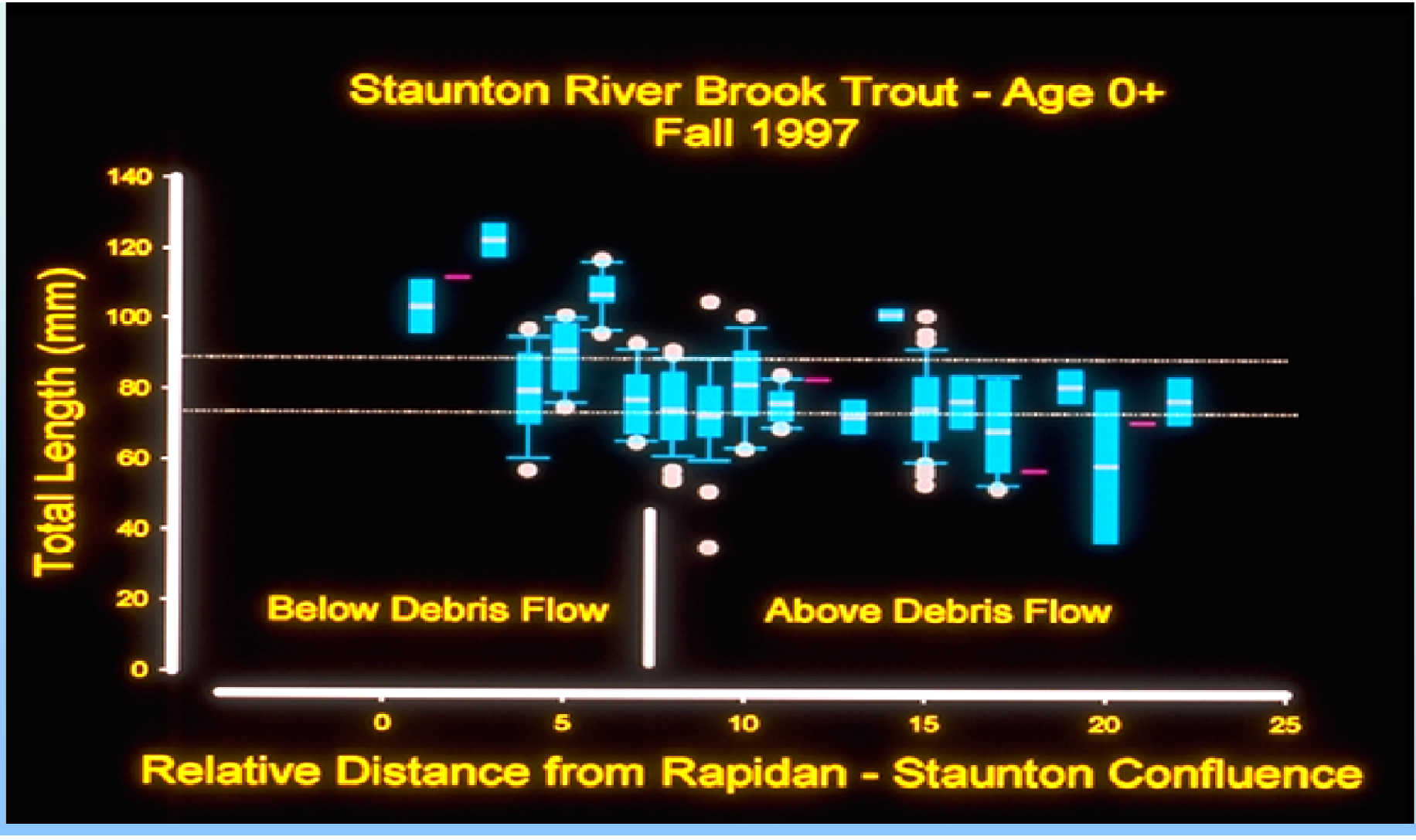
Staunton River, Shenandoah NP

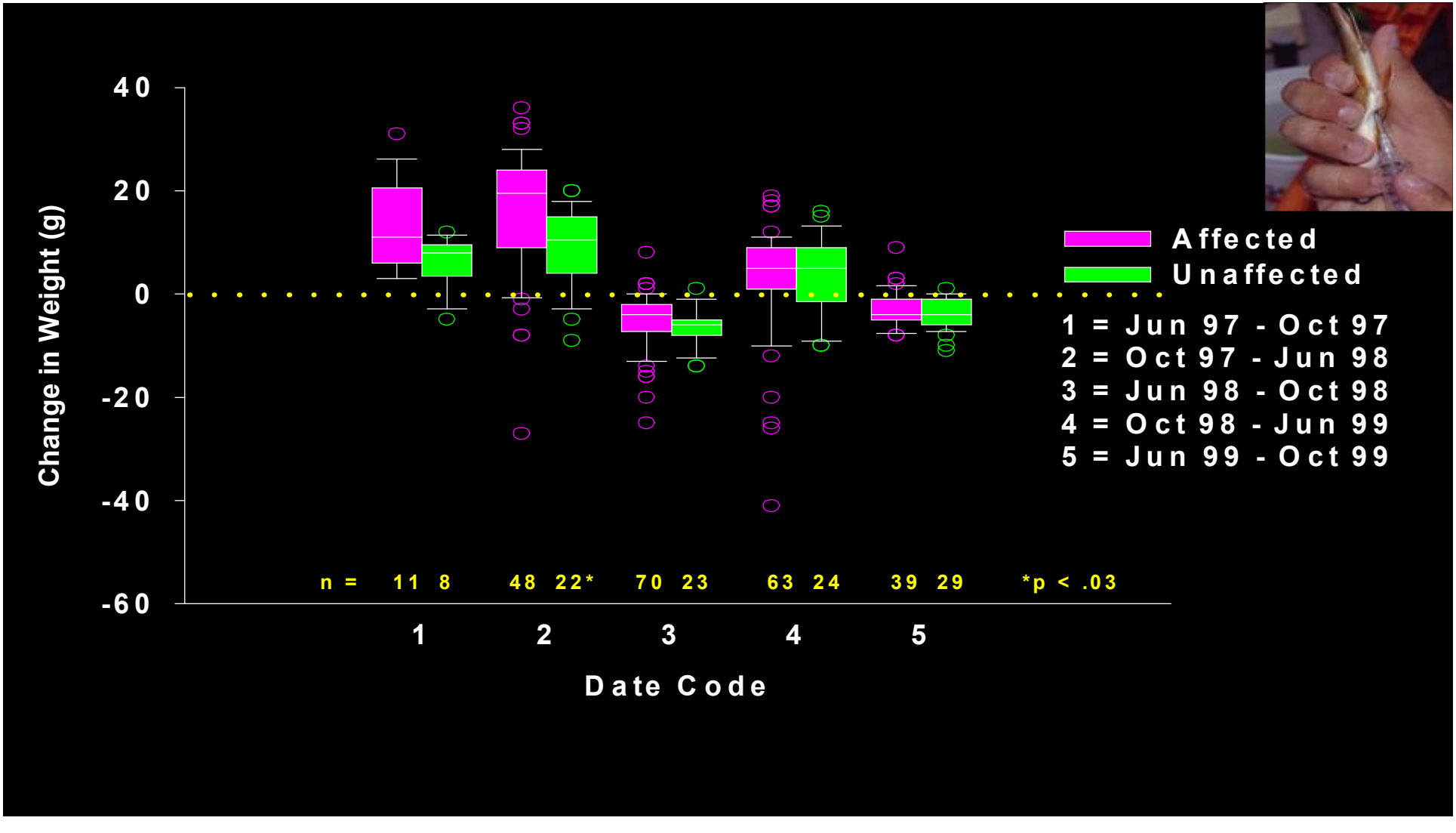
Debris Flow Study 1995 - 1999

- Natural variation
  - temporal & spatial
- Water temperature
  - continuous
- Habitat
  - type, substrate, large wood
- Fish fauna
  - diversity, distribution, production

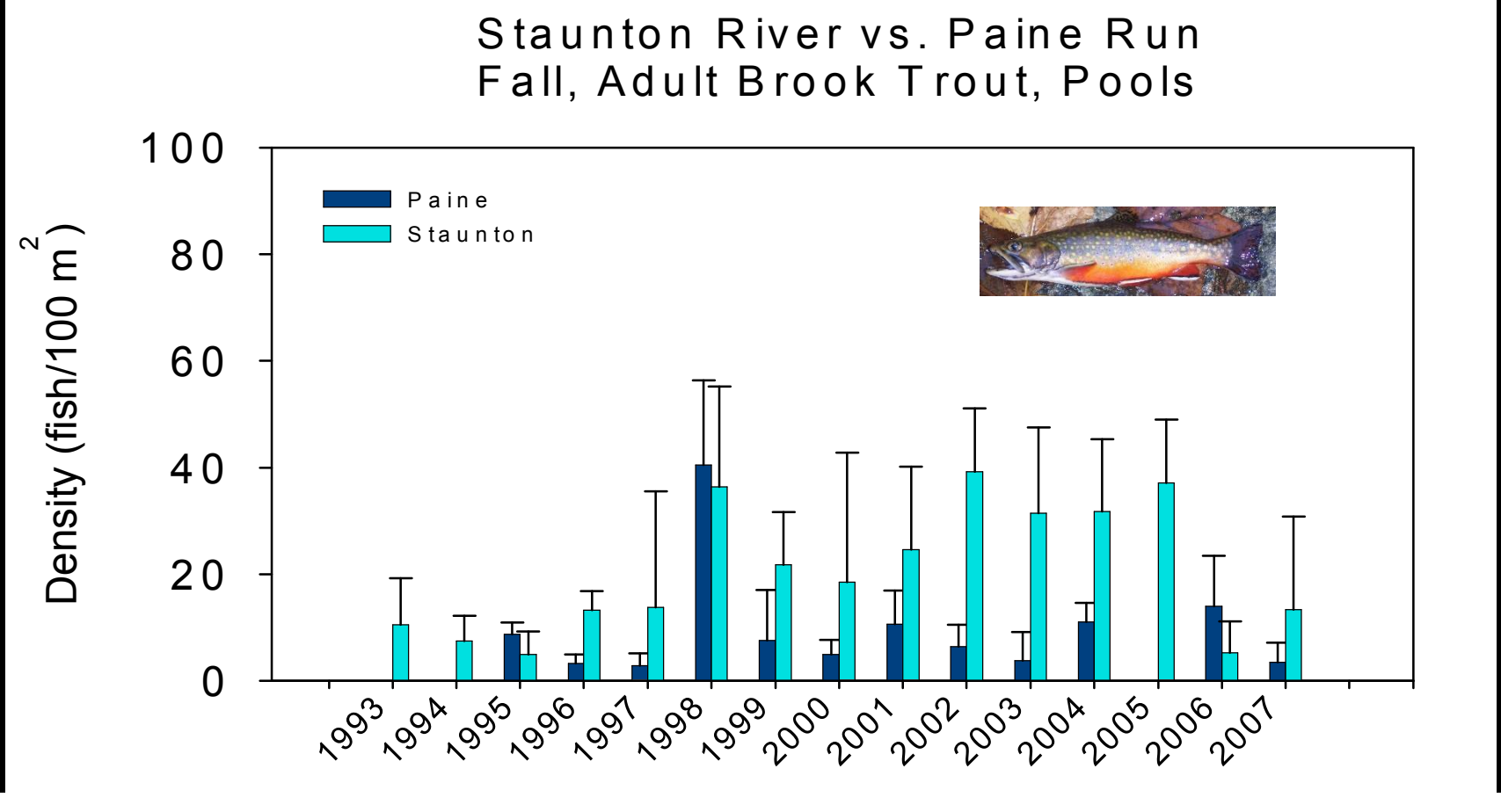
Master's Thesis, Craig Roghair, 2000, Virginia Tech

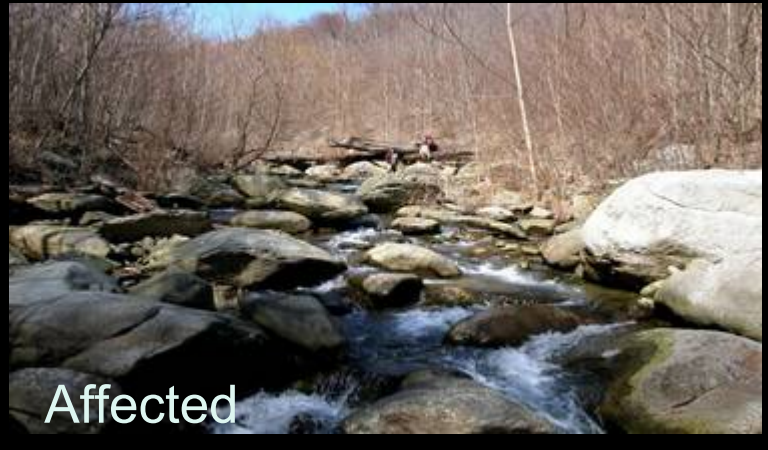

1995 pre-event
1995 Oct
1996 May
Meters
1996 Oct
1997 June-Oct
1998 May


Staunton River Brook Trout - Age 0+
Fall 1997
Total Length (mm)
140
120
100
80
60
40
20
0
Below Debris Flow
Above Debris Flow
0
5
10
15
20
25
Relative Distance from Rapidan - Staunton Confluence

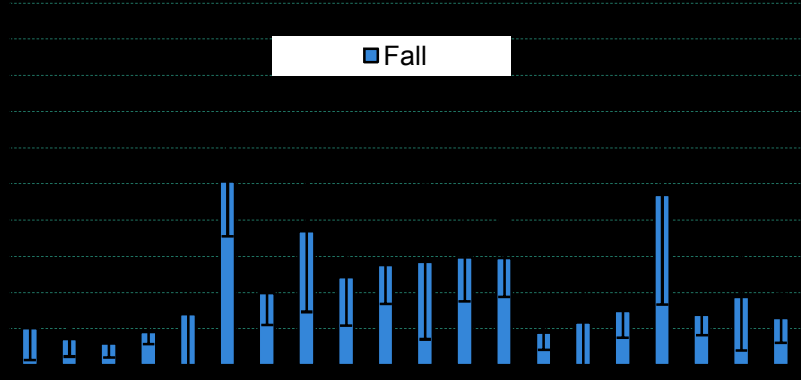

40
20
0
-20
-40
-60
Change in Weight (g)
n = 11 8 48 22* 70 23 63 24 39 29 *p < .03
1
2
3
4
5
Date Code
Affected
Unaffected
1 = Jun 97 - Oct 97
2 = Oct 97 - Jun 98
3 = Jun 98 - Oct 98
4 = Oct 98 - Jun 99
5 = Jun 99 - Oct 99

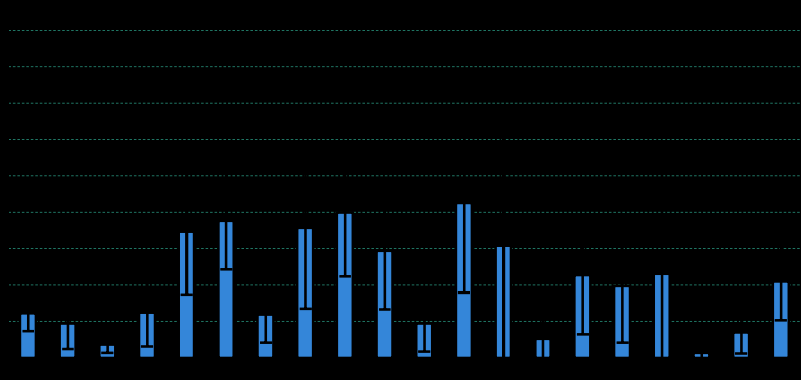
Quiz: when was the disaster?




Affected


Unaffected


Fall



Questions/Observations

First time recaps up to 5 yrs post mark
-typical recap rate ~20%; at least 50% alive at time of first recap attempt

Tag loss?
-estimate by scar exam, bed scan (redds), recap effort outside study area

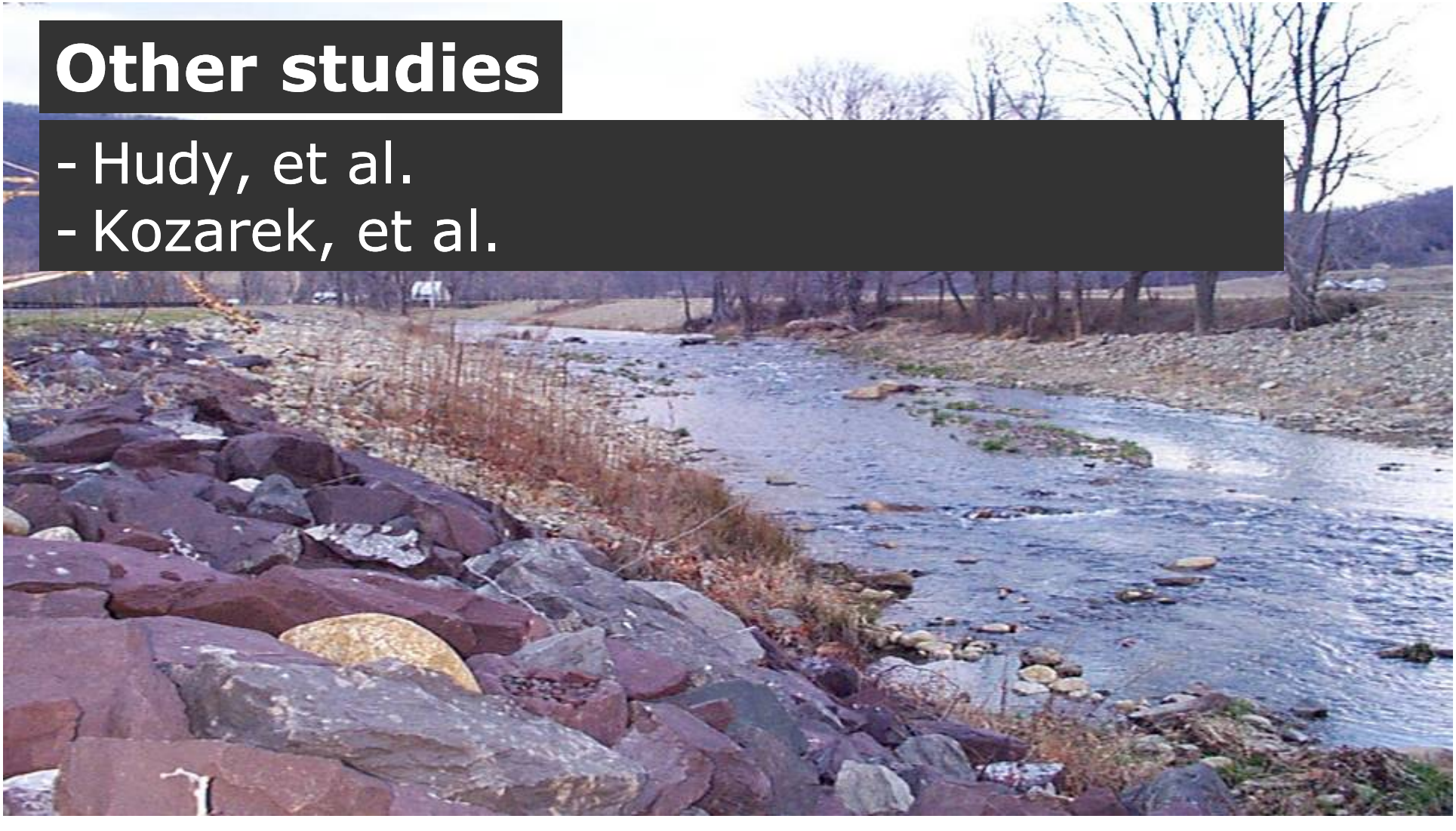
'Good' or 'best' habitat=greatest number of fish?
-Large annual variation w/in & among habitat units

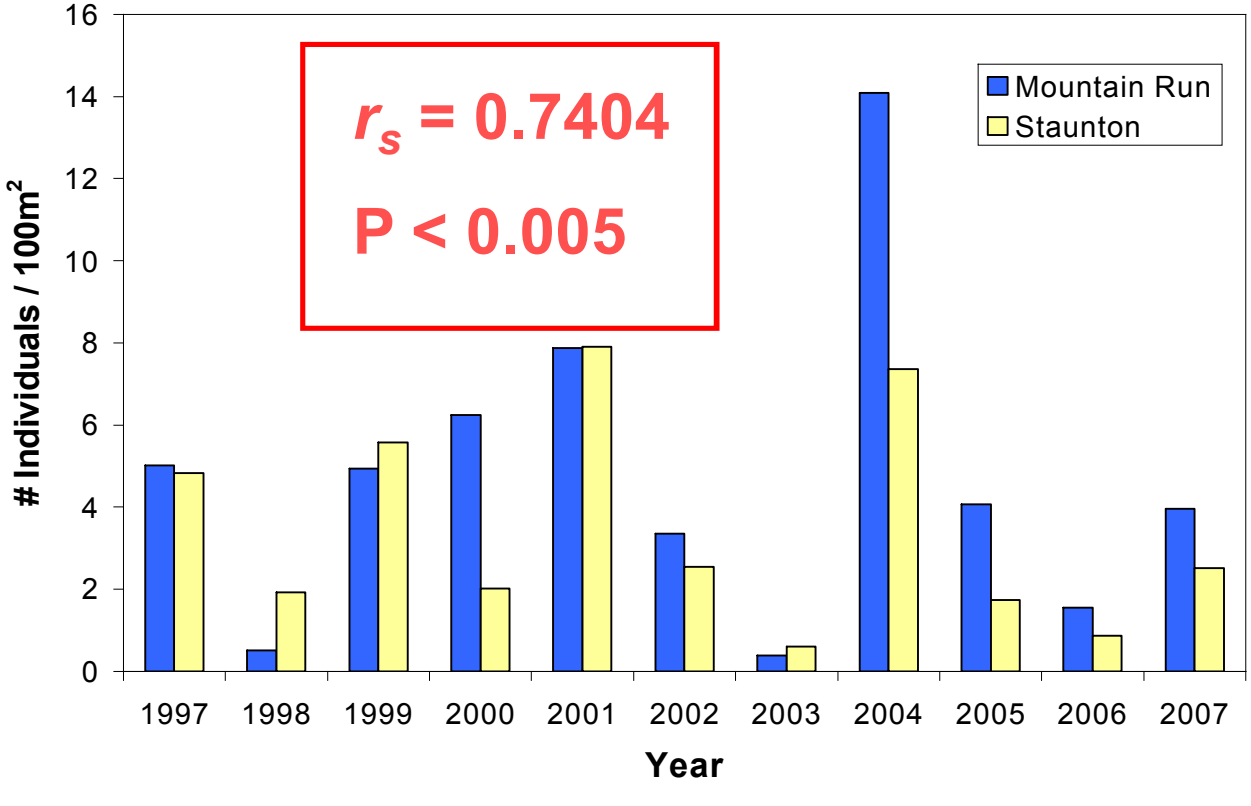
Conclusions

- Within 3 years population larger than before flood
- Increased population = decreased growth
- Source population = speedy recovery
- ‘It’s only catastrophic if you’re in the way’

Other studies

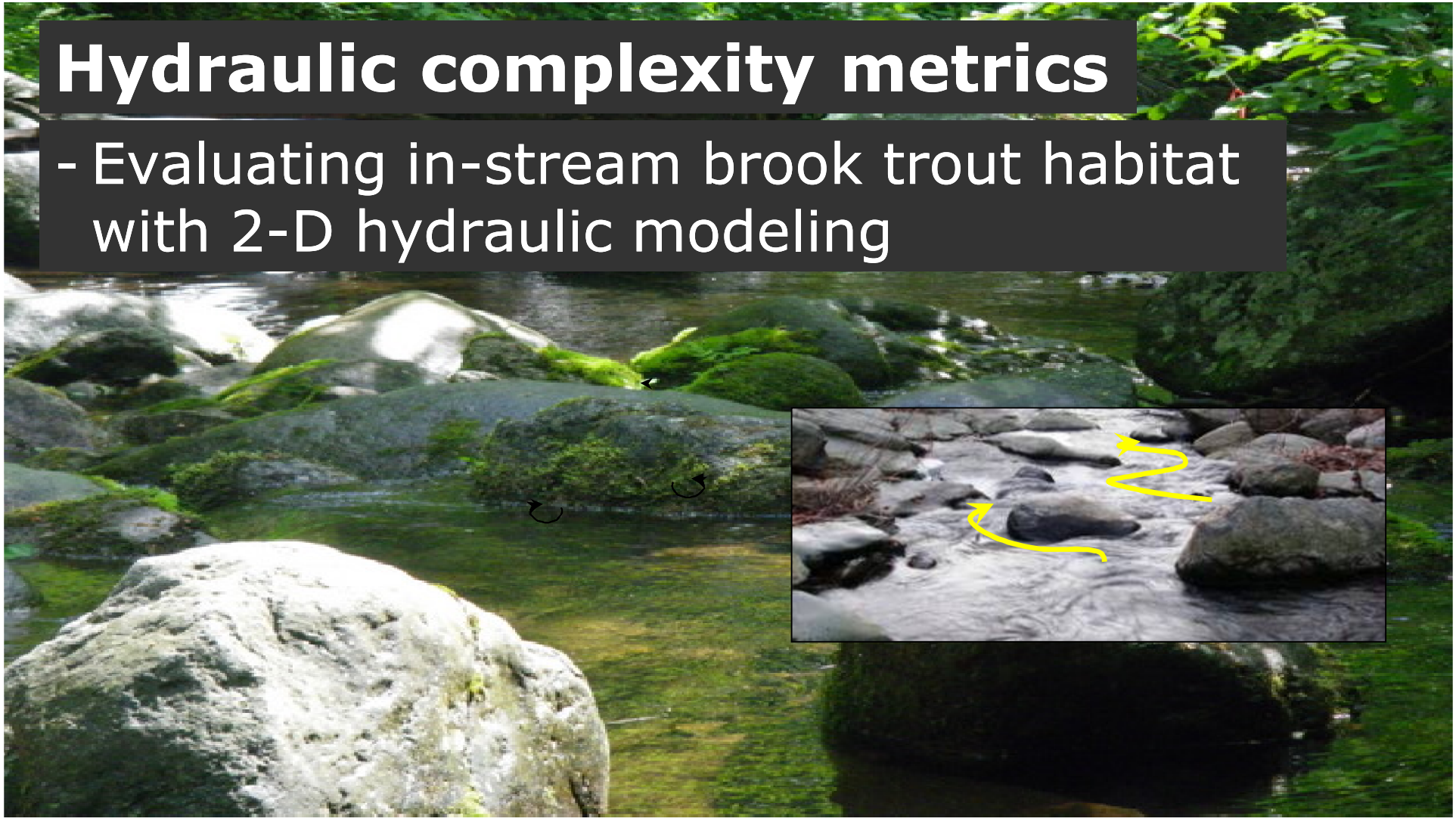
- Hudy, et al.
- Kozarek, et al.




Relative abundance of YOY brook trout populations in Mountain Run and Staunton River (1997-2007)
r_s = 0.7404
P < 0.005
Mountain Run
Staunton
Individuals / 100m²
0
2
4
6
8
10
12
14
16
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year

Hydraulic complexity metrics

- Evaluating in-stream brook trout habitat with 2-D hydraulic modeling

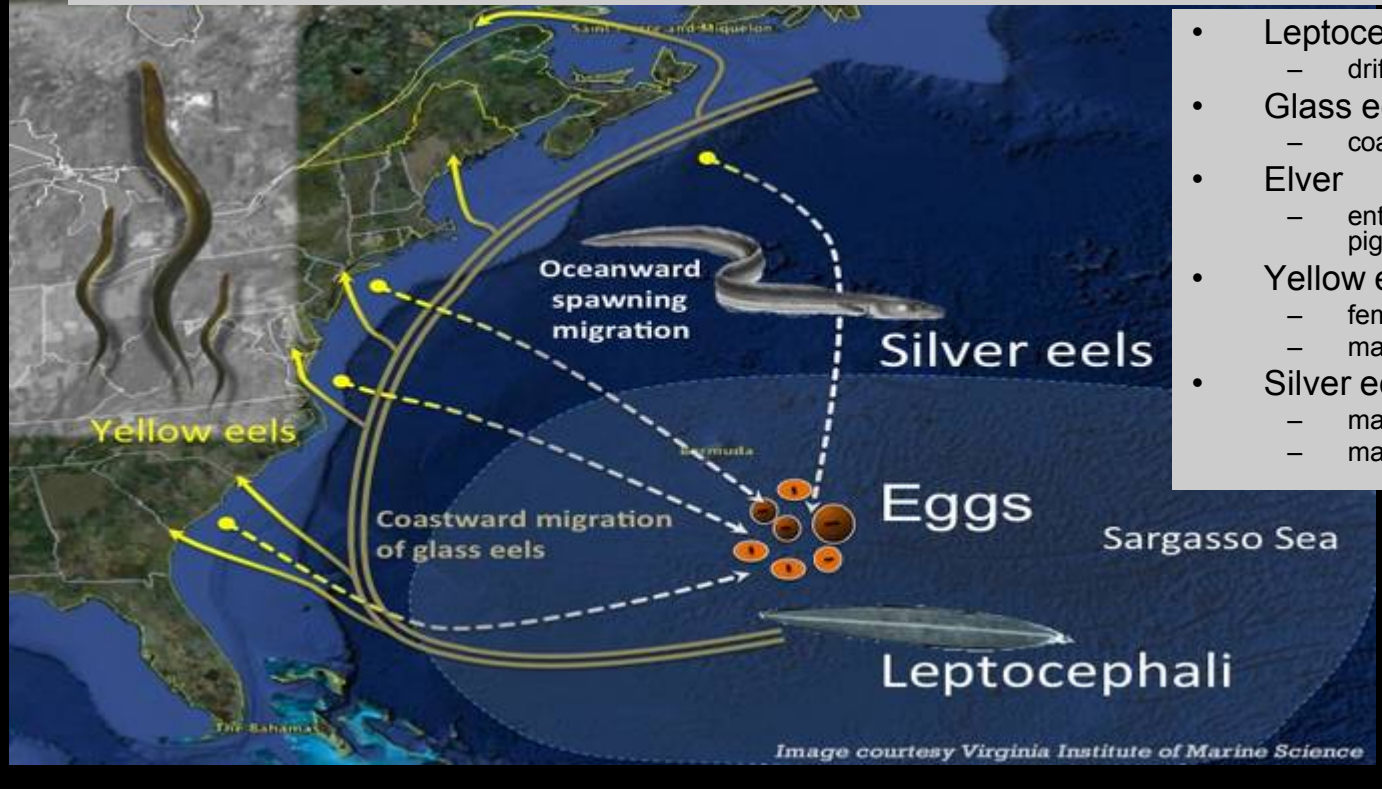


American Eels in Virginia Mountain Streams

Andy Dolloff, Colin Krause, Craig Roghair,
USFS, SRS, CATT
Dawn Kirk – GWJ National Forest
Scott Smith - VDGIF

Eel Life Cycle

American eel (*Anguilla rostrata*) – catadromous, nocturnal benthic omnivore



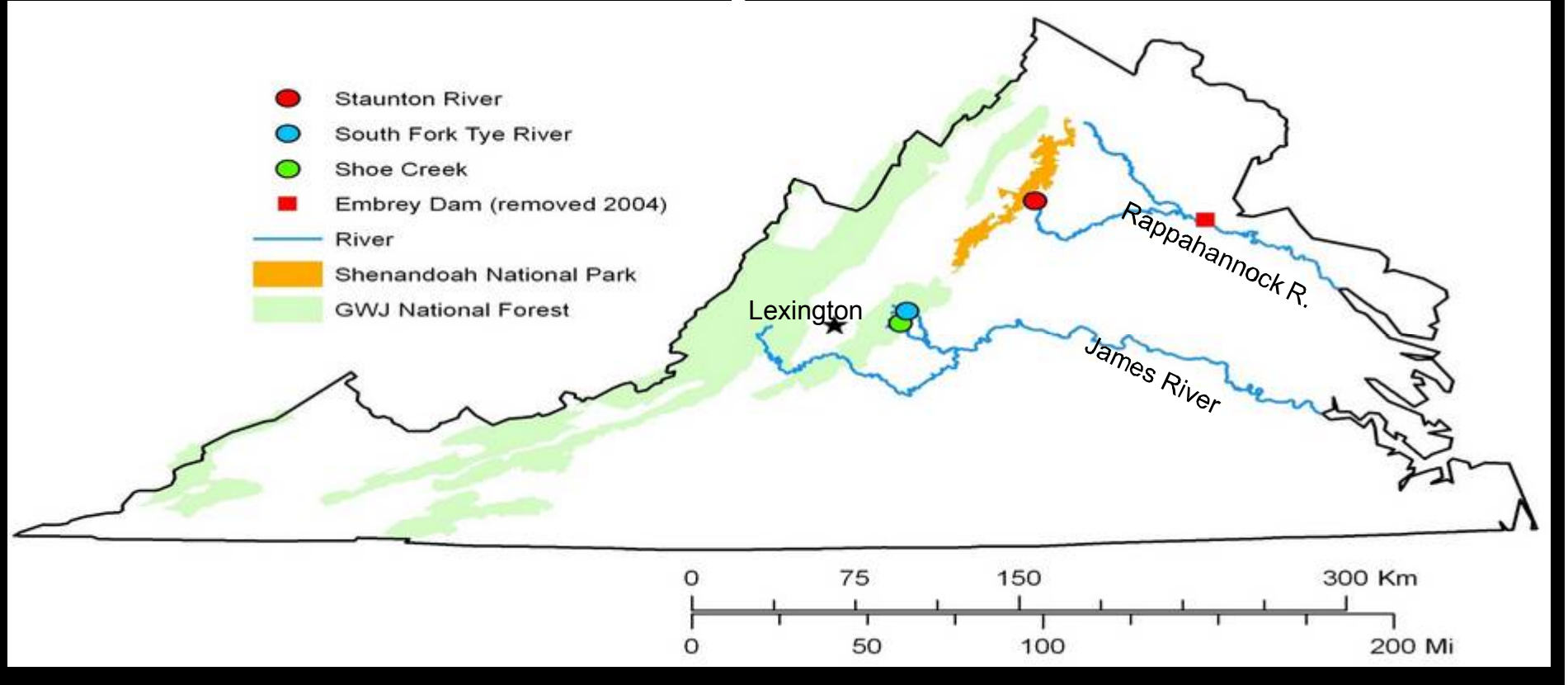
- Leptocephalus larvae
  - drift westward for ~1 yr.
- Glass eel
  - coastward migration into estuaries
- Elver
  - entering coastal waters they become pigmented; still sexually undifferentiated
- Yellow eels
  - females move upstream
  - males remain in estuaries
- Silver eels
  - mature females >450mm; 4-18 yrs.
  - mature males <450mm; 3-10 yrs.

Threats-
Dams, dredging, pollution, habitat loss, commercial fishing, management?

Background/Objectives

- **1999: US Forest Service & VDGIF**
  - Headwater stream eel survey on USFS lands
  - Eels found in several streams in summer
  - Gone in fall – where did they go??
- **2000 – 2001: P. A. Strickland, Virginia Tech**
  - Thesis 2002
  - Habitat preference, pop. density, growth, movement
- **2002 – Present: US Forest Service & VDGIF**
  - Annual sampling for long-term monitoring of growth & movement

Study Sites


Staunton River
South Fork Tye River
Shoe Creek
Embrey Dam (removed 2004)
River
Shenandoah National Park
GWJ National Forest
Lexington
Rappahannock R.
James River
0
75
150
300 Km
0
50
100
200 Mi

Methods

- **2000-2001 P. A. Strickland**
  - 2 km reaches, 3 streams
  - Multiple pass efishing for population est.
  - Radio telemetry for movement & habitat preference
  - PIT (passive integrated transponder) tagging for growth estimates

- **2002-Present USFS**
  - 2 km reaches, 2 streams
  - Single pass efishing in summer
  - PIT tagging
  - Location, length, & weight

. Strickland's Results (2000-2001)

- Habitat Preference (telemetry)
  - Deep pools; large substrate
- Movement (telemetry)
  - Greatest in summer, least in winter
  - Daily activity greatest at night
  - Mid-fall to mid-spring, eels moved very little, shelter in substrate and under stream banks
- Density estimates, population estimates, growth rates

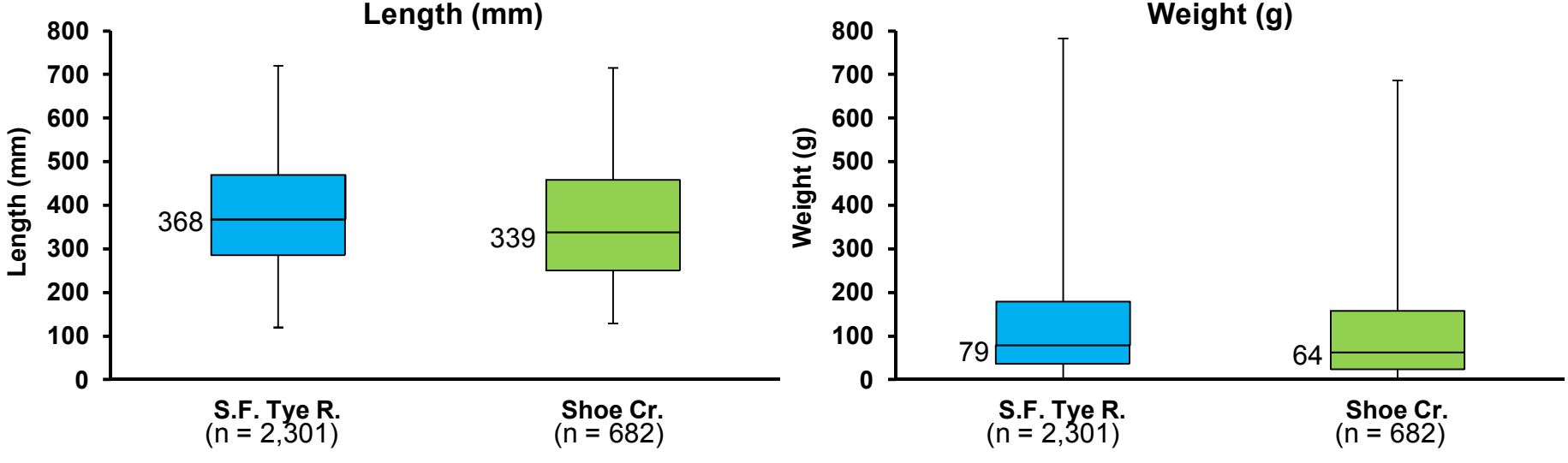
Strickland, P.A. 2002. American eel distribution and growth in selected tributaries of the James River. MS Thesis, Virginia Polytechnic Institute and State University, Blacksburg. http://scholar.lib.vt.edu/theses/browse/

Tagging Summary

	S.F. Tye River	Shoe Creek
# Tag Yrs.	11 (2000 – 2010)	6 (1999 – 2004)

Size

Length and weights typical for VA streams.



Comparison Data:

Adults **220 – 1,000 mm** (Jenkins and Burkhead 1993)

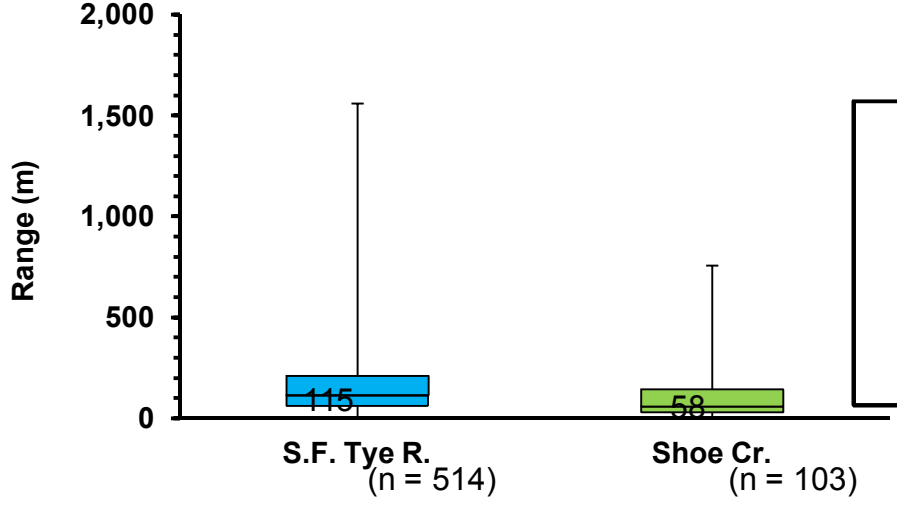
Lower Potomac tribs, **76 - 820 mm** (Goodwin and Angermeier 2003)

Shenandoah drainage, **292 – 1,023 mm** (Goodwin and Angermeier 2003)

Range

i.e. the difference between min. & max. capture distance

When recaptured, the majority of eels were very close to the location they were 1st captured at 1-10 years earlier.



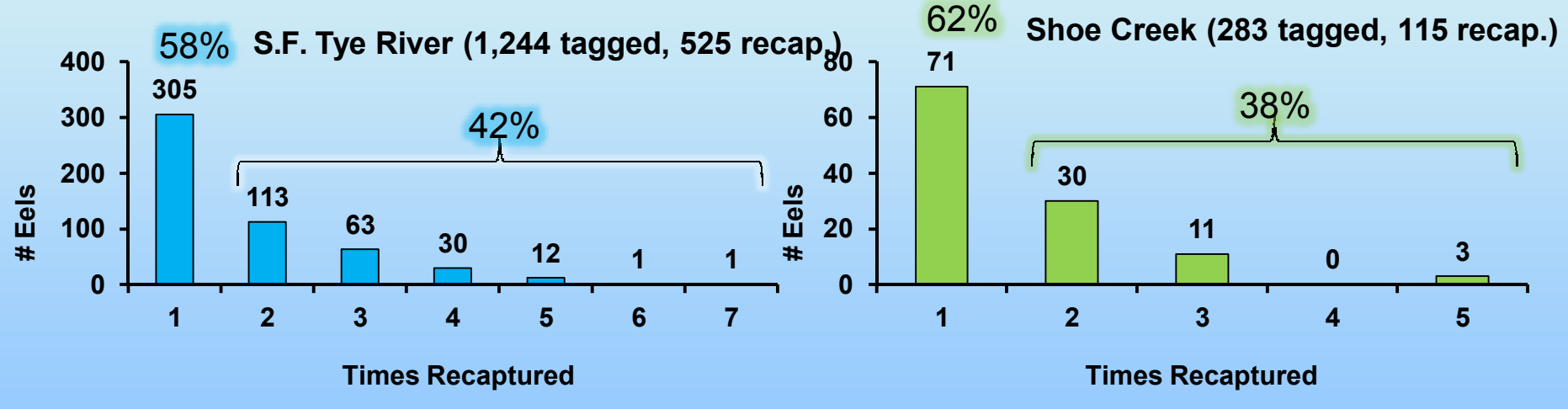
Radio Telemetry

(Strickland 2002)

Summer	Mean Range (m)	n
2000	**228** (±114)	18
2001	**36** (±24)	15

Multiple Recaptures

~40% of recaptured eels were recaptured 2 or more times.



New Recaptures

Every year we sample, we continue to catch eels that have never been recaptured before!

	Tag Year	Total Tagged	New Recaptures per Sample Year									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
S.F. Tye River	2000	279		97	32	11	8	7	6	4	4	2	5
	2001	225		97	65	43	45	32	24	18	16	14	14
	2002	149											
	2003	76											
	2004	116											
	2005	72											
	2006	49											
	2007	61											
	2008	67											
	2009	62											
	2010	88											
Shoe Creek	1999	68											
	2000	93											
	2001	41											
	2002	22											
	2003	16											
	2004	43											

New & Multiple Recaptures

New Recaptures

If you sample only once after tagging, % recapture rates avg. 14% & 17%.

			New Recaptures per Sample Year													
	Tag Year	Total Tagged	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total Recaps	% Recaps at 1st Sample Yr.	Total % Recaps
S.F. Tye River	2000	279		97	32	11	8	7	6	4	4	2	5	176	35%	63%
	2001	225			56	18	15	10	3	4	5	2	4	117	25%	52%
	2002	149				25	16	8	8	3	4	2	4	70	17%	47%
	2003	76					11	8	3	1	4	1	3	31	14%	41%
	2004	116						21	8	3	6	7	4	49	18%	42%
	2005	72							10	5	8	5	3	31	14%	43%
	2006	49								6	6	2	2	16	12%	33%
	2007	61									8	5	2	15	13%	25%
	2008	67										4	6	10	6%	15%
	2009	62											10	10	16%	16%
														Avg.	17%	
Shoe Creek	1999	68	22	5	1	2	1		1					32	32%	47%
	2000	93		19	7	3	4	1		1	1	2	1	39	20%	42%
	2001	41			3	4	2	1	1	3				14	7%	34%
	2002	22				2	3	1	2	1	1			10	9%	45%
	2003	16					2	1		1		1	1	6	13%	38%
	2004	43						1	5	3	4		1	14	2%	33%
														Avg.	14%	

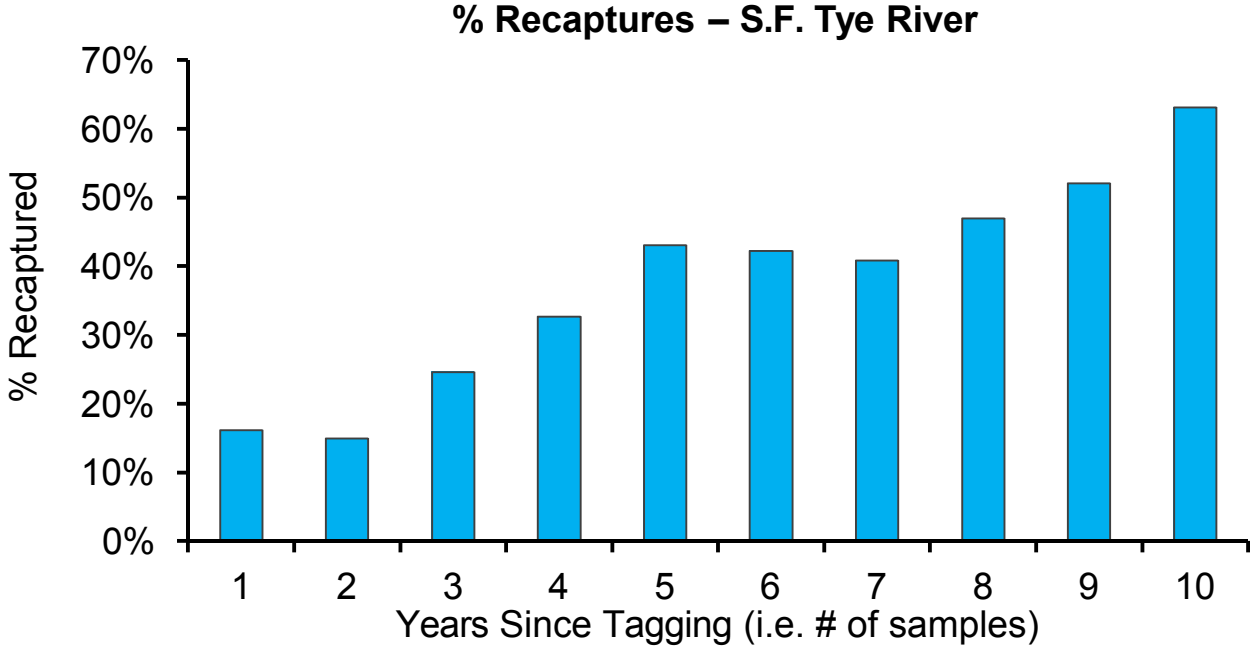
New Recaptures

Additional sample years increases % recaptured.

	Tag Year	Total Tagged	New Recaptures per Sample Year 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total Recaps	% Recaps at 1st Sample Yr.	Total % Recaps
S.F. Tye River	2000	279		97	32	11	8	7	6	4	4	2	5	176	35%	63%
	2001	225			56	18	15	10	3	4	5	2	4	117	25%	52%
	2002	149				25	16	8	8	3	4	2	4	70	17%	47%
	2003	76					11	8	3	1	4	1	3	31	14%	41%
	2004	116						21	8	3	6	7	4	49	18%	42%
	2005	72							10	5	8	5	3	31	14%	43%
	2006	49								6	6	2	2	16	12%	33%
	2007	61									8	5	2	15	13%	25%
	2008	67										4	6	10	6%	15%
	2009	62											10	10	16%	16%
														Avg.	17%	
Shoe Creek	1999	68	22	5	1	2	1		1					32	32%	47%
	2000	93		19	7	3	4	1		1	1	2	1	39	20%	42%
	2001	41			3	4	2	1	1	3				14	7%	34%
	2002	22				2	3	1	2	1	1			10	9%	45%
	2003	16					2	1		1		1	1	6	13%	38%
	2004	43						1	5	3	4		1	14	2%	33%
														Avg.	14%	

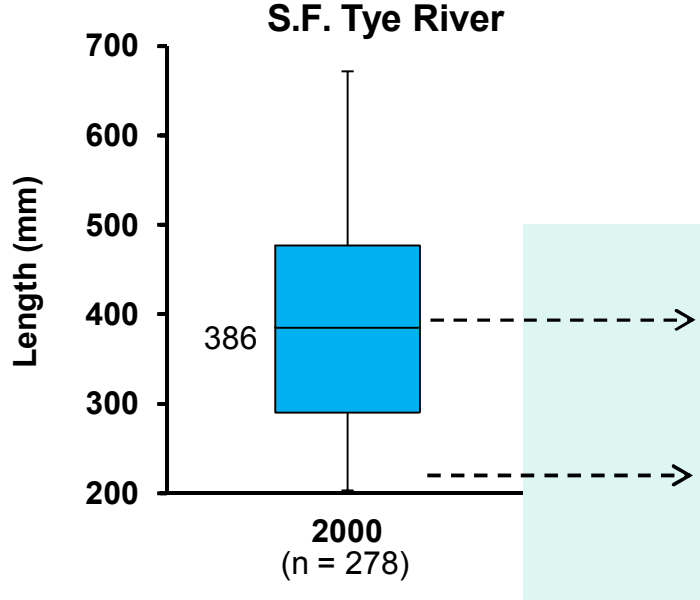
Recapture Rates

The more years we sample, the higher the recapture rate.



Eels Recaptured 10 Years Later

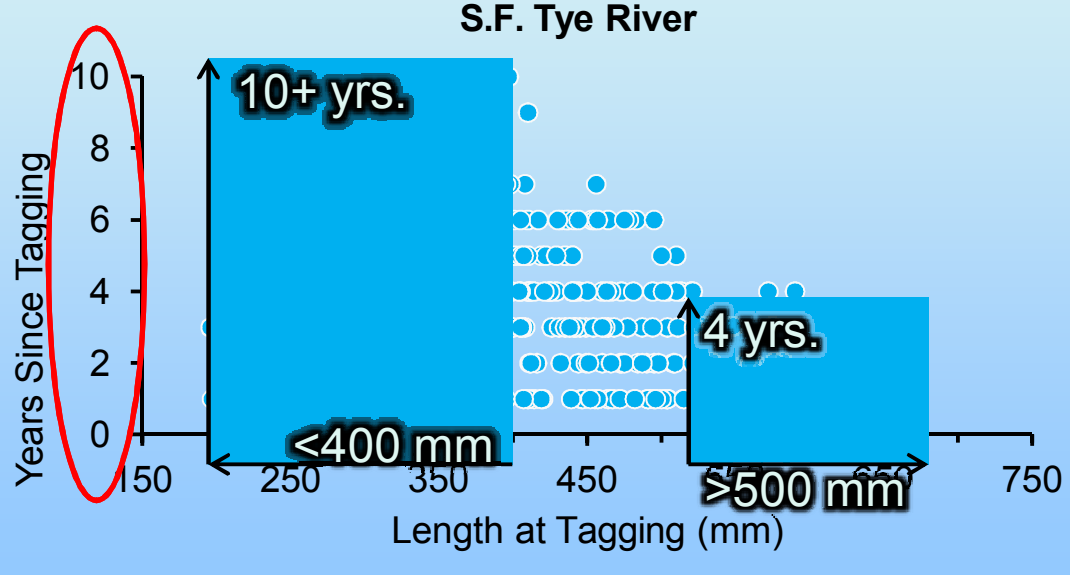
Tagging small eels offers long-term recapture possibilities.



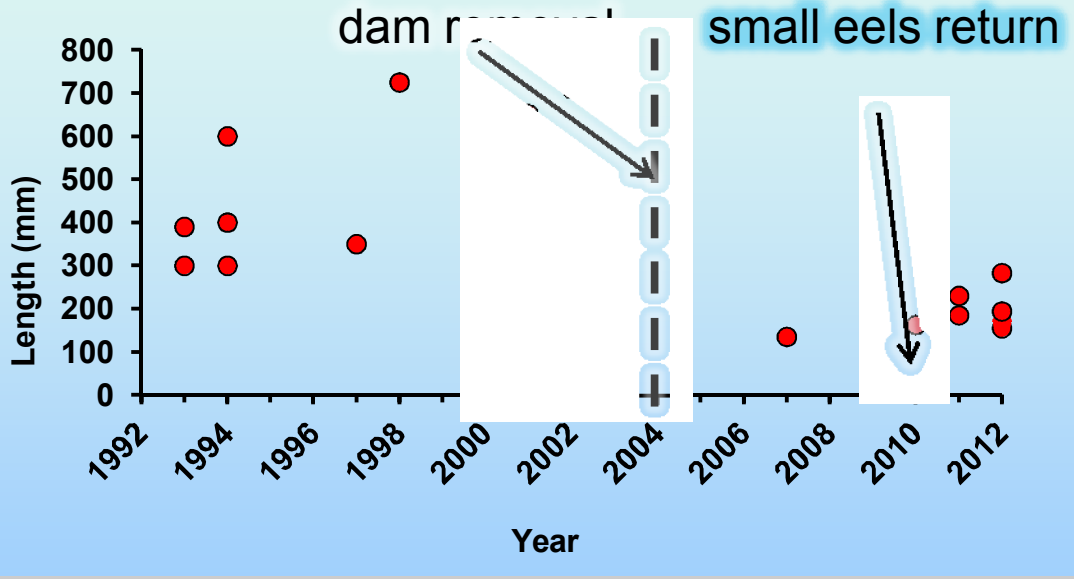
Eels recaptured 10 yrs. later were <400 mm when tagged.

Eel Length vs. Years Since Tagged

Tagging small eels provides more years of recapture data.



Eels in the Staunton River



Embrey dam out 2004

- 6.7 m high (22 ft)
- 153 km (95 mi) downstr of Staunton R

Hitt, et al. also found increase # small eels after removal of Embrey dam.

Nathaniel P. Hitt, Sheila Eyler & John E. B. Wofford (2012): Dam Removal Increases American Eel Abundance in Distant Headwater Streams, Transactions of the American Fisheries Society, 141:5, 1171-1179

Conclusions

- Highly mobile or highly sedentary depending on life stage
- Don’t move much in headwaters
- Stay a long time
  - Local conditions important
- Long-term studies have great benefits
  - High recapture %
- Small eels return to Staunton!