Souhegan River Protected Instream Flow Study

INSTREAM HABITAT ANALYSIS

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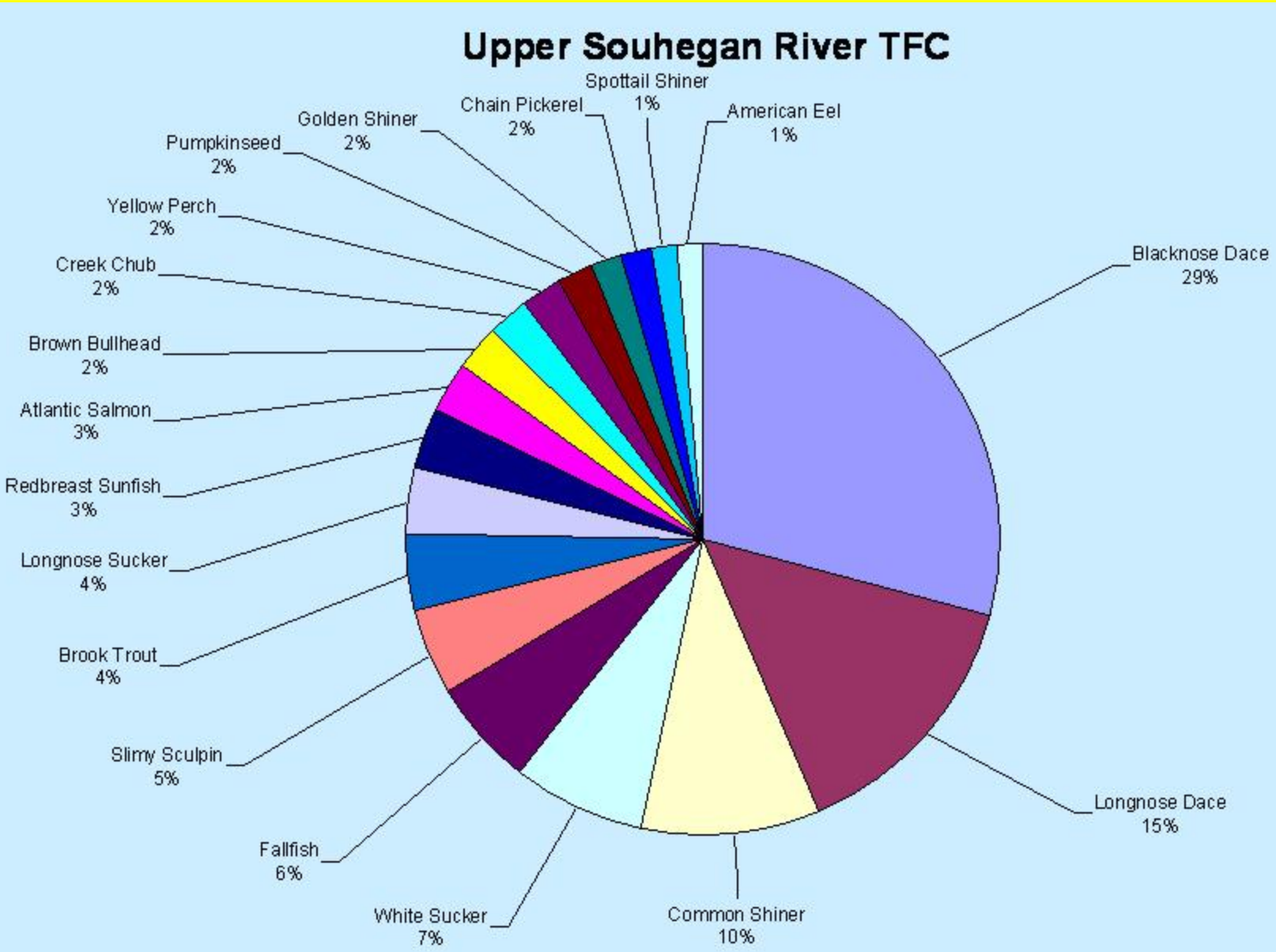
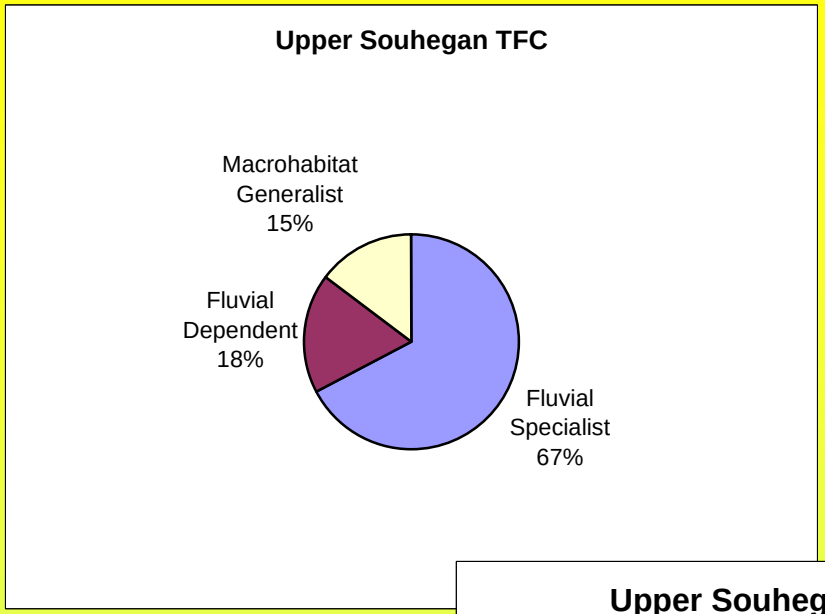
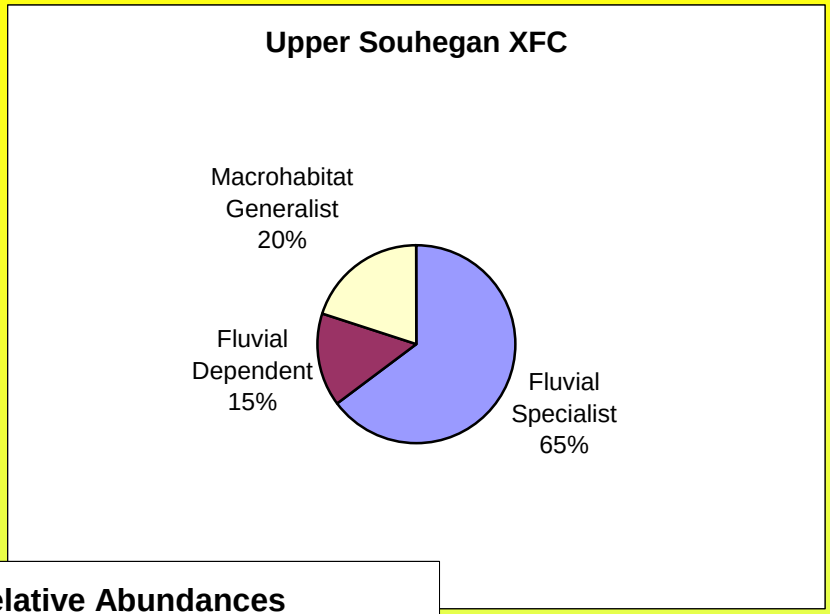
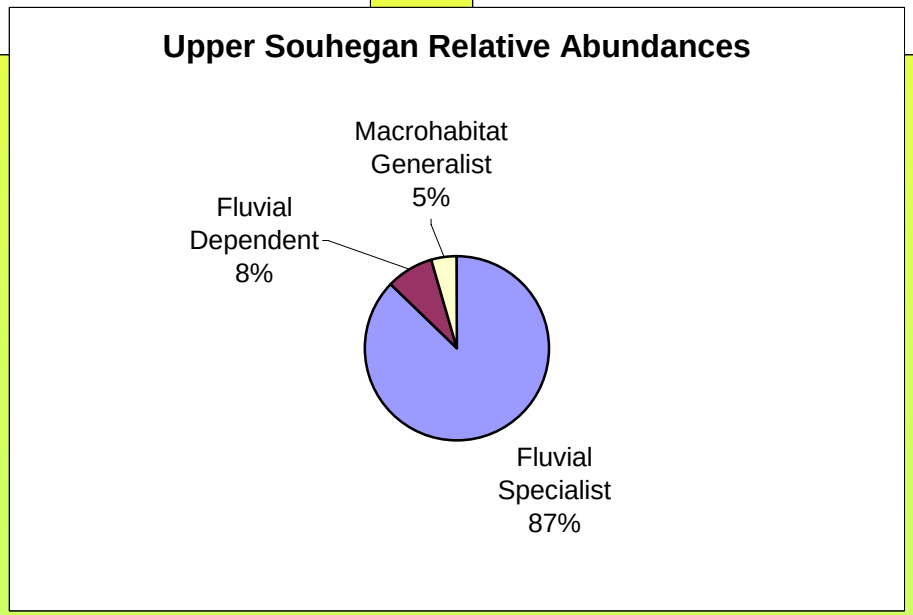
Reported tasks

- Existing fish fauna vs. habitat
- Bioperiods and indicator species
- Available fish habitat
- Proposed PISF values
- Management recommendations


Upper Souhegan River TFC
Spottail Shiner 1%
Chain Pickerel 2%
American Eel 1%
Golden Shiner 2%
Pumpkinseed 2%
Yellow Perch 2%
Creek Chub 2%
Brown Bullhead 2%
Atlantic Salmon 3%
Redbreast Sunfish 3%
Longnose Sucker 4%
Brook Trout 4%
Slimy Sculpin 5%
Fallfish 6%
White Sucker 7%
Common Shiner 10%
Longnose Dace 15%
Blacknose Dace 29%


Upper Souhegan TFC
Macrohabitat Generalist 15%
Fluvial Dependent 18%
Fluvial Specialist 67%

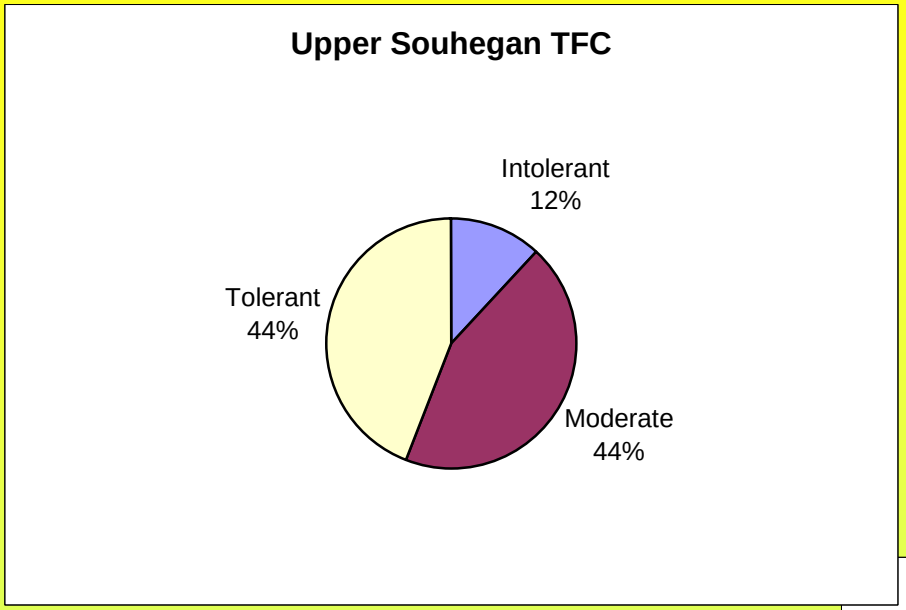

Upper Souhegan XFC
Macrohabitat Generalist 20%
Fluvial Dependent 15%
Fluvial Specialist 65%

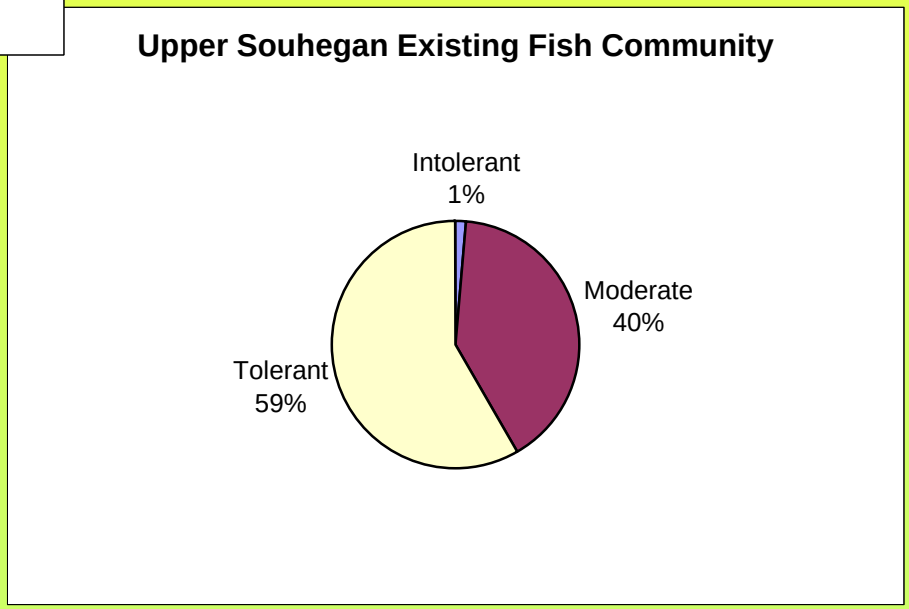

Upper Souhegan Relative Abundances
Macrohabitat Generalist 5%
Fluvial Dependent 8%
Fluvial Specialist 87%

Upper Souhegan

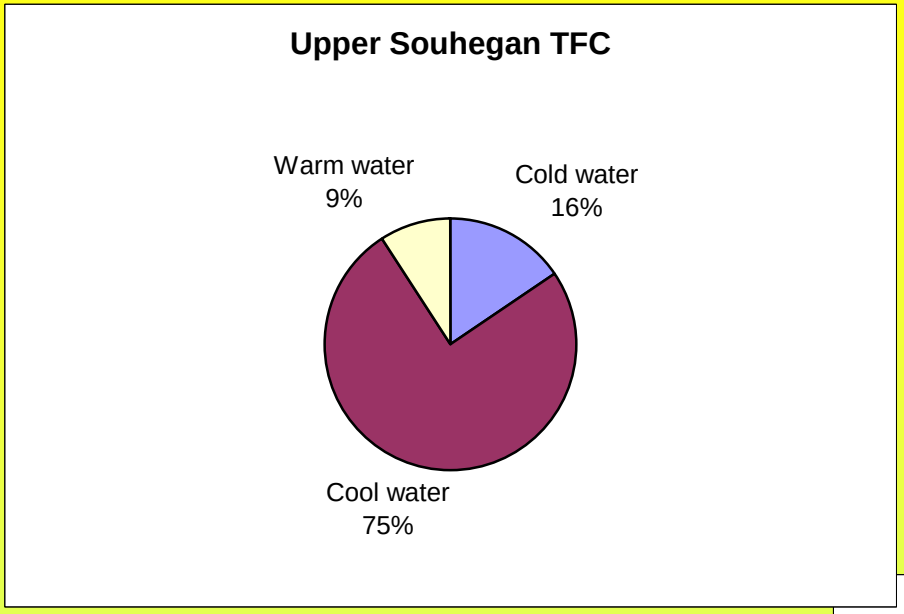
Species	Proportion of Target Fish Community	Proportion of Existing Fish Community	Native or Introduced	Habitat use Classification	Pollution Tolerance	Thermal Regime
Underrepresented native target fish species						
Atlantic salmon	3%	1%	N	FS	I	Cold
Common shiner	10%	5%	N	FD	M	Cool
Golden shiner	2%	<1%	N	MG	T	Cool
Pumpkinseed	2%	<1%	N	MG	M	Warm
White sucker	7%	3%	N	FD	T	Cool
Target fish species recorded as expected						
Fallfish	6%	6%	N	FS	M	Cool
Yellow perch	2%	2%	N	MG	M	Cool
Overly abundant native target fish species						
Blacknose dace	29%	55%	N	FS	T	Cool
Longnose dace	15%	25%	N	FS	M	Cool
Missing native target fish species						
American eel	1%	0%	N	FD	T	Cool
Brown bullhead	2%	0%	N	MG	T	Warm
Chain pickerel	2%	0%	N	MG	M	Warm
Creek chub	2%	0%	N	FS	T	Cool
Eastern brook trout	4%	0%	N	FS	I	Cold
Longnose sucker	4%	0%	N	FS	M	Cold
Redbreast sunfish	3%	0%	N	MG	M	Warm
Slimy sculpin	5%	0%	N	FS	I	Cold
Spottail shiner	1%	0%	N	MG	M	Cool
Introduced species present in the existing fish community						
Brown trout	0%	<1%	I	FD	I	Cool
Largemouth bass	0%	2%	I	MG	M	Warm

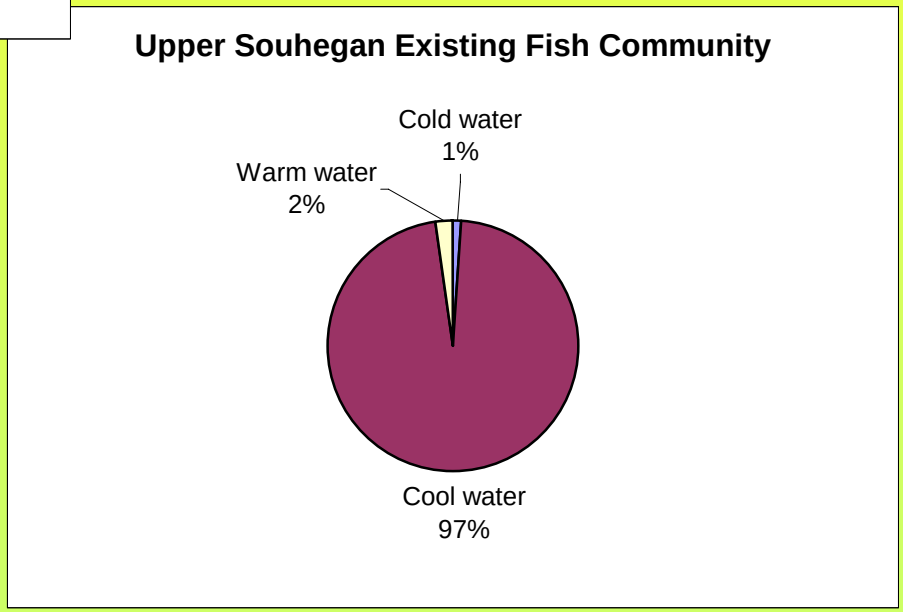
Pollution tolerance

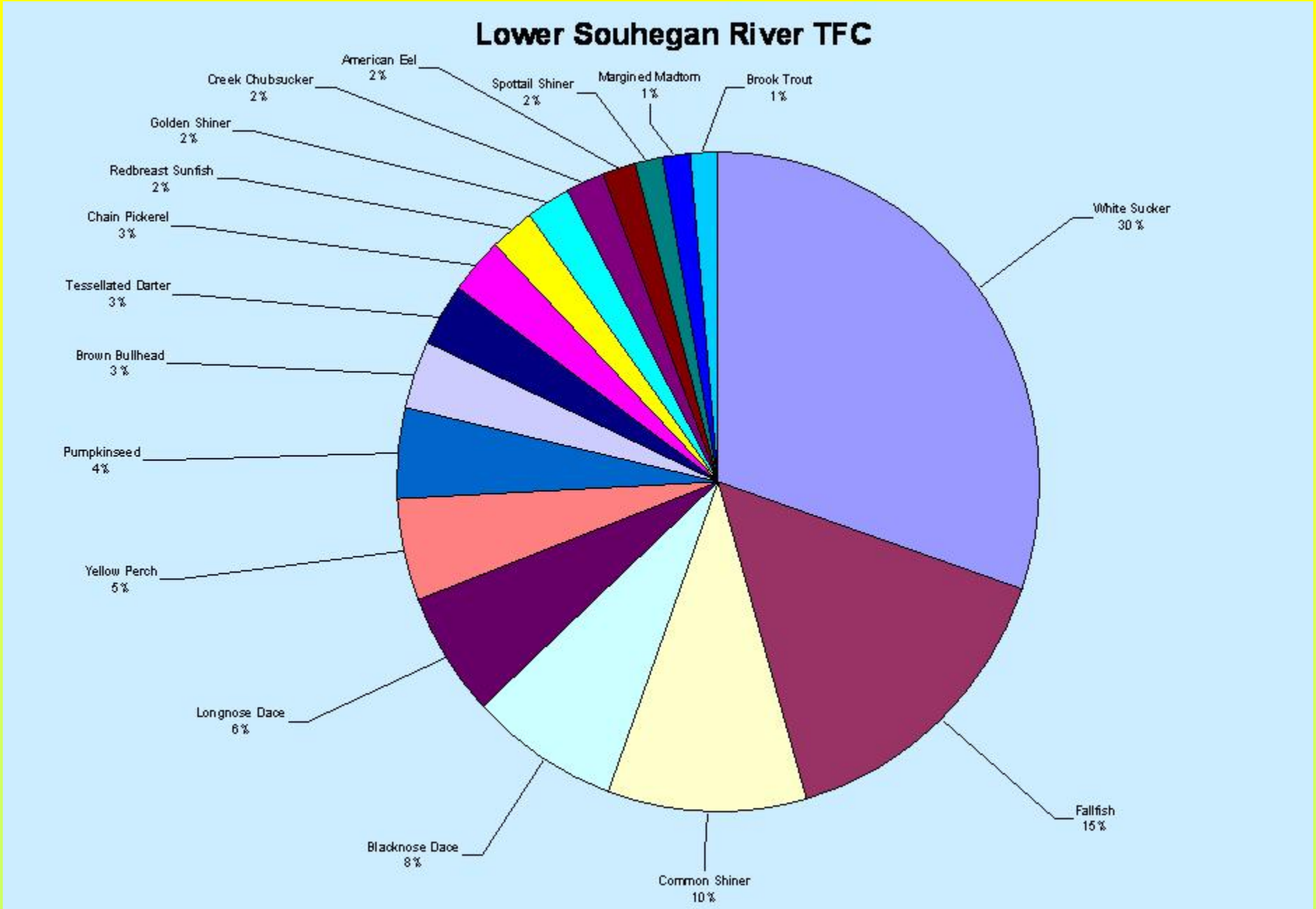


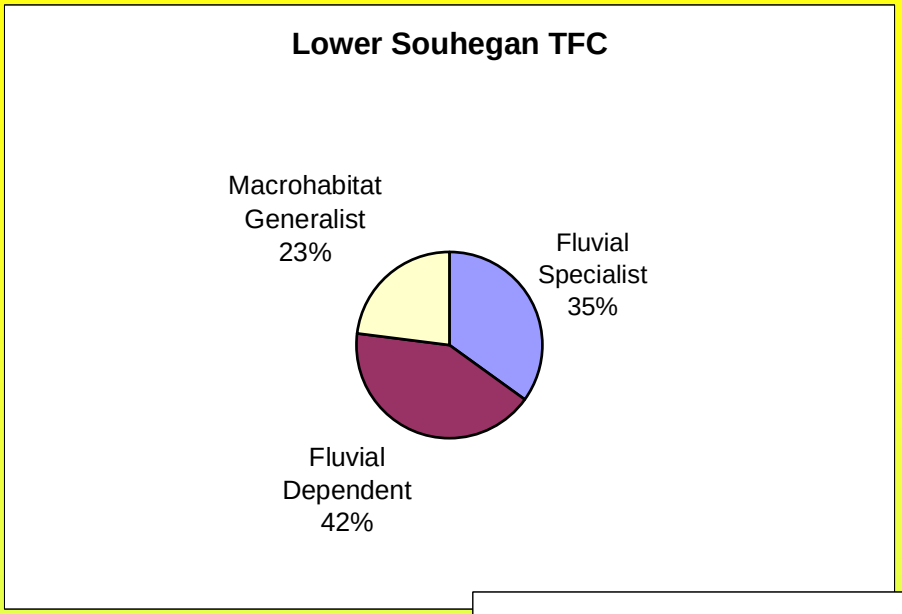


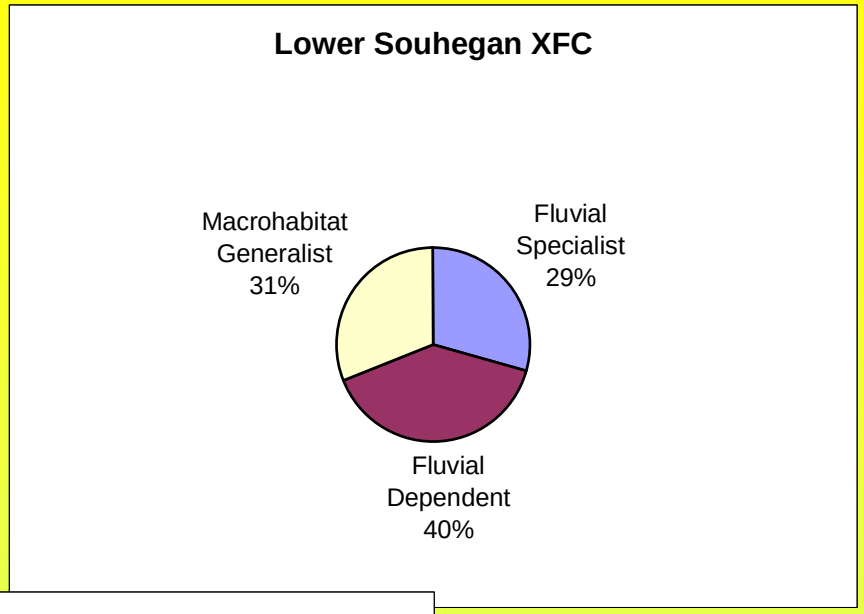
Thermal tolerance

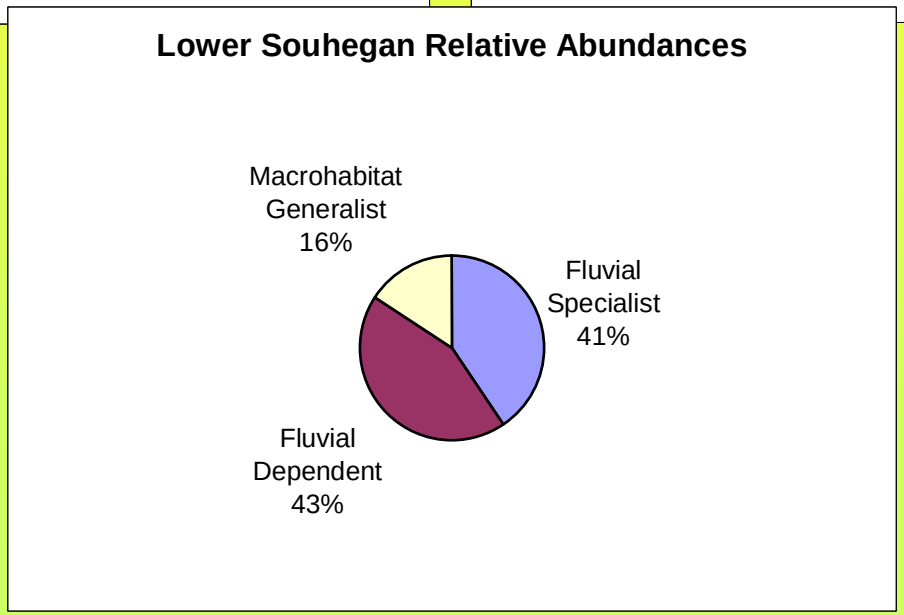





Lower Souhegan River TFC
American Eel 2%
Creek Chubsucker 2%
Golden Shiner 2%
Redbreast Sunfish 2%
Chain Pickerel 3%
Tessellated Darter 3%
Brown Bullhead 3%
Pumpkinseed 4%
Yellow Perch 5%
Longnose Dace 6%
Blacknose Dace 8%
Common Shiner 10%
Fallfish 15%
White Sucker 30%
Brook Trout 1%
Margined Madtom 1%
Spottail Shiner 2%


Lower Souhegan TFC
Macrohabitat Generalist 23%
Fluvial Specialist 35%
Fluvial Dependent 42%

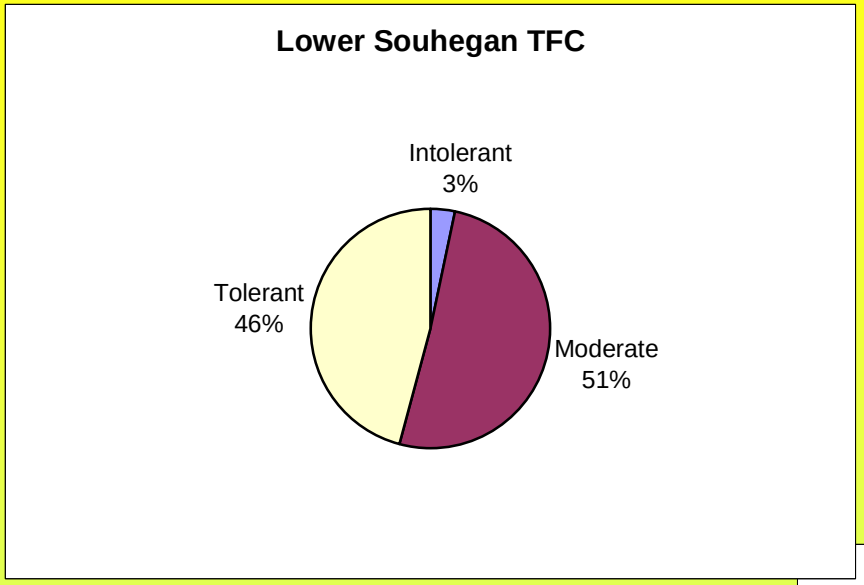

Lower Souhegan XFC
Macrohabitat Generalist 31%
Fluvial Specialist 29%
Fluvial Dependent 40%

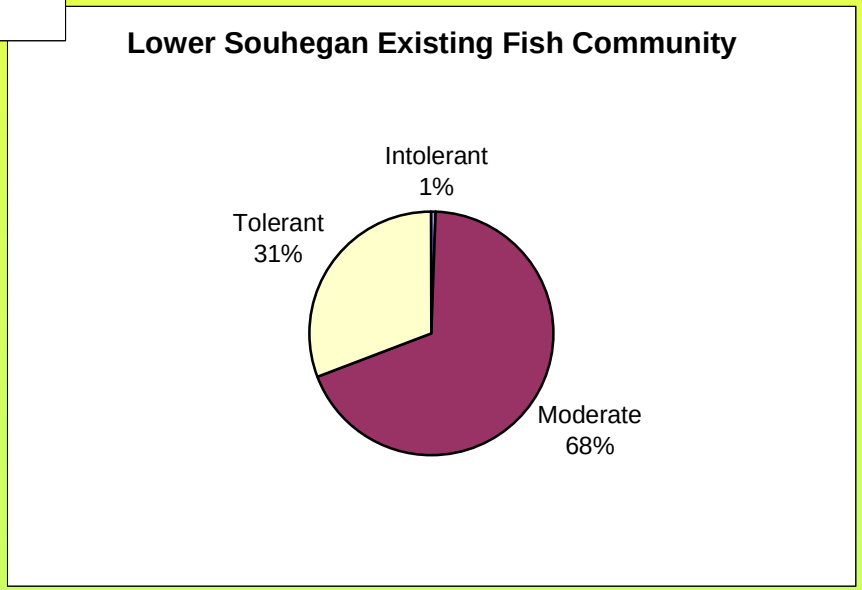

Lower Souhegan Relative Abundances
Macrohabitat Generalist 16%
Fluvial Specialist 41%
Fluvial Dependent 43%

Lower Souhegan

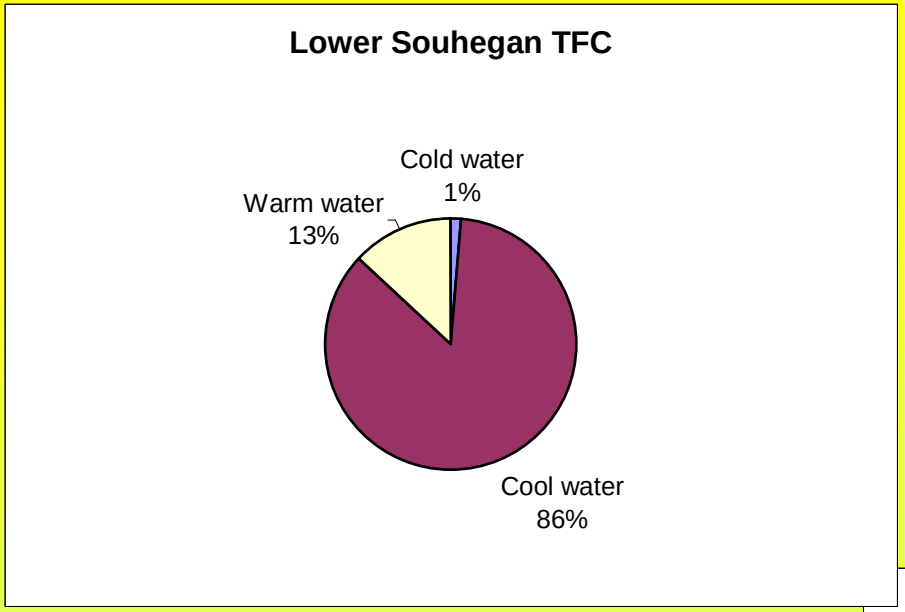
Species	Proportion of Target Fish Community	Proportion of Existing Fish Community	Native or Introduced	Habitat use Classification	Pollution Tolerance	Thermal Regime
Underrepresented native target fish species						
Chain pickerel	3%	<1%	N	MG	M	Warm
Creek chubsucker	2%	<1%	N	FS	I	Cool
Pumpkinseed	4%	<1%	N	MG	M	Warm
Yellow perch	5%	<1%	N	MG	M	Cool
White sucker	31%	13%	N	FD	T	Cool
Target fish species recorded as expected						
Fallfish	15%	20%	N	FS	M	Cool
Golden shiner	2%	1%	N	MG	T	Cool
Longnose dace	6%	4%	N	FS	M	Cool
Overly abundant native target fish species						
Blacknose dace	8%	17%	N	FS	T	Cool
Common shiner	10%	30%	N	FD	M	Cool
Redbreast sunfish	2%	13%	N	MG	M	Warm
Missing native target fish species						
American eel	2%	0%	N	FD	T	Cool
Brown bullhead	3%	0%	N	MG	T	Warm
Eastern brook trout	1%	0%	N	FS	I	Cold
Spottail shiner	2%	0%	N	MG	M	Cool
Tessellated darter	3%	0%	N	FS	M	Cool
Introduced species present in the existing fish community						
Bluegill	NA	<1%	I	MG	T	Warm
Brown trout	NA	<1%	I	FD	I	Cool
Largemouth bass	NA	2%	I	MG	M	Warm
Rainbow trout	NA	<1%	I	FD	I	Cold
Yellow bullhead	NA	<1%	I	MG	T	Warm

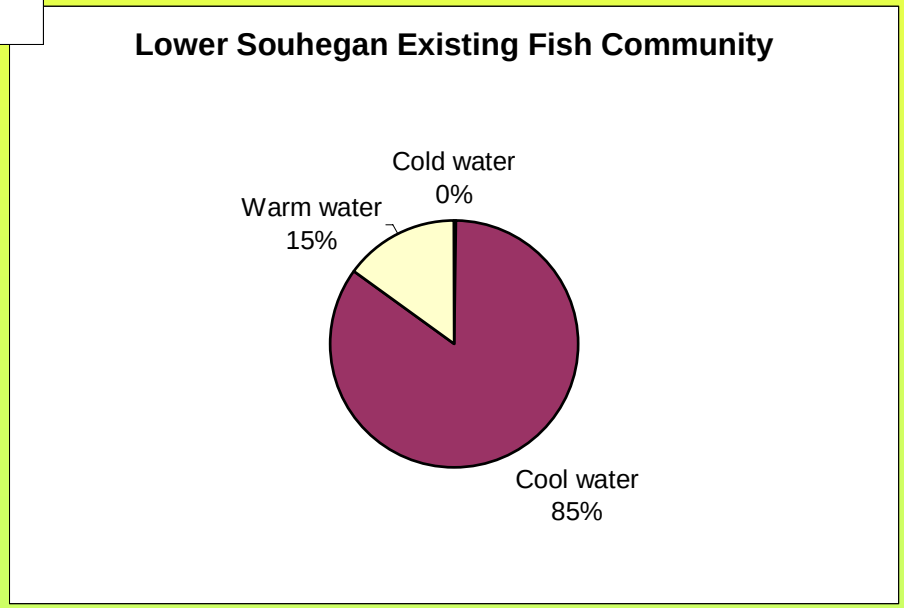
Pollution tolerance





Thermal tolerance





Species selected for habitat modeling

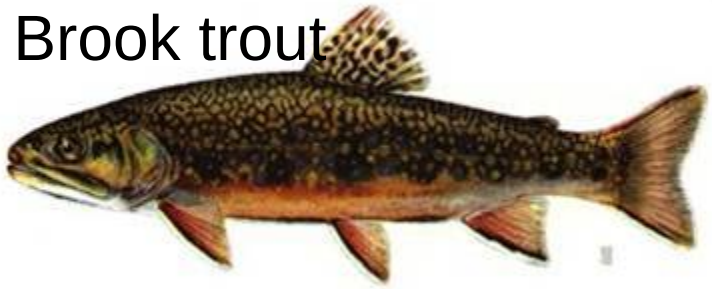
Fallfish

Slimy sculpin

Common shiner

Longnose dace

Brook trout

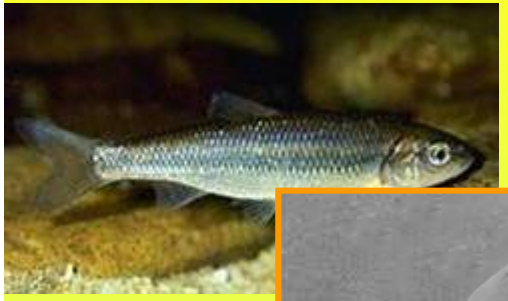


White sucker

Blacknose dace

Species selected for habitat modeling

Fallfish

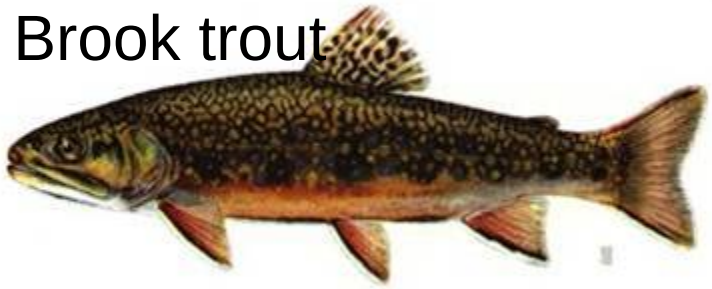


Slimy sculpin

Common

se dace

Brook trout



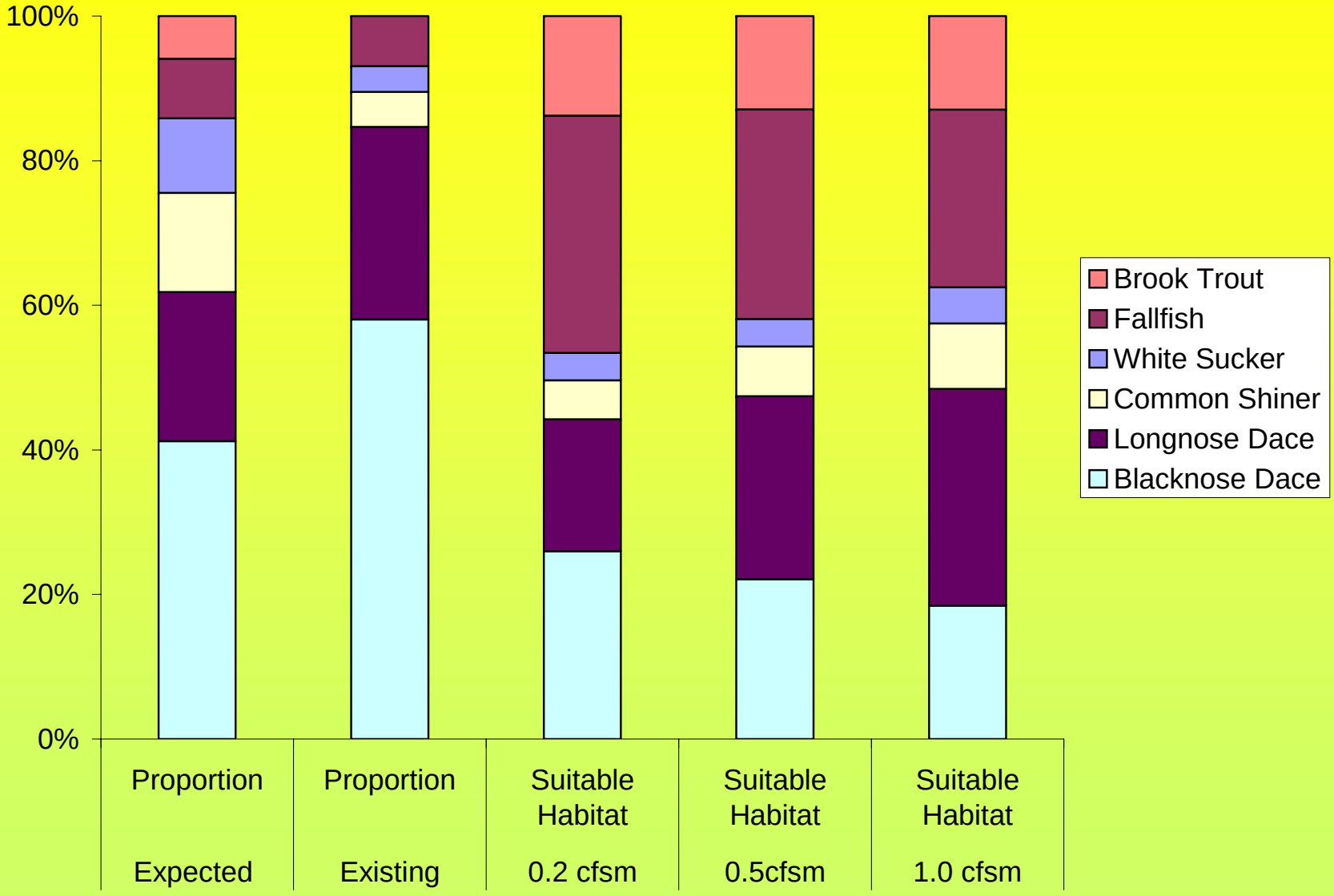
White su

se dace

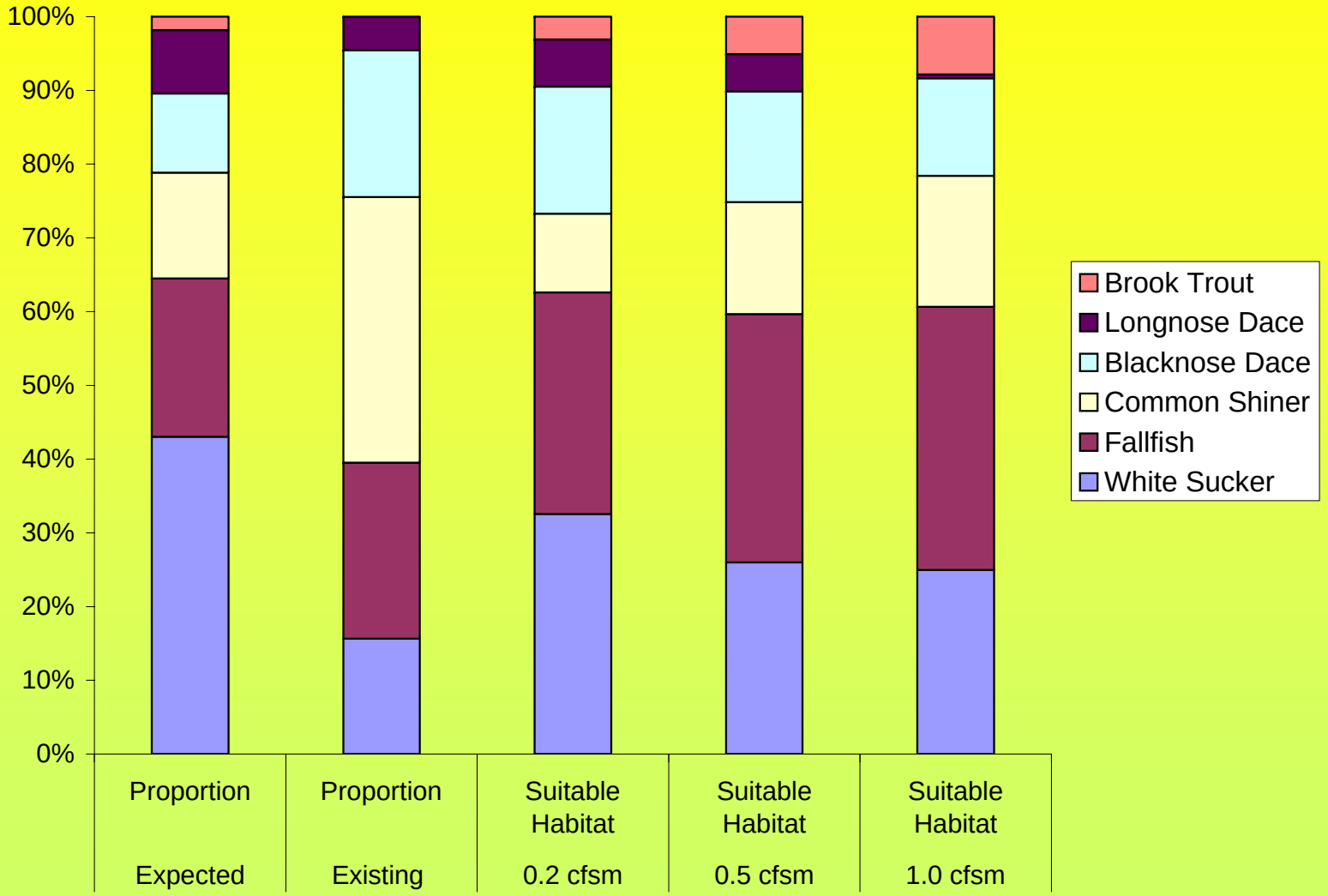
Generic Resident Adult Fish

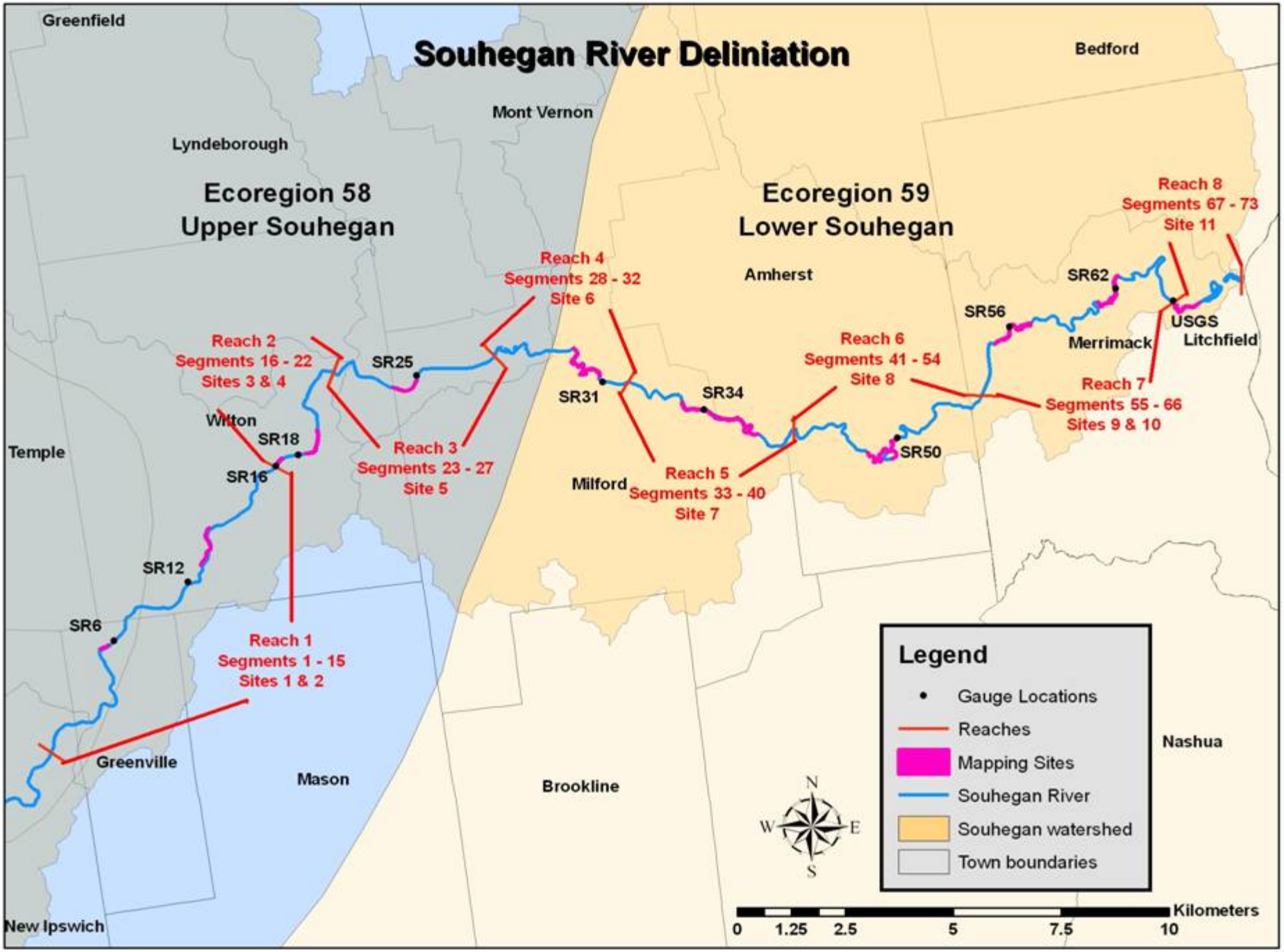
Atlantic salmon

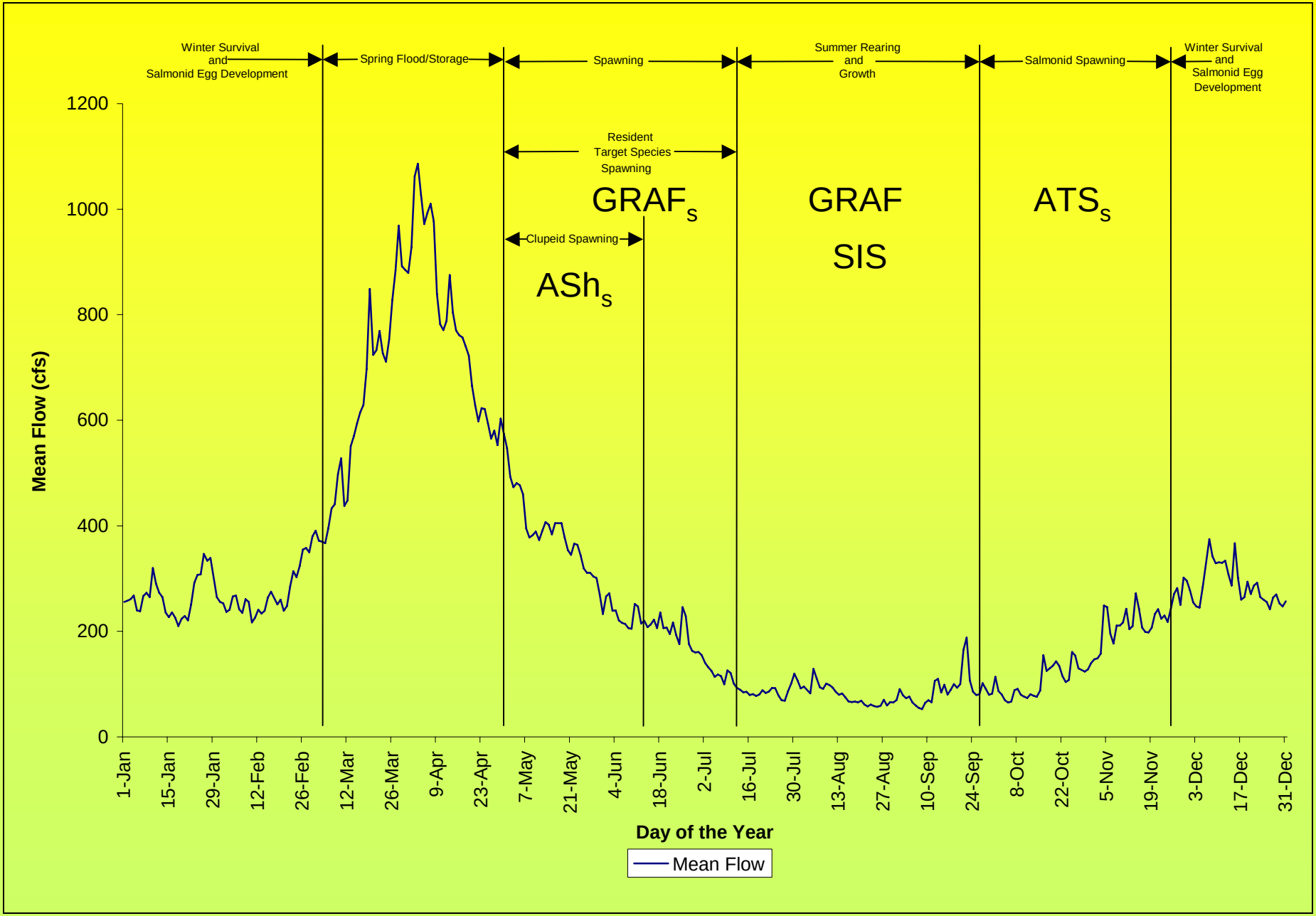
Upper Souhegan



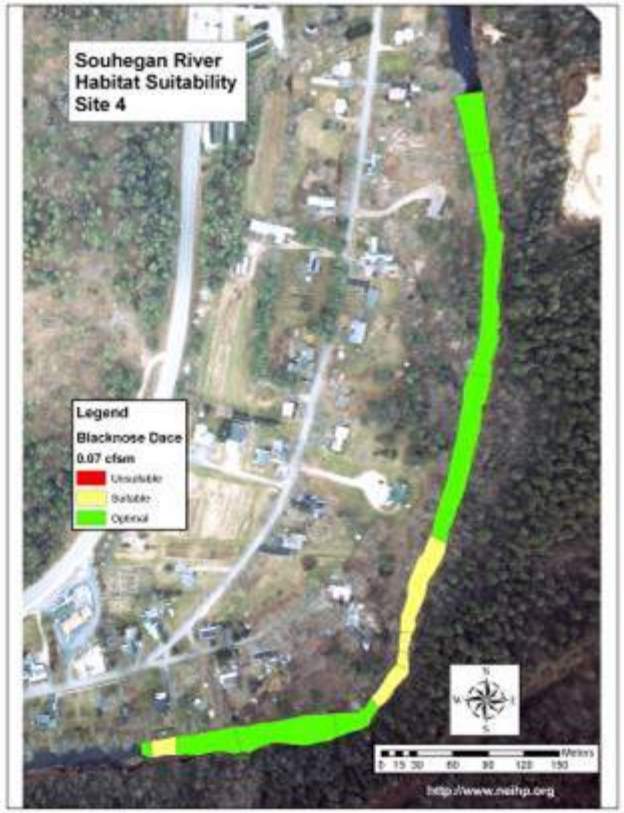
Lower Souhegan

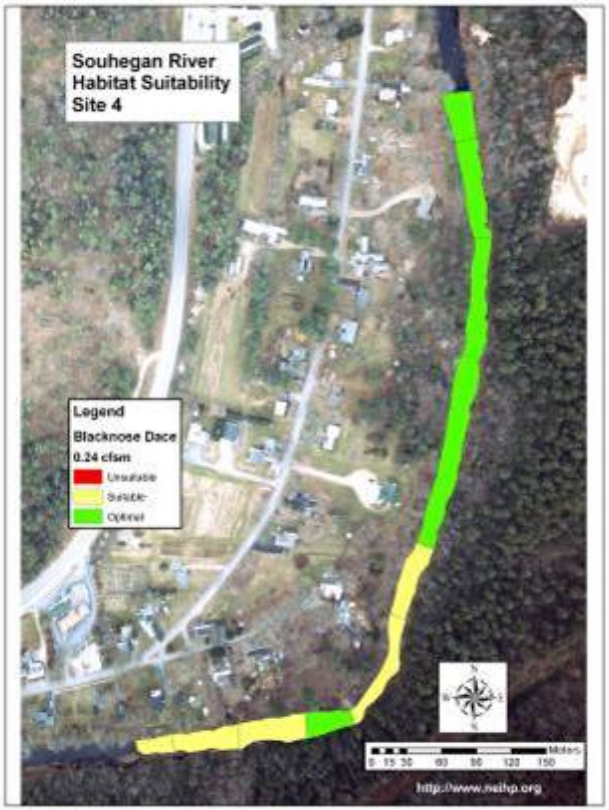


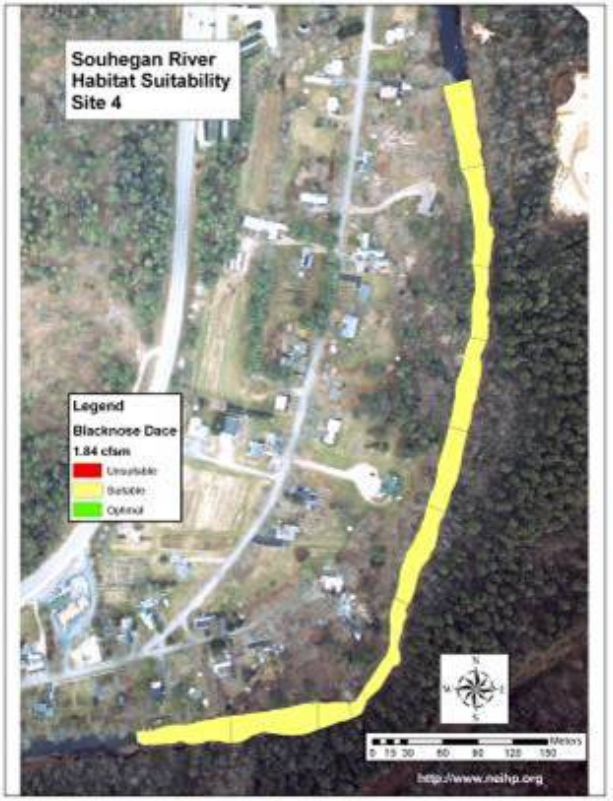

Souhegan River Deliniation
Greenfield
Bedford
Mont Vernon
Lyndeborough
Ecoregion 58
Upper Souhegan
Ecoregion 59
Lower Souhegan
Amherst
Reach 8
Segments 67 - 73
Site 11
Reach 4
Segments 28 - 32
Site 6
SR62
SR56
USGS
Litchfield
Merrimack
Reach 2
Segments 16 - 22
Sites 3 & 4
SR25
Reach 6
Segments 41 - 54
Site 8
Reach 7
Segments 55 - 66
Sites 9 & 10
SR31
SR34
Wilton
SR18
Temple
SR16
SR50
Reach 3
Segments 23 - 27
Site 5
Milford
Reach 5
Segments 33 - 40
Site 7
SR12
SR6
Reach 1
Segments 1 - 15
Sites 1 & 2
Greenville
Mason
Brookline
Nashua
New Ipswich
Legend
Gauge Locations
Reaches
Mapping Sites
Souhegan River
Souhegan watershed
Town boundaries
N
W
E
S
Kilometers
0
1.25
2.5
5
7.5
10

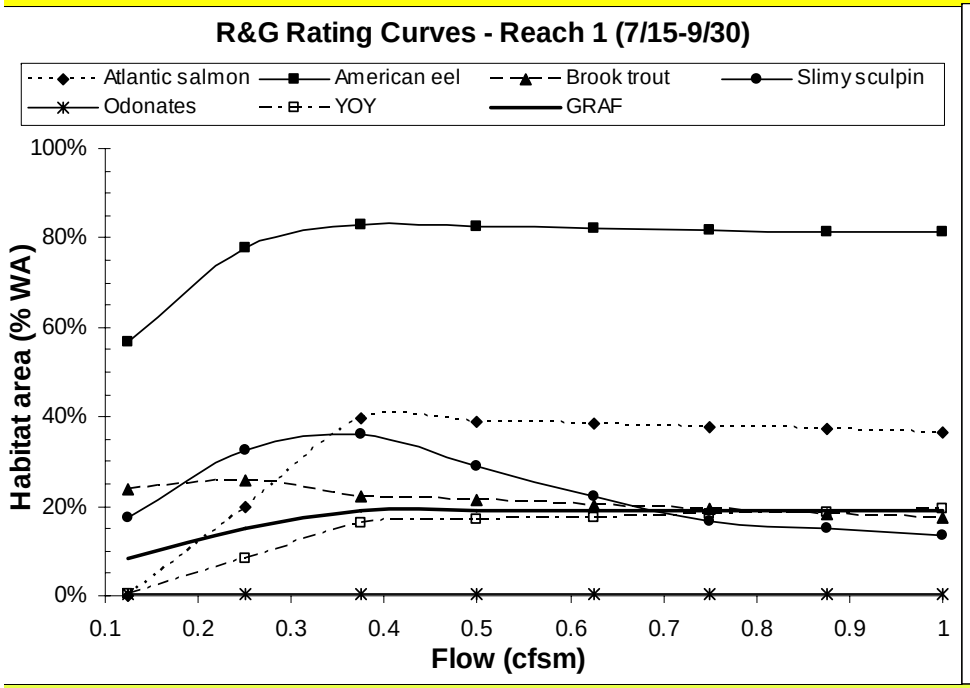

Winter Survival and Salmonid Egg Development
Spring Flood/Storage
Spawning
Summer Rearing and Growth
Salmonid Spawning
Winter Survival and Salmonid Egg Development
Resident Target Species Spawning
Clupeid Spawning
GRAF$_s$
GRAF
ATS$_s$
ASh$_s$
SIS
Mean Flow (cfs)
0
200
400
600
800
1000
1200
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
Day of the Year
Mean Flow

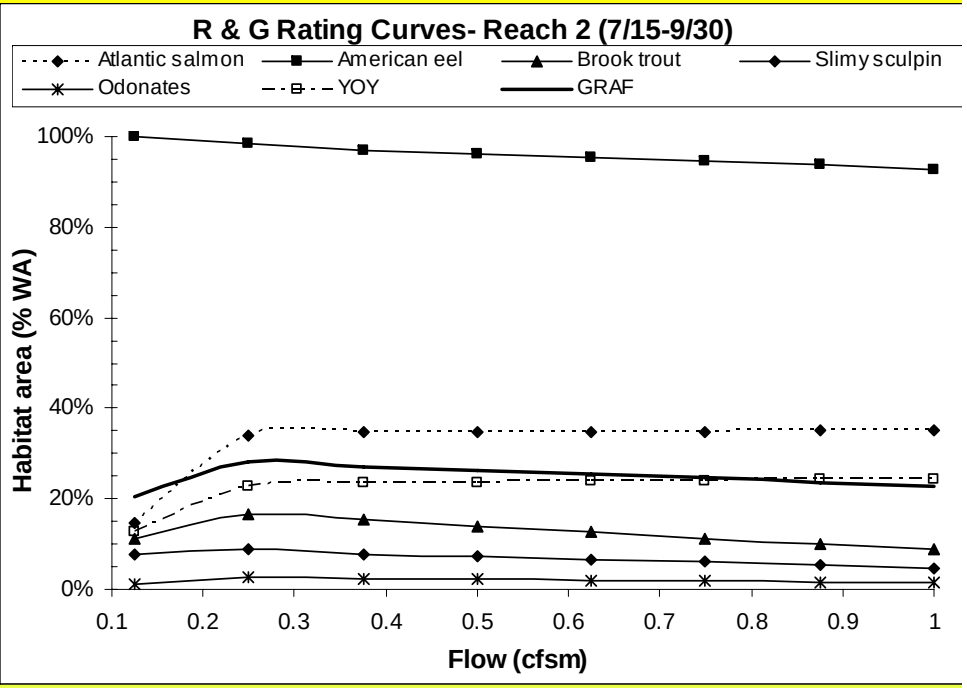
Site 4 Suitability: Blacknose Dace

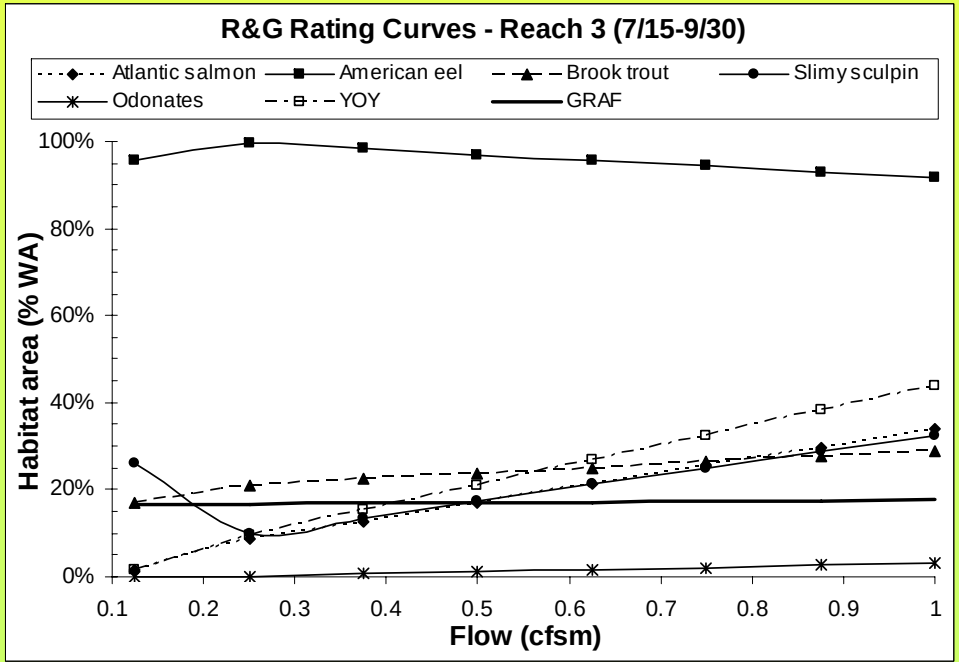


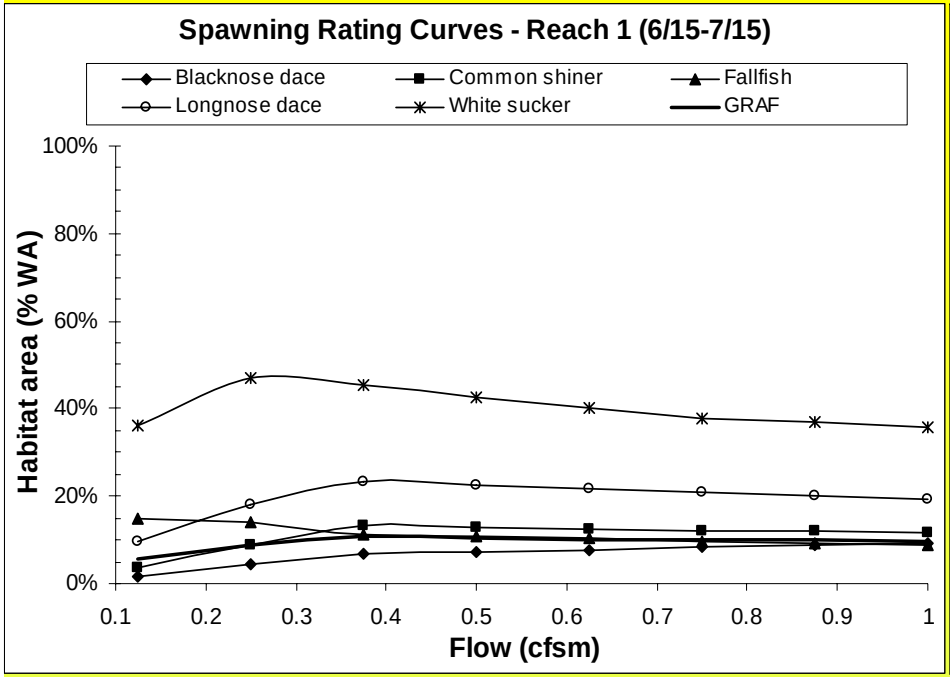


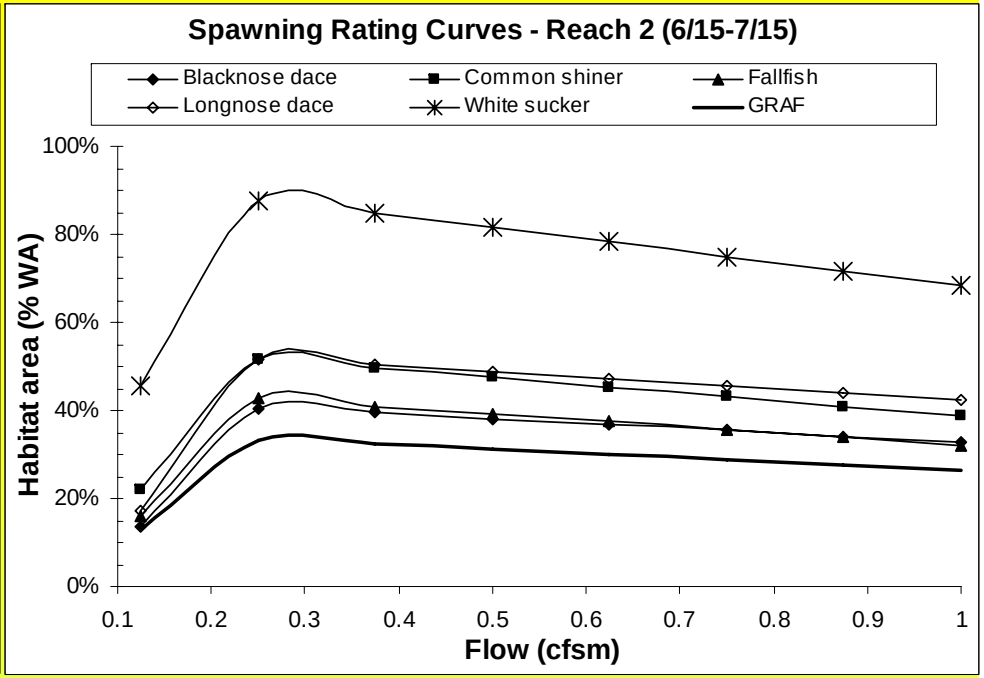


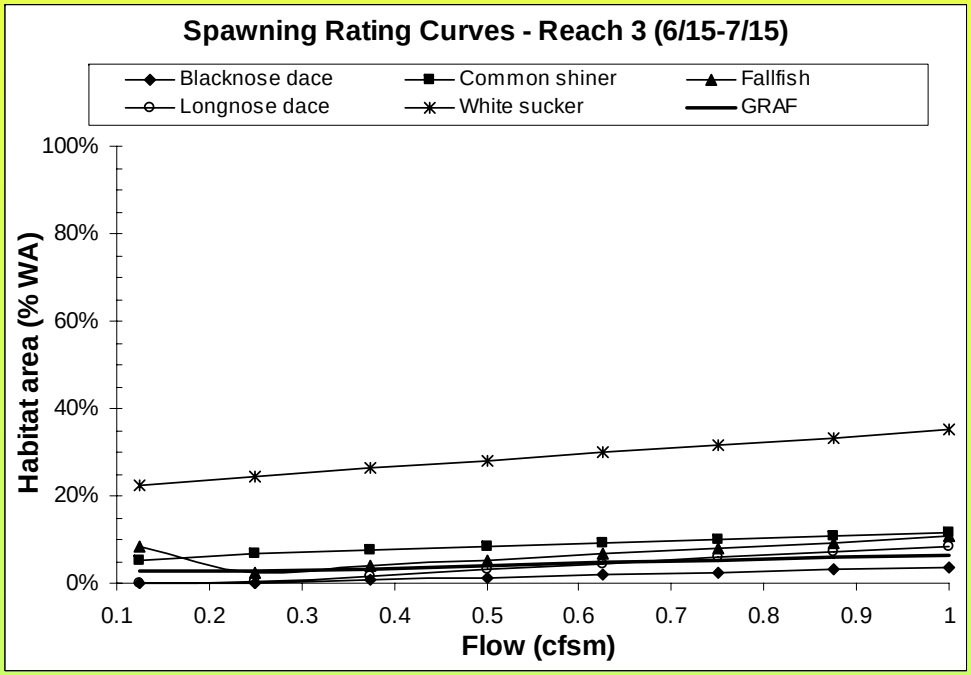

R&G Rating Curves - Reach 1 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Slimy sculpin
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

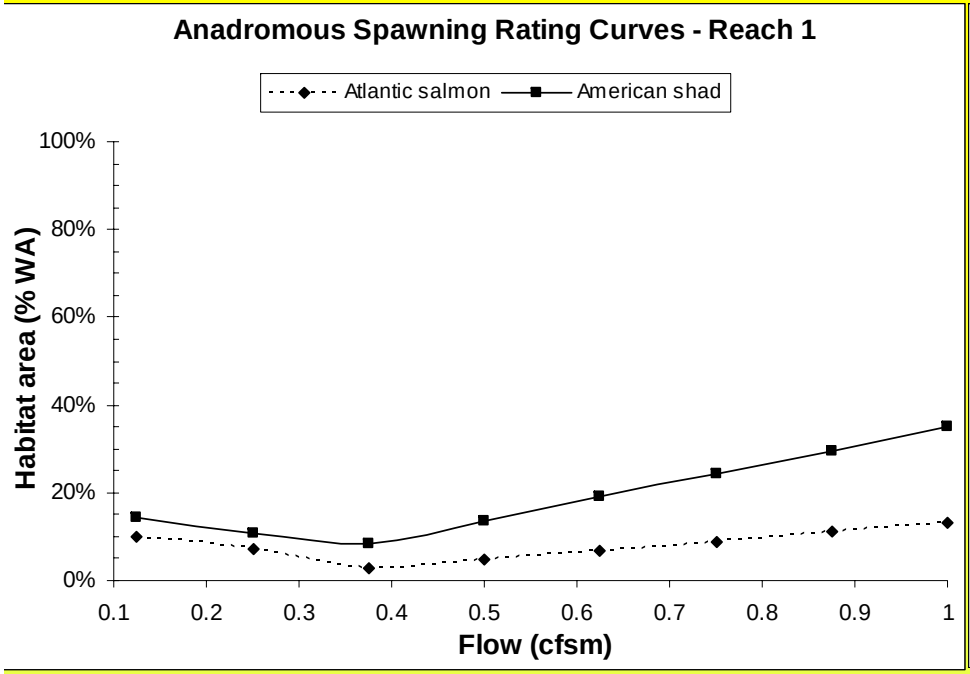

R & G Rating Curves- Reach 2 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Slimy sculpin
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

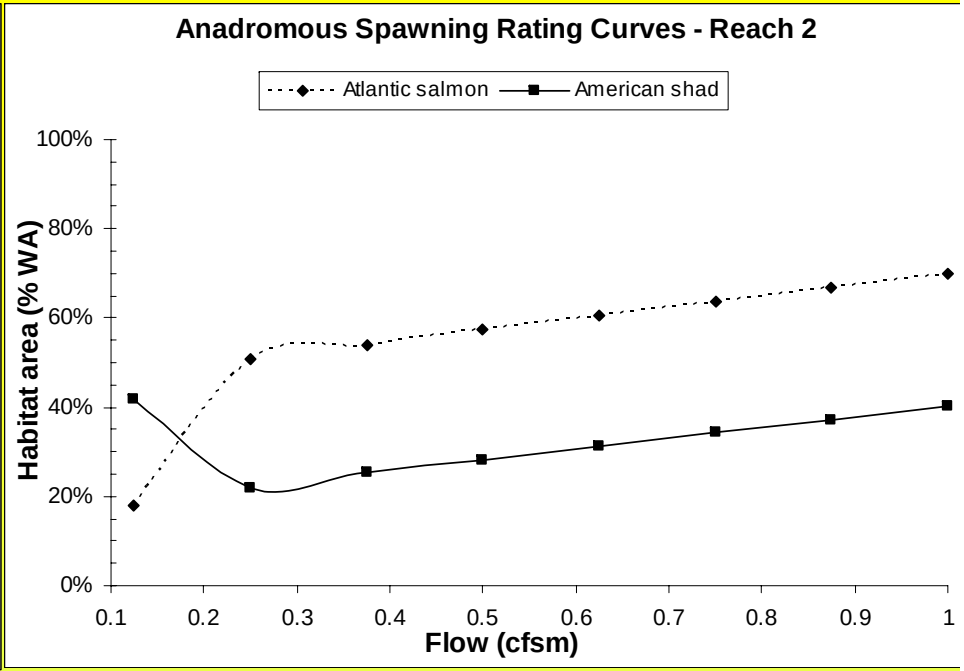

R&G Rating Curves - Reach 3 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Slimy sculpin
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

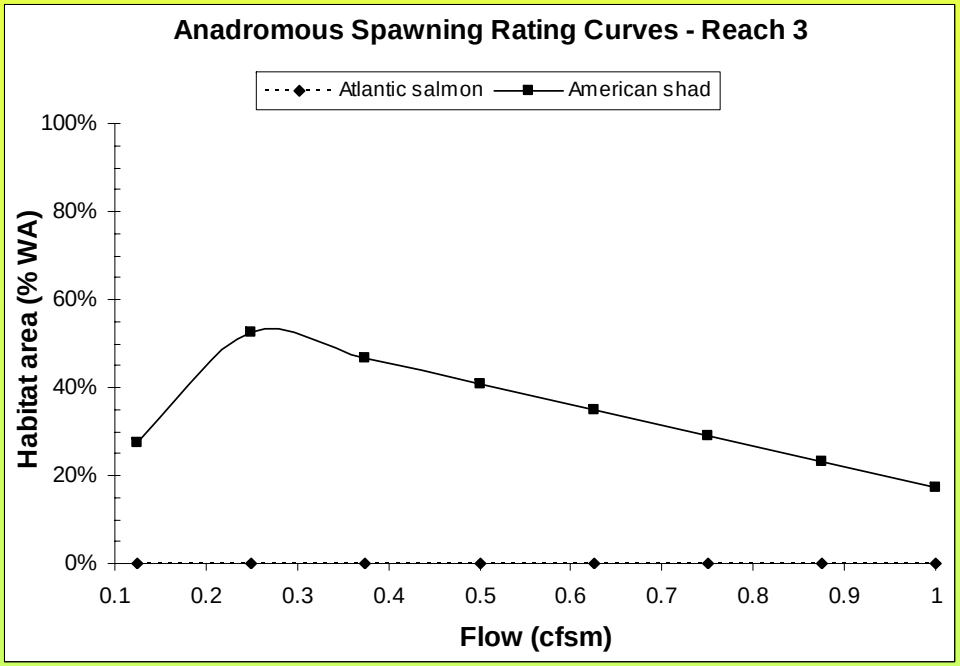

Spawning Rating Curves - Reach 1 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

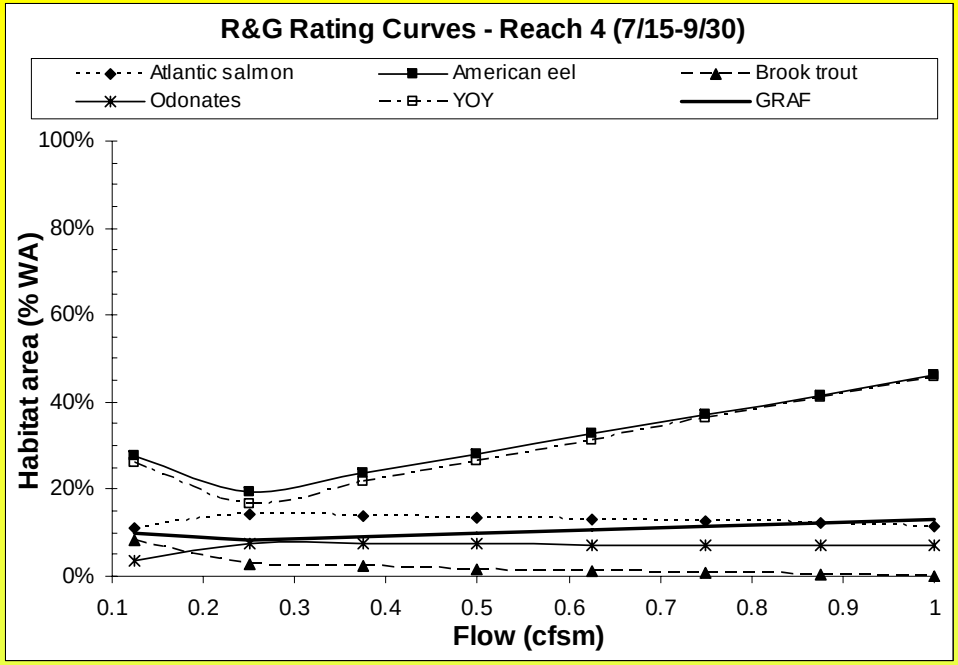

Spawning Rating Curves - Reach 2 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

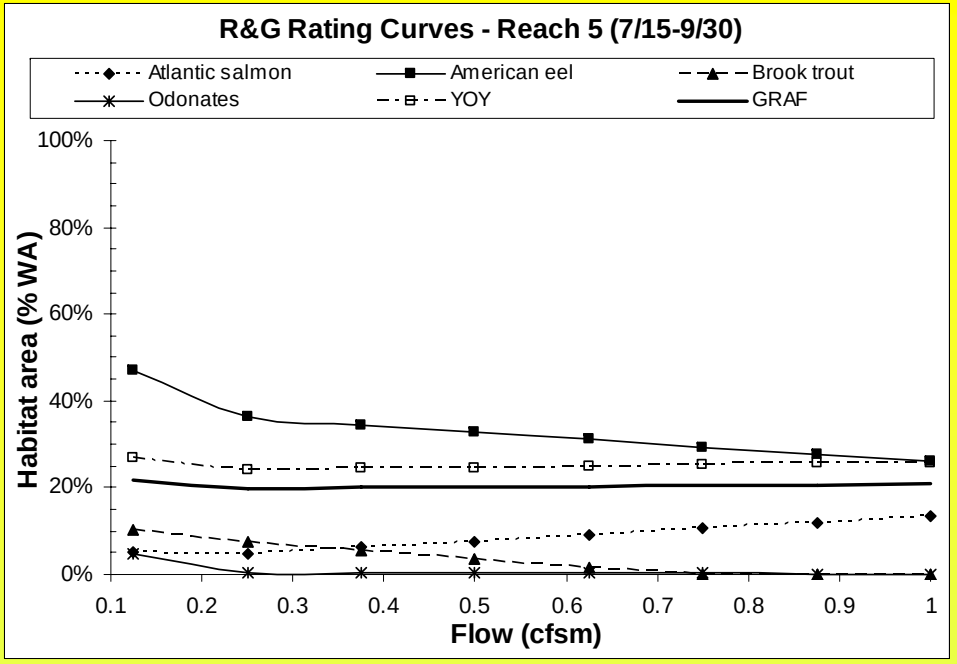

Spawning Rating Curves - Reach 3 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

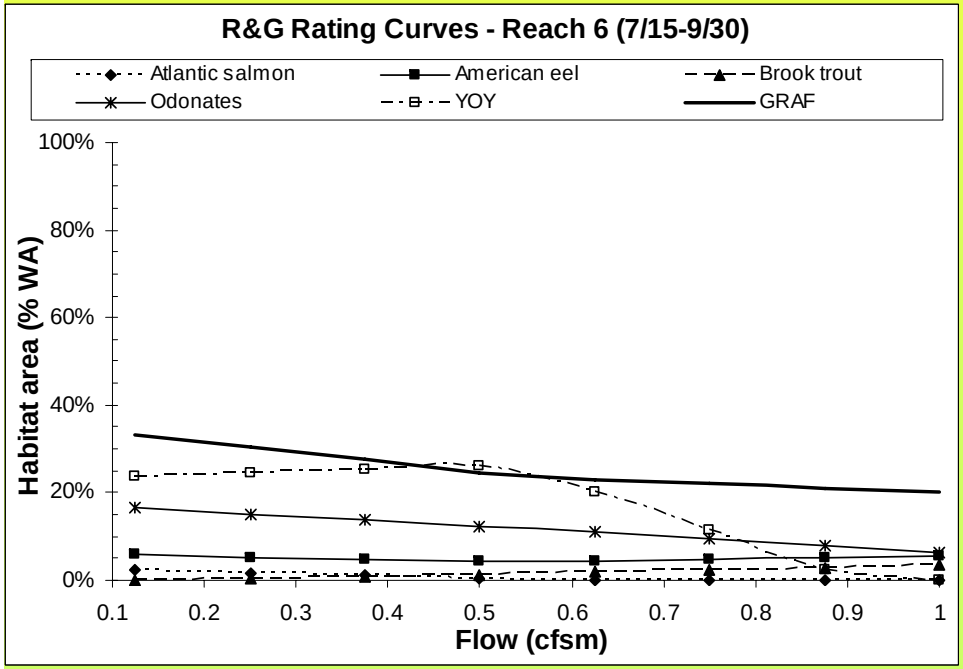

Anadromous Spawning Rating Curves - Reach 1
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

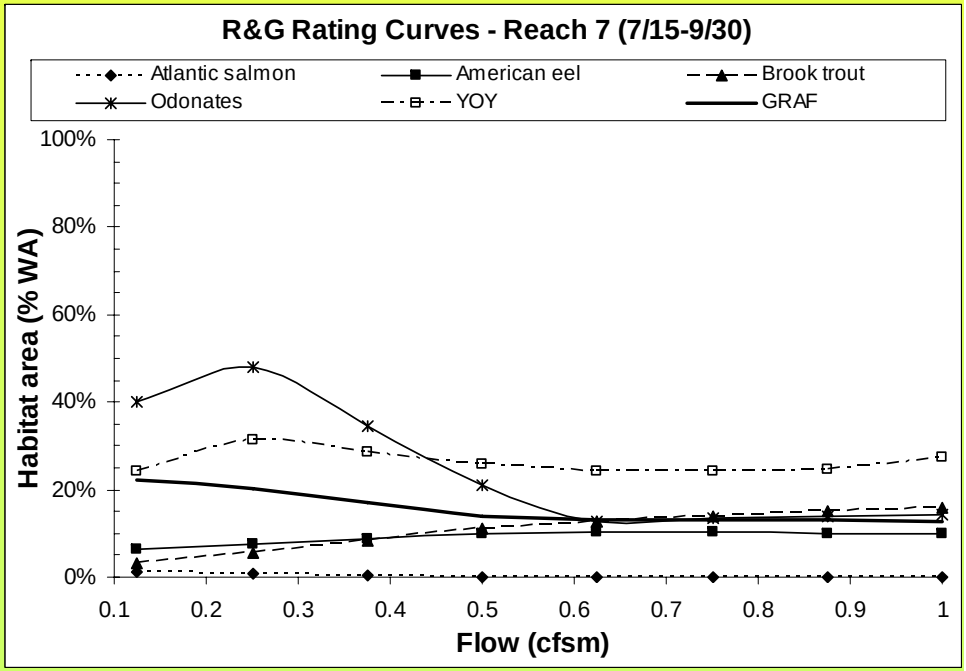

Anadromous Spawning Rating Curves - Reach 2
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

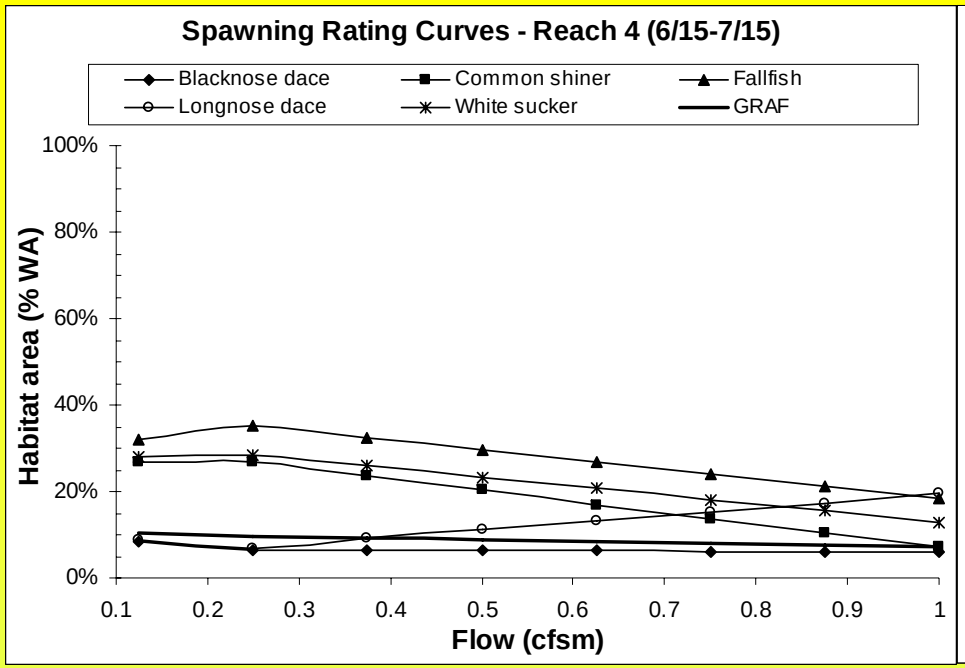

Anadromous Spawning Rating Curves - Reach 3
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

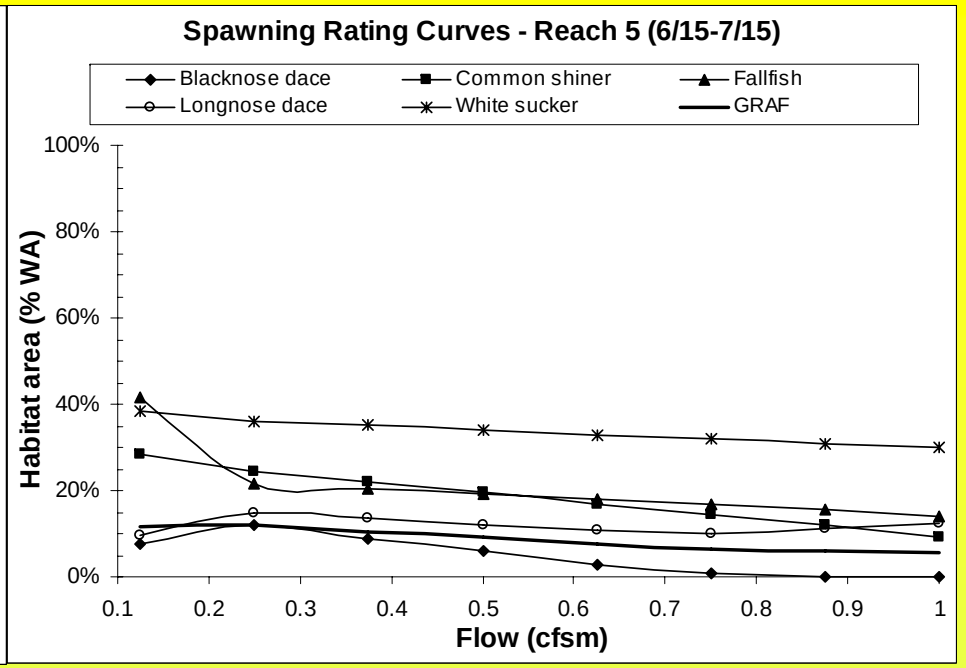

R&G Rating Curves - Reach 4 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

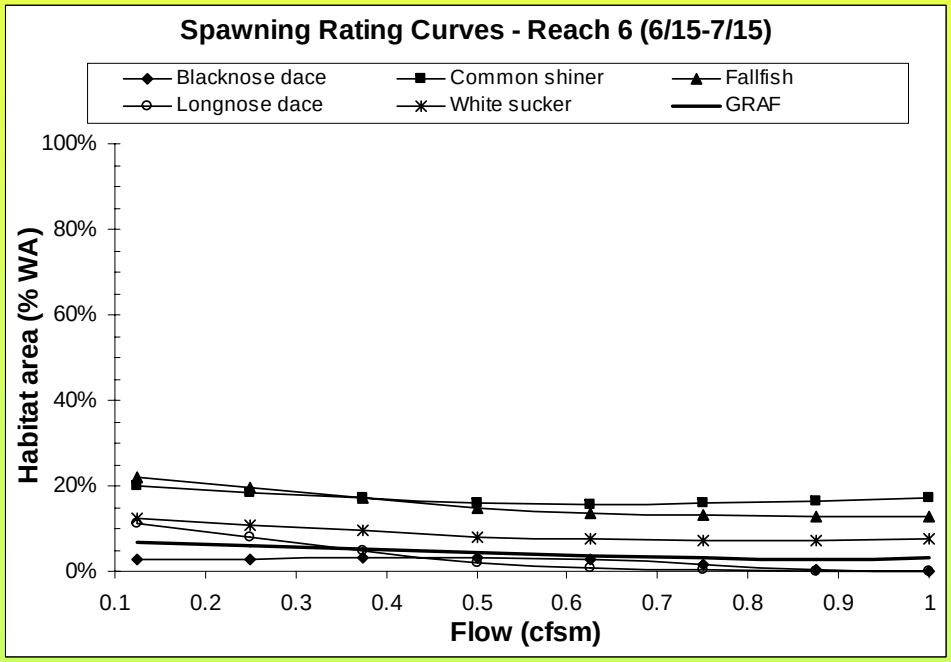

R&G Rating Curves - Reach 5 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

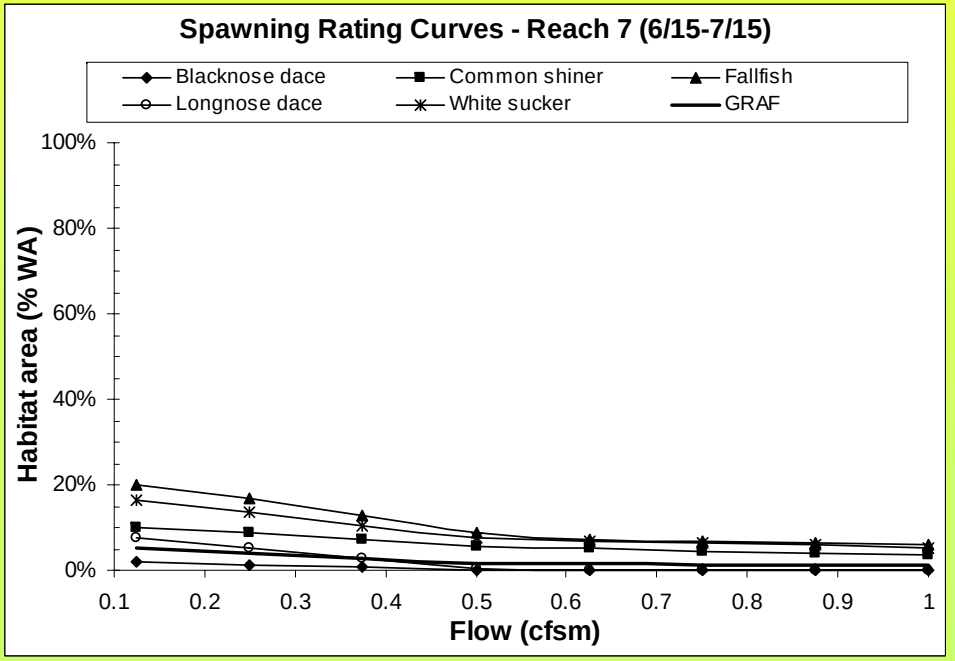

R&G Rating Curves - Reach 6 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

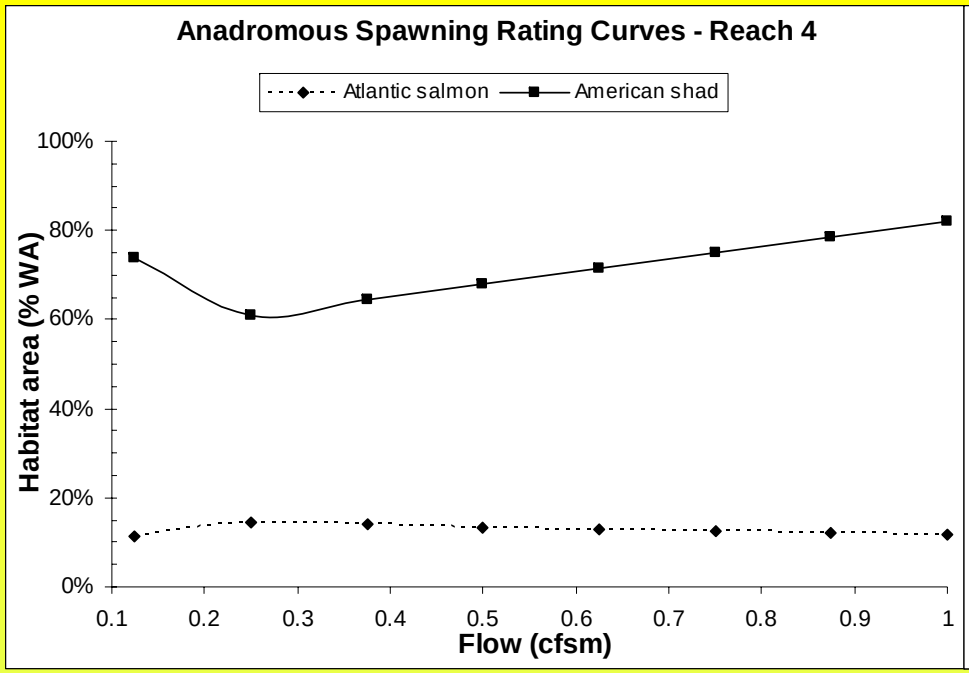

R&G Rating Curves - Reach 7 (7/15-9/30)
Atlantic salmon
American eel
Brook trout
Odonates
YOY
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

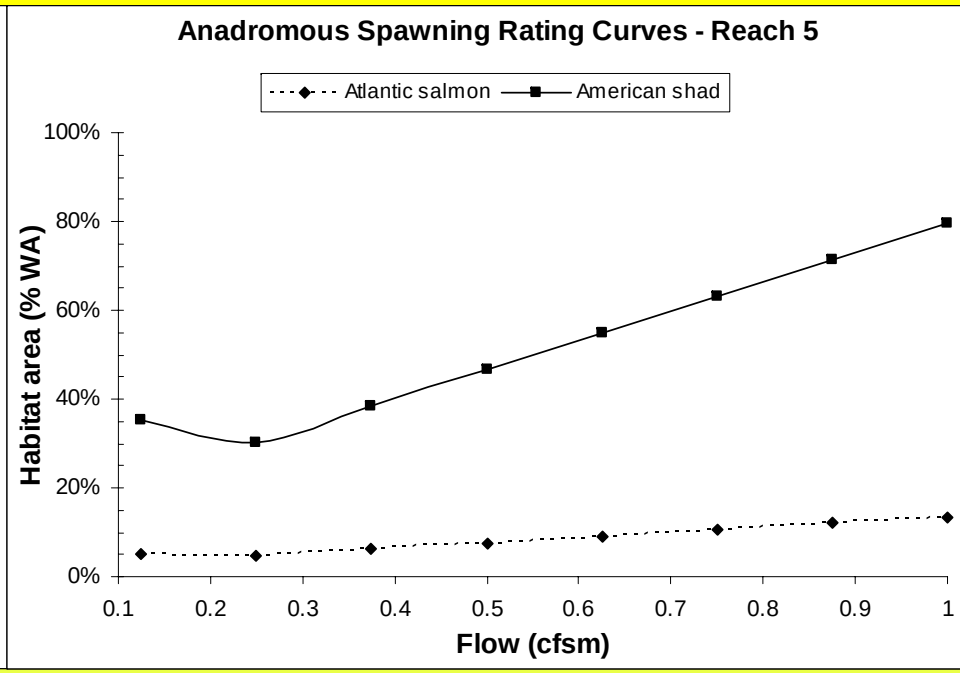

Spawning Rating Curves - Reach 4 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

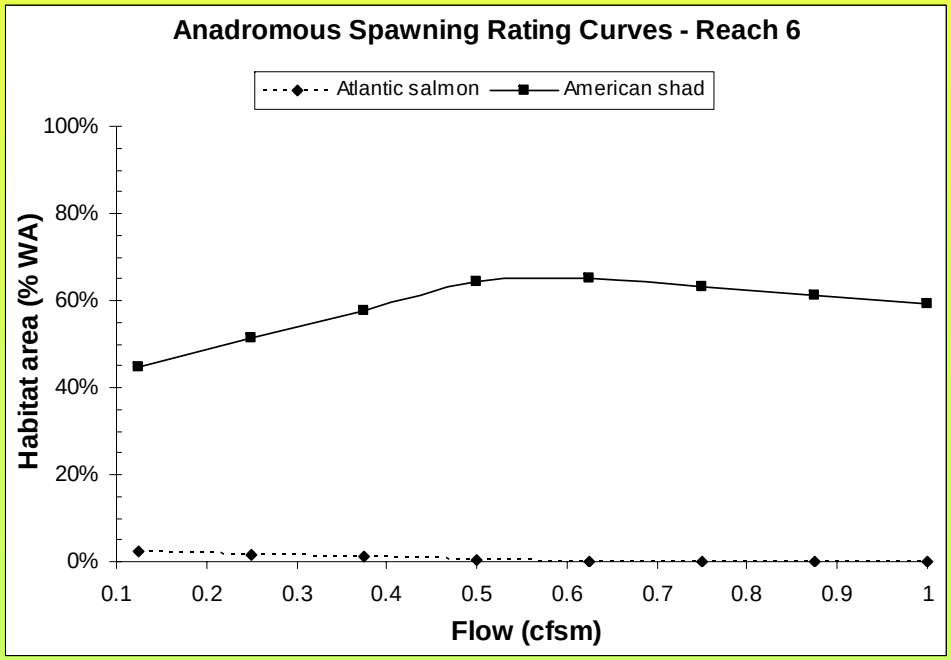

Spawning Rating Curves - Reach 5 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

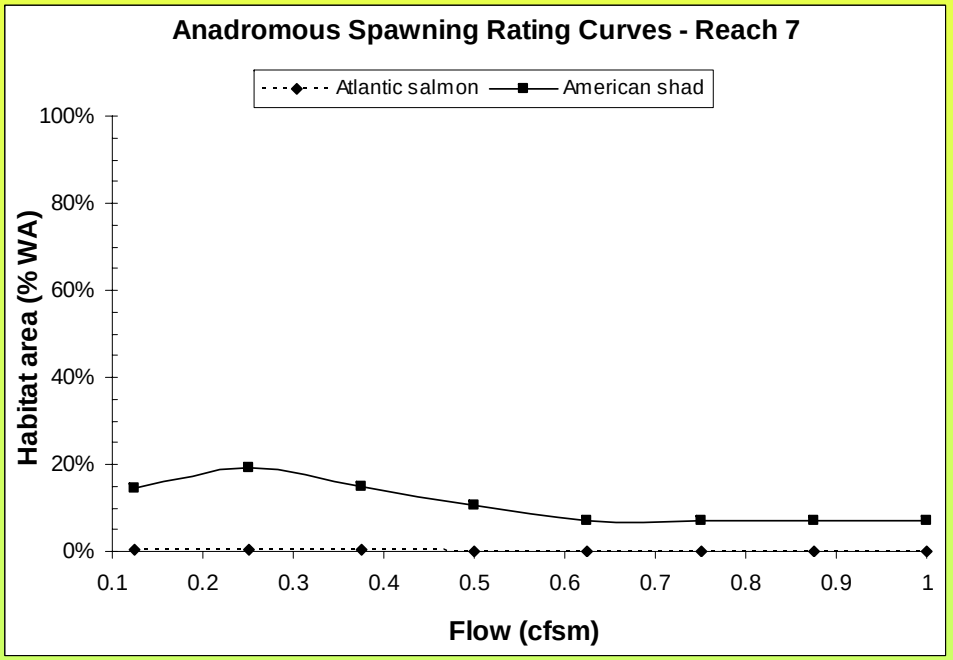

Spawning Rating Curves - Reach 6 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

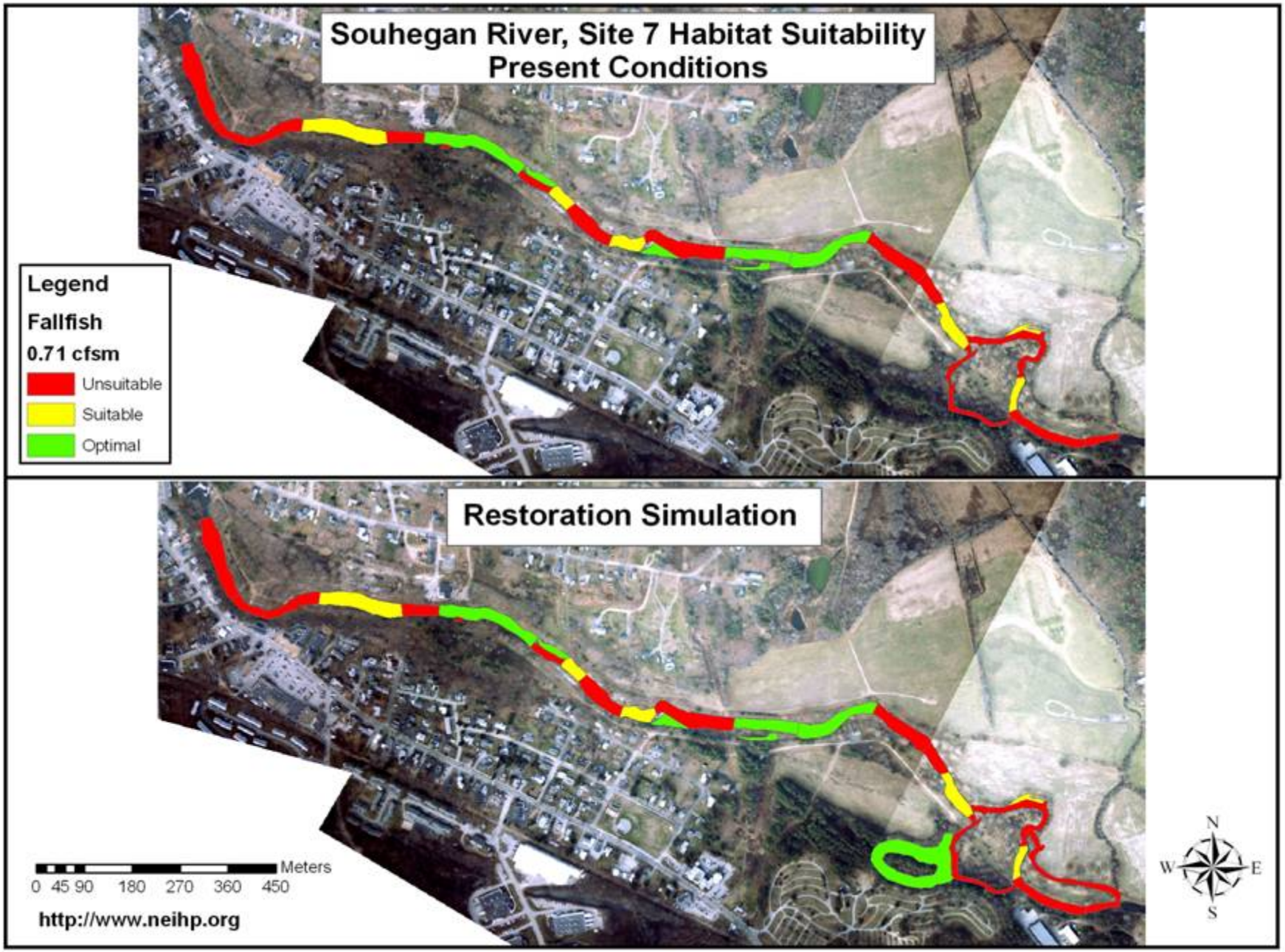

Spawning Rating Curves - Reach 7 (6/15-7/15)
Blacknose dace
Common shiner
Fallfish
Longnose dace
White sucker
GRAF
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

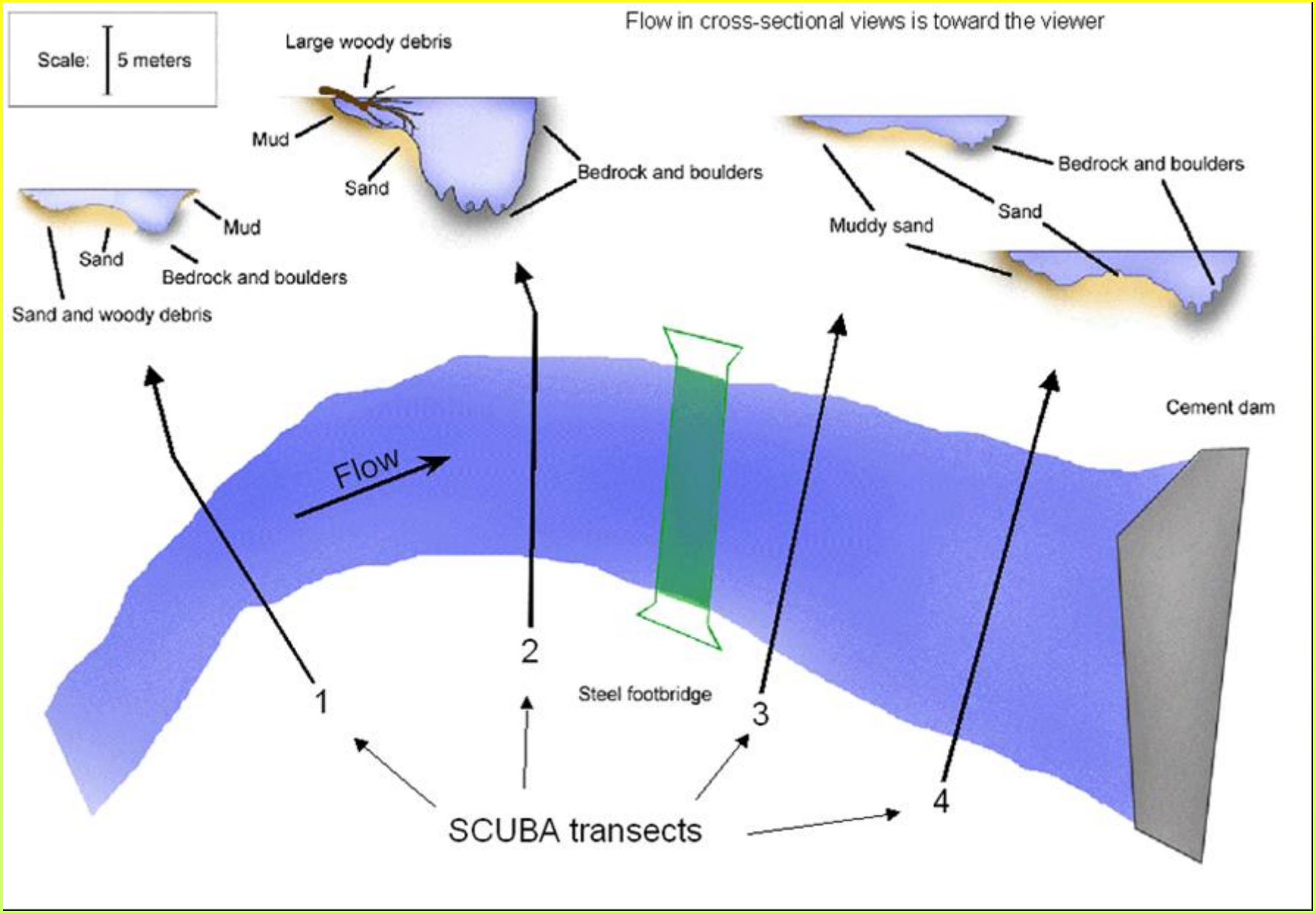

Anadromous Spawning Rating Curves - Reach 4
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)


Anadromous Spawning Rating Curves - Reach 5
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

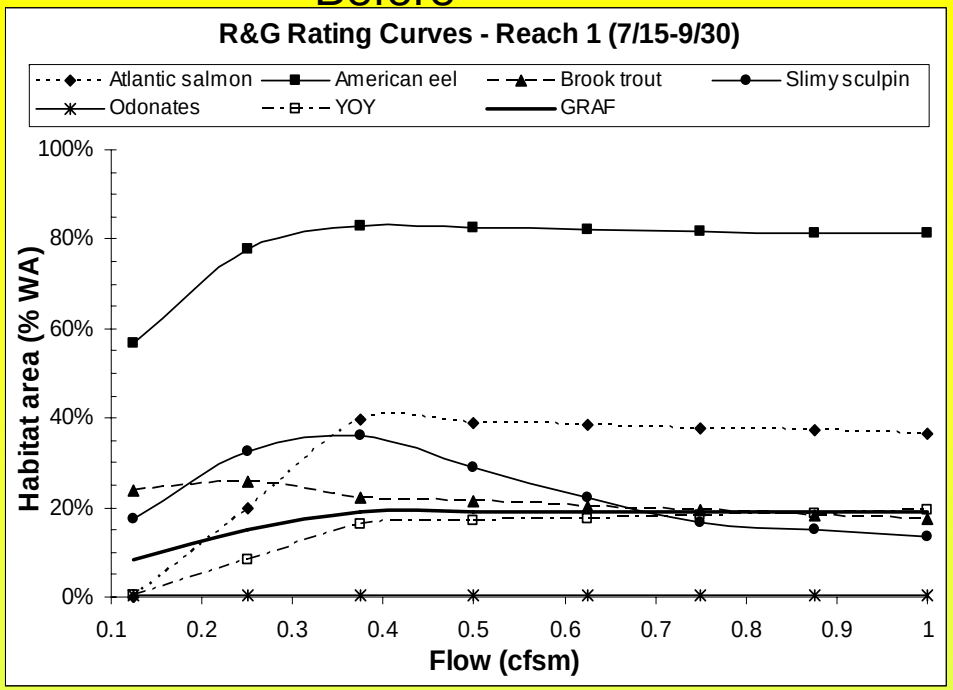

Anadromous Spawning Rating Curves - Reach 6
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)


Anadromous Spawning Rating Curves - Reach 7
Atlantic salmon
American shad
Habitat area (% WA)
100%
80%
60%
40%
20%
0%
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Flow (cfsm)

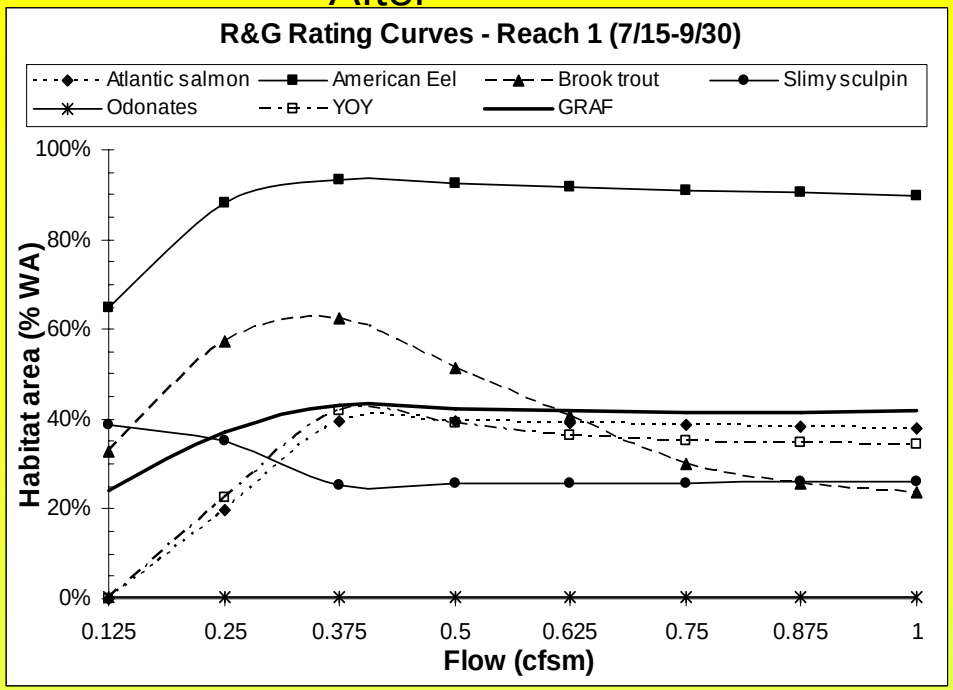

Souhegan River, Site 7 Habitat Suitability
Present Conditions
Legend
Fallfish
0.71 cfsm
Unsuitable
Suitable
Optimal
Restoration Simulation
Meters
0 45 90 180 270 360 450
http://www.neihp.org
N
W
E
S

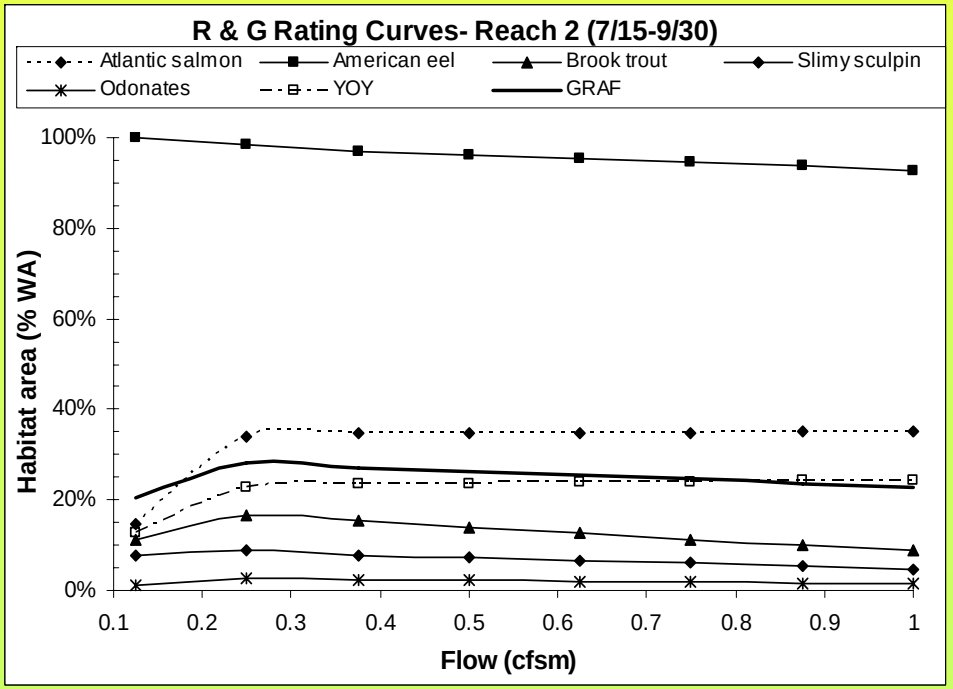

Scale: 5 meters
Flow in cross-sectional views is toward the viewer
Large woody debris
Mud
Sand
Bedrock and boulders
Mud
Sand
Bedrock and boulders
Sand and woody debris
Bedrock and boulders
Muddy sand
Sand
Flow
Cement dam
1
2
Steel footbridge
3
4
SCUBA transects

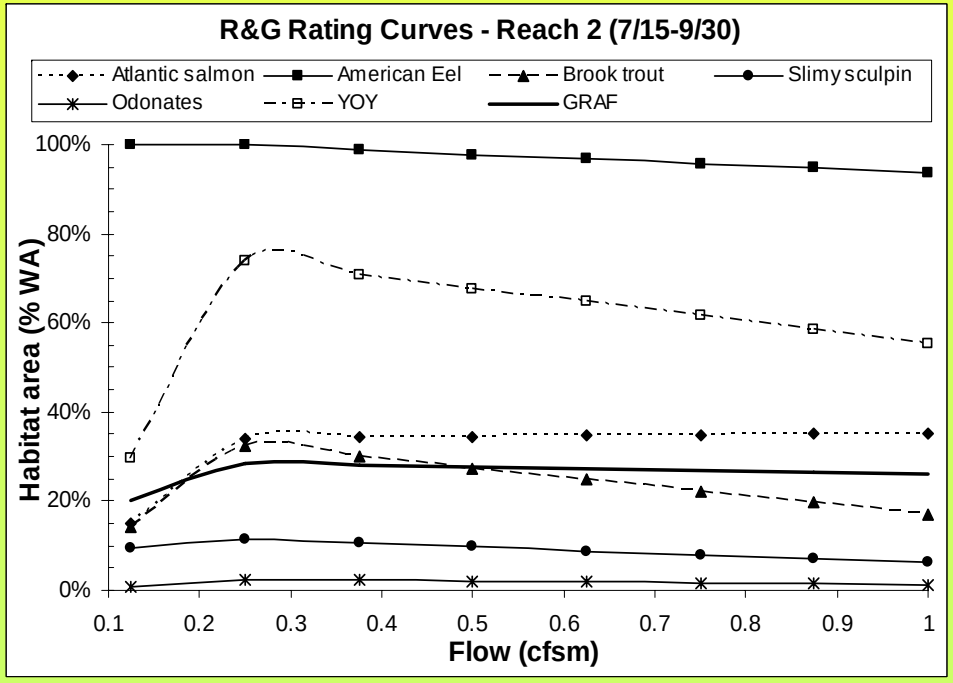
Before



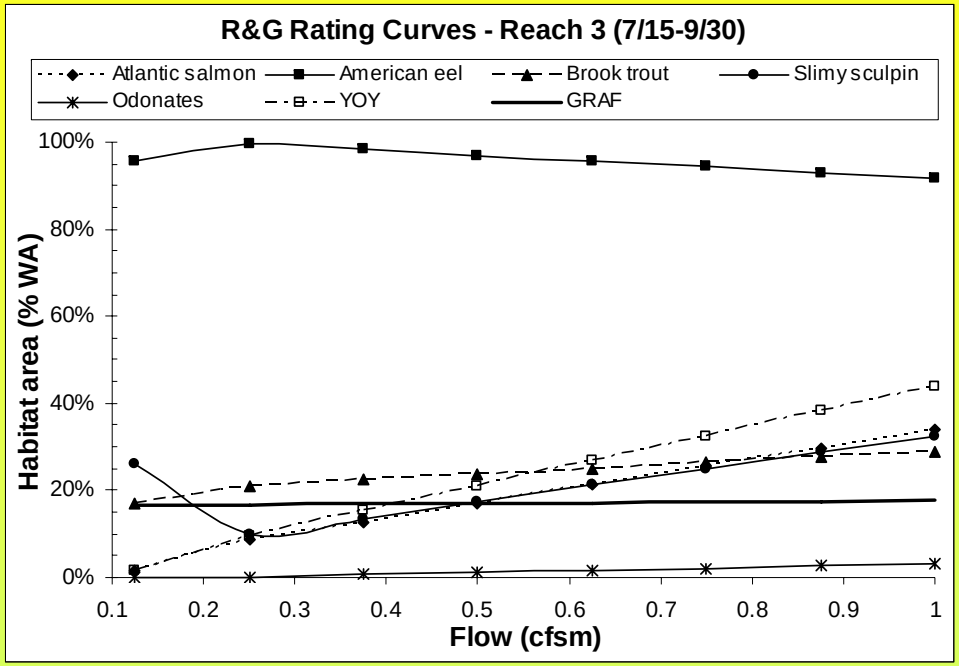
After



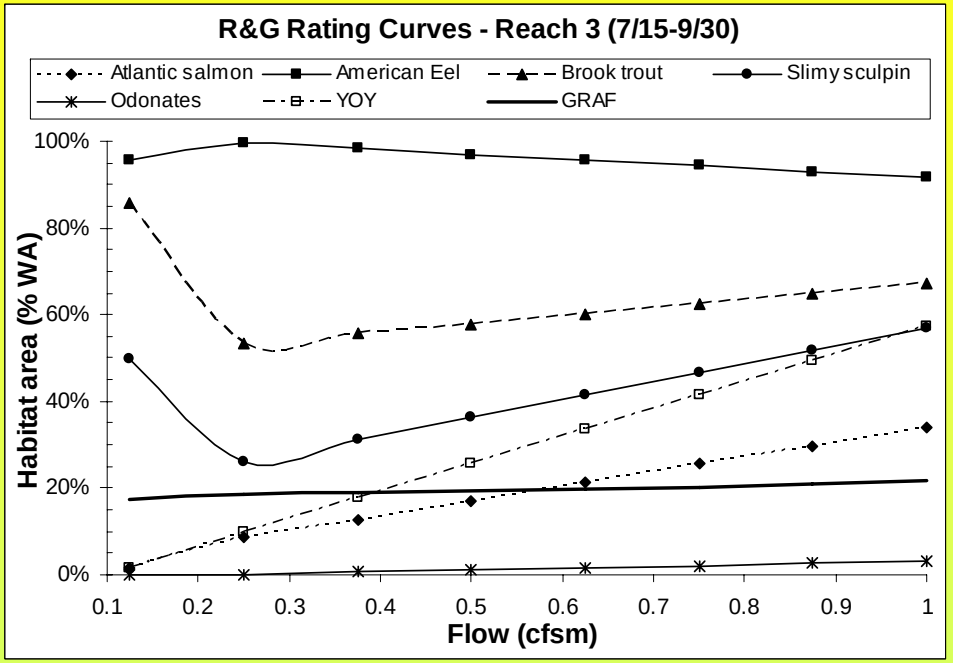




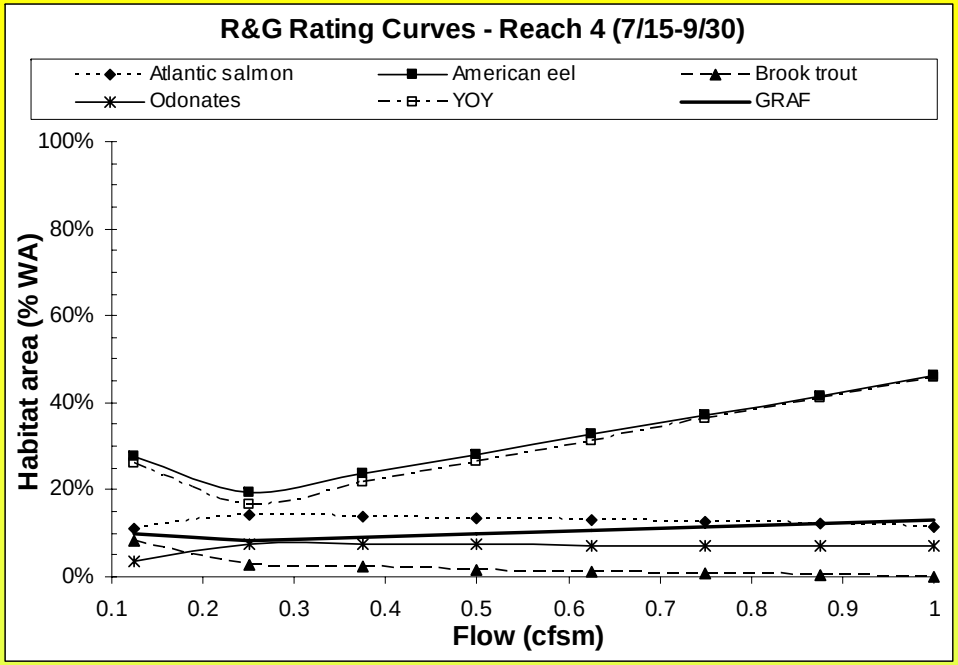
Before



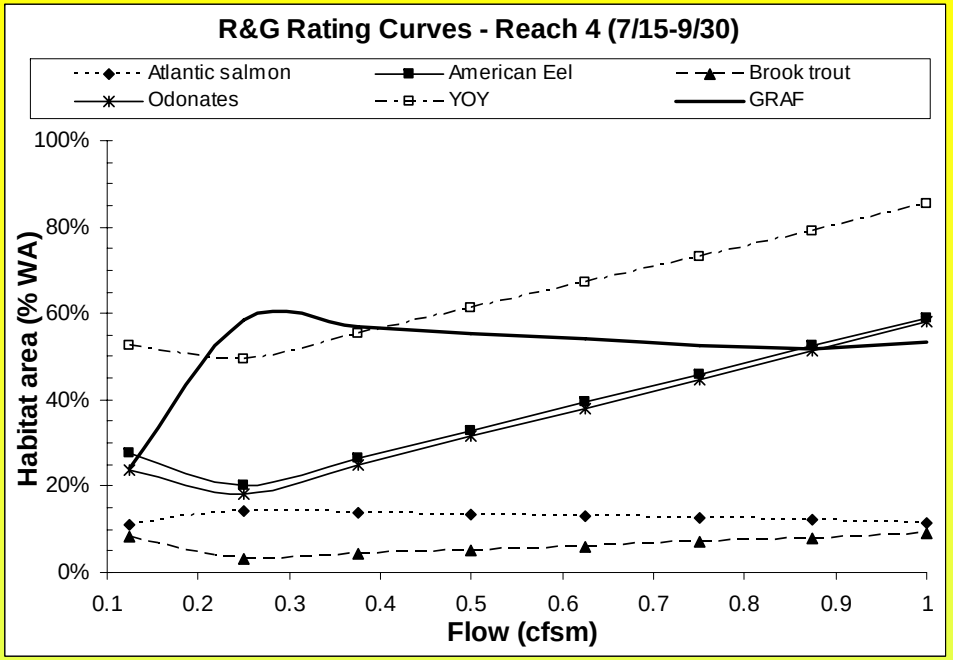
After

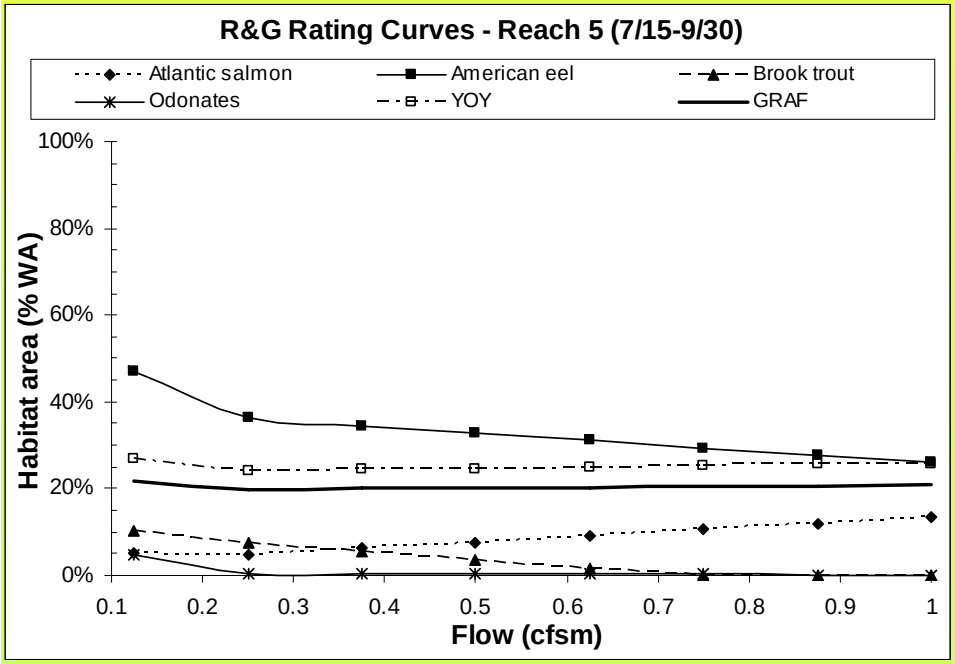


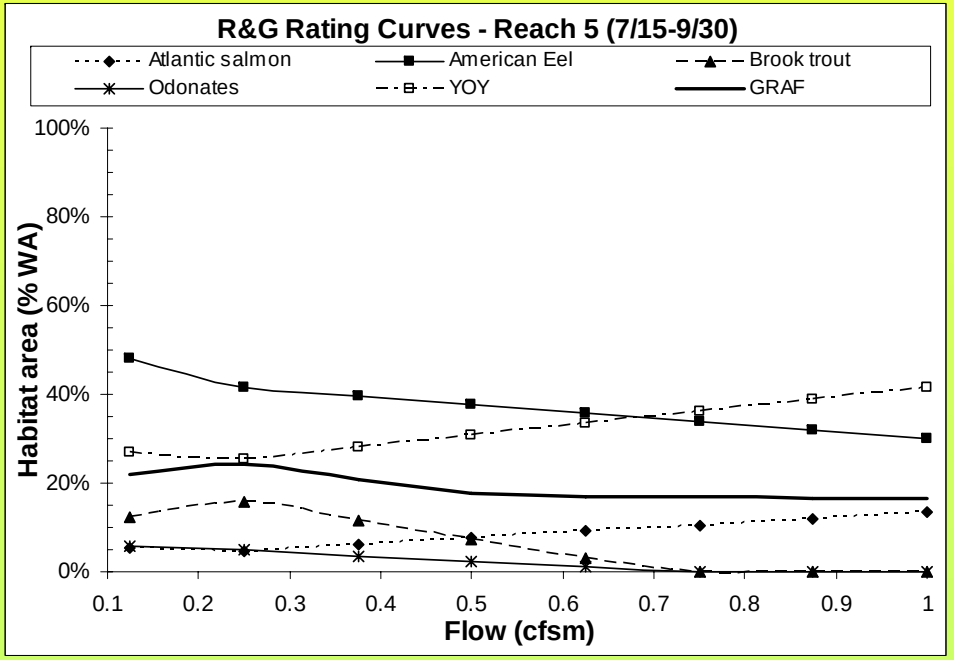
Before



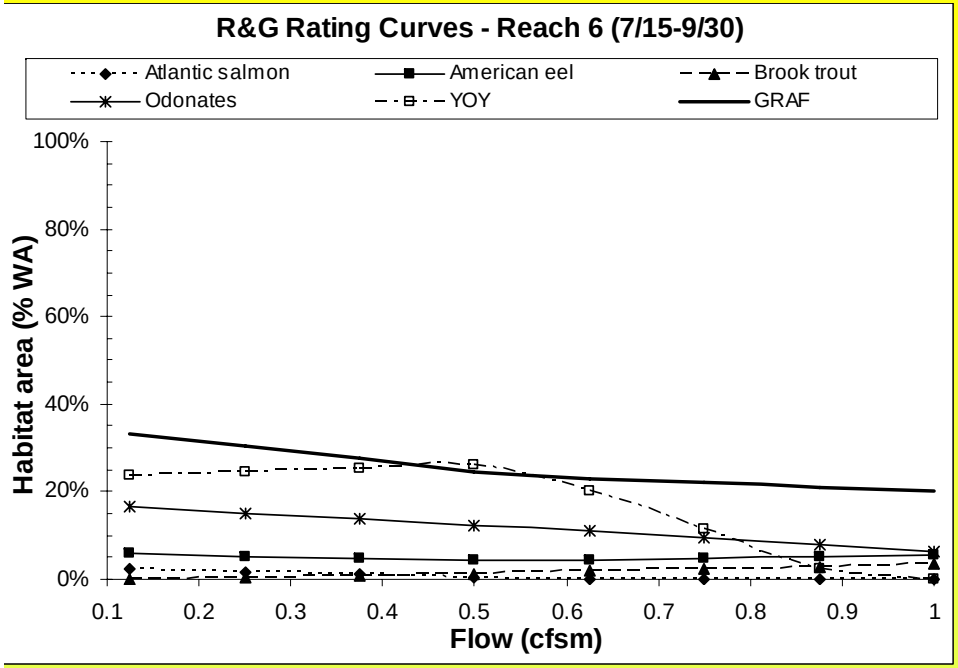
After



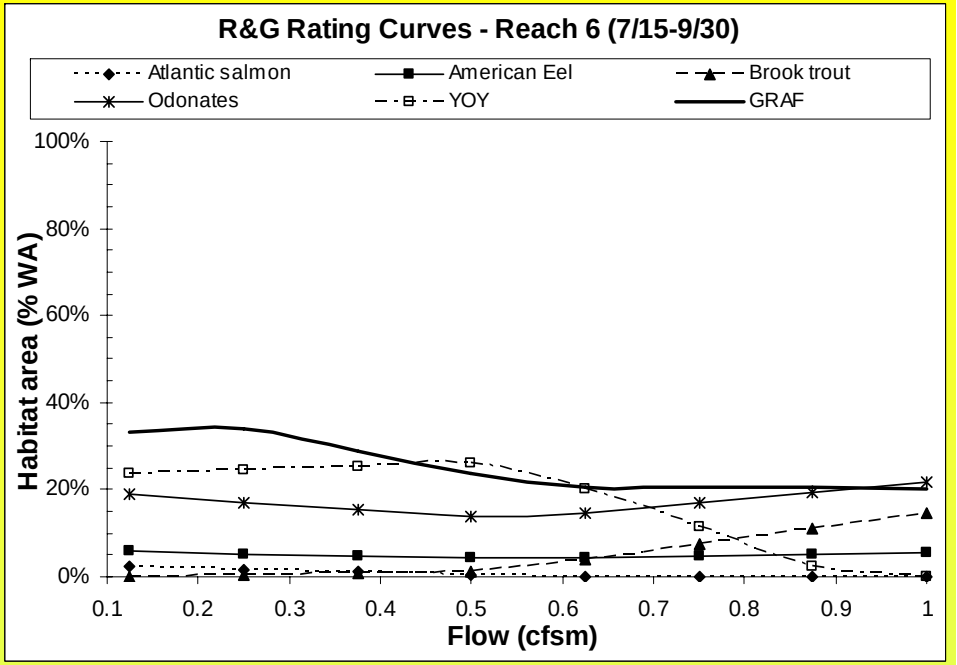


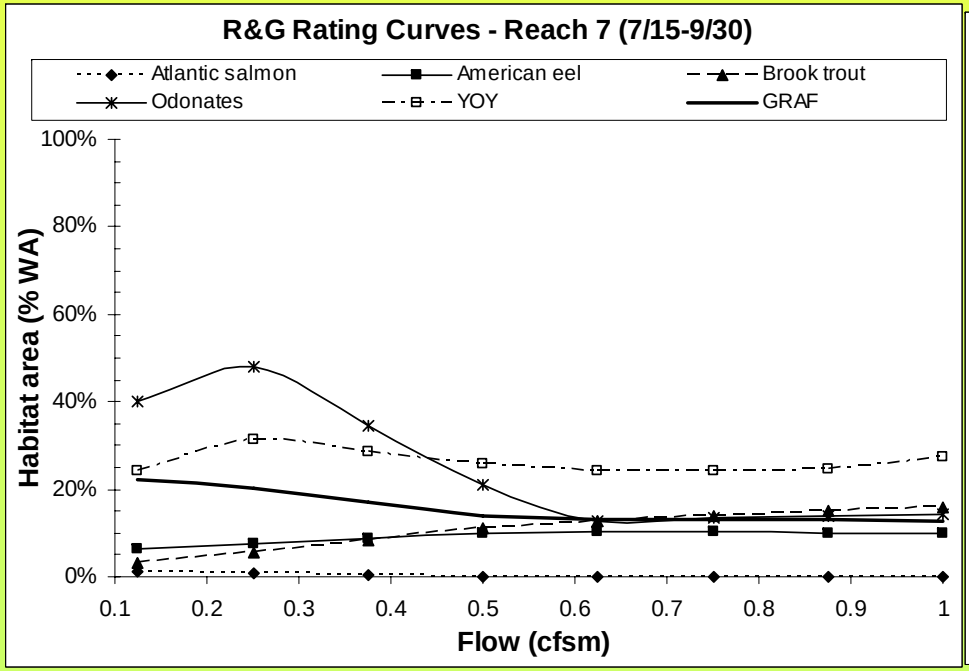


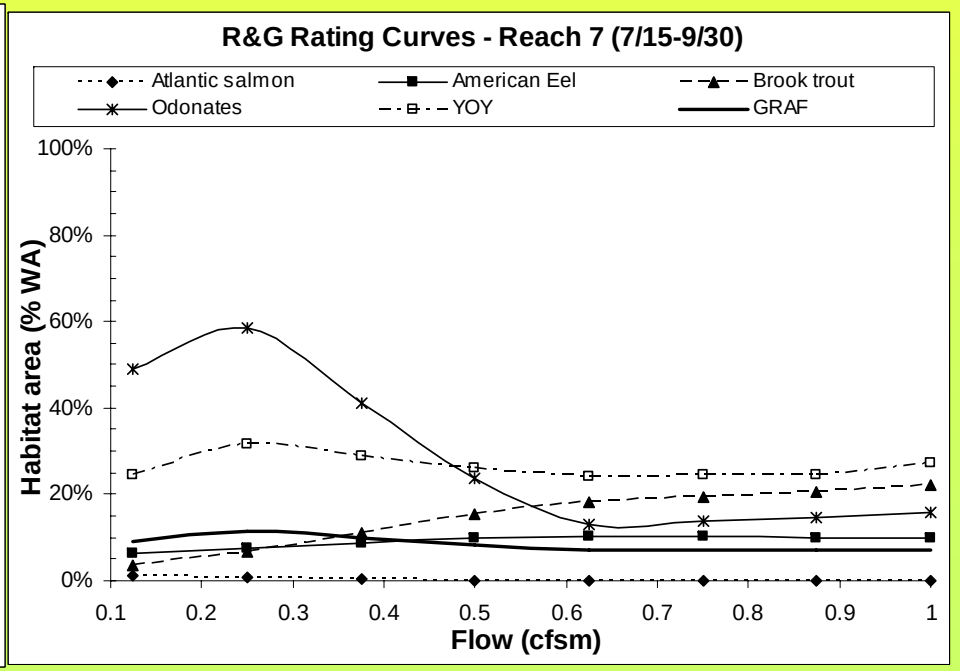
Before

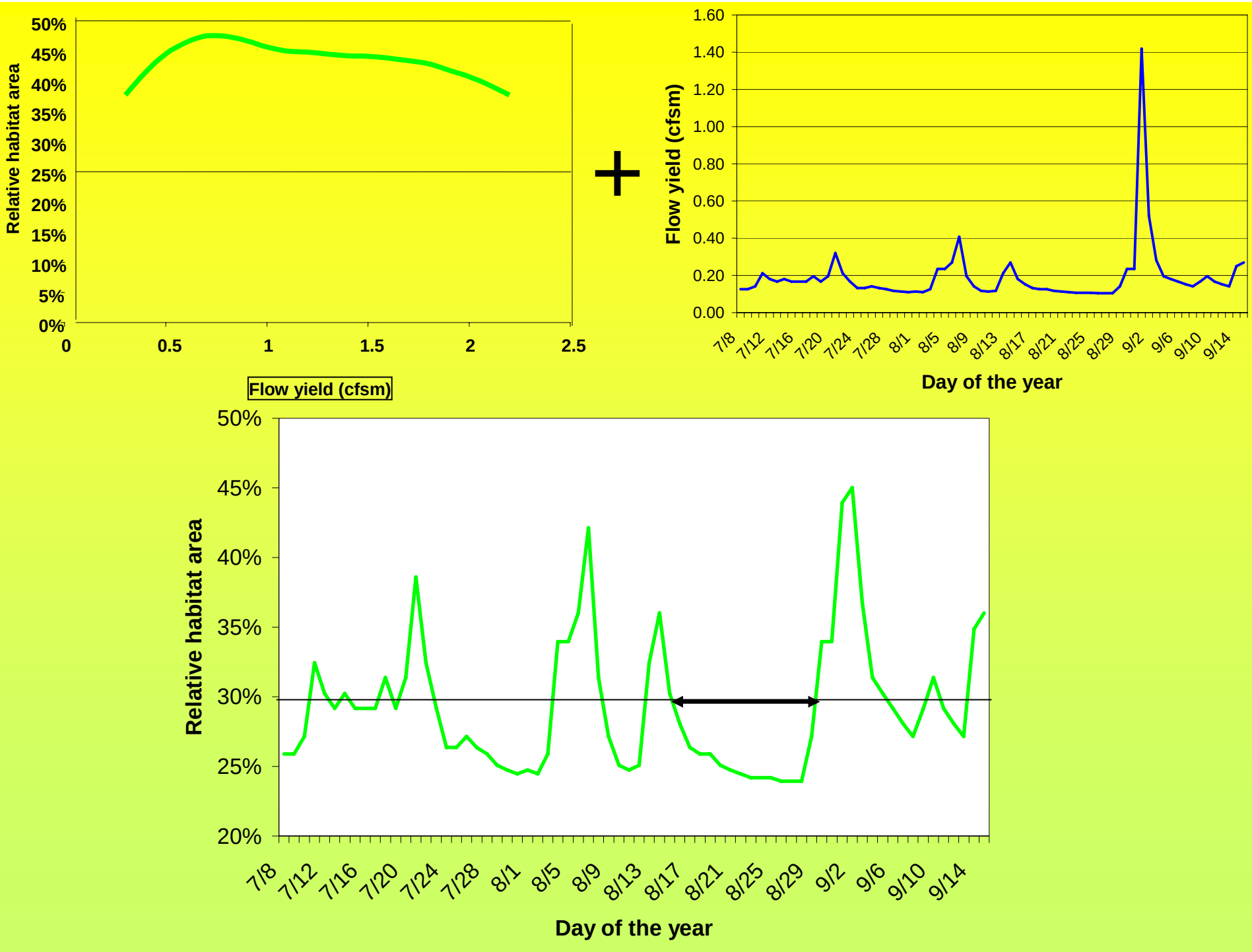


After



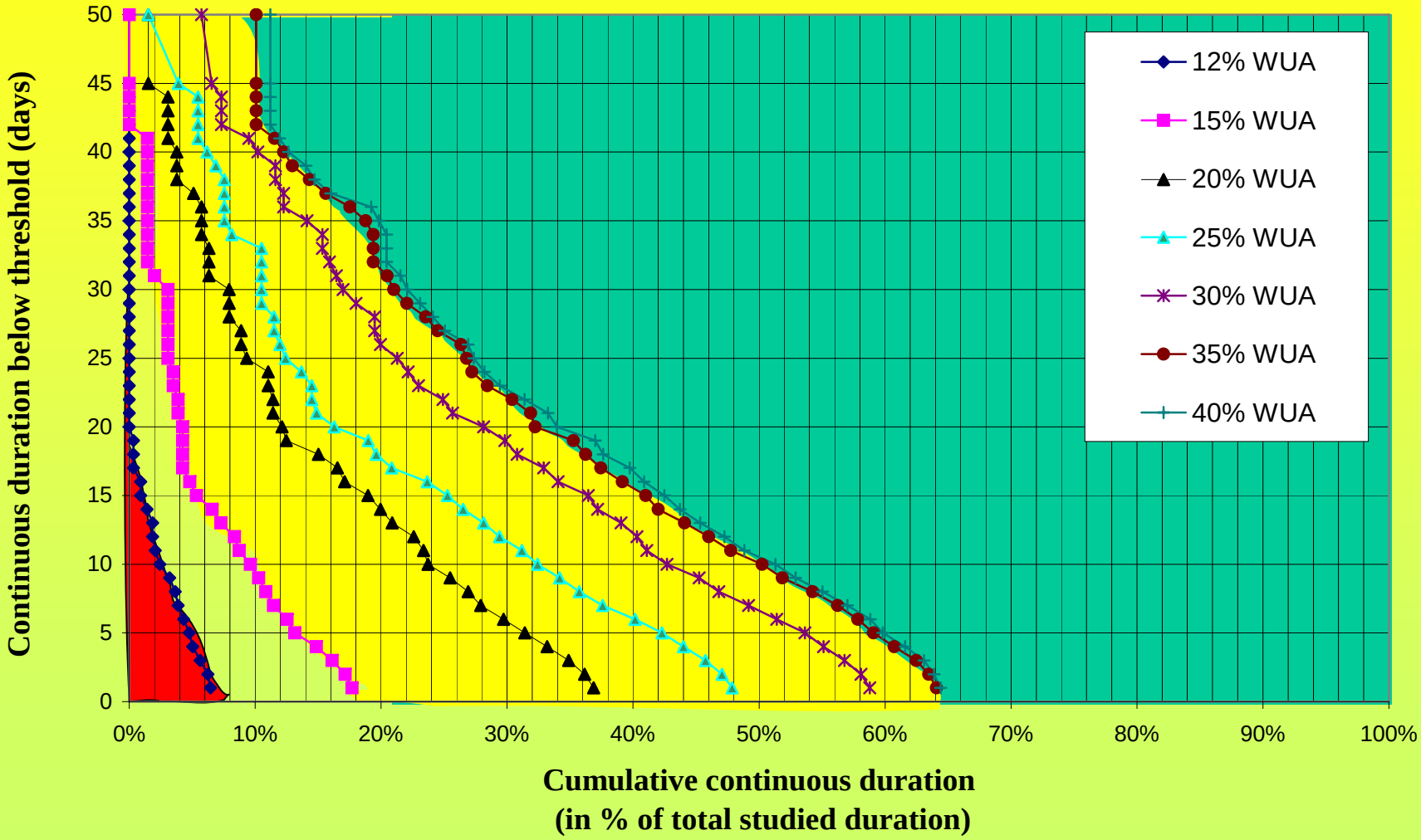





Relative habitat area
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
0.5
1
1.5
2
2.5
+
Flow yield (cfsm)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
7/8
7/12
7/16
7/20
7/24
7/28
8/1
8/5
8/9
8/13
8/17
8/21
8/25
8/29
9/2
9/6
9/10
9/14
Day of the year
Flow yield (cfsm)
Relative habitat area
50%
45%
40%
35%
30%
25%
20%
7/8
7/12
7/16
7/20
7/24
7/28
8/1
8/5
8/9
8/13
8/17
8/21
8/25
8/29
9/2
9/6
9/10
9/14
Day of the year

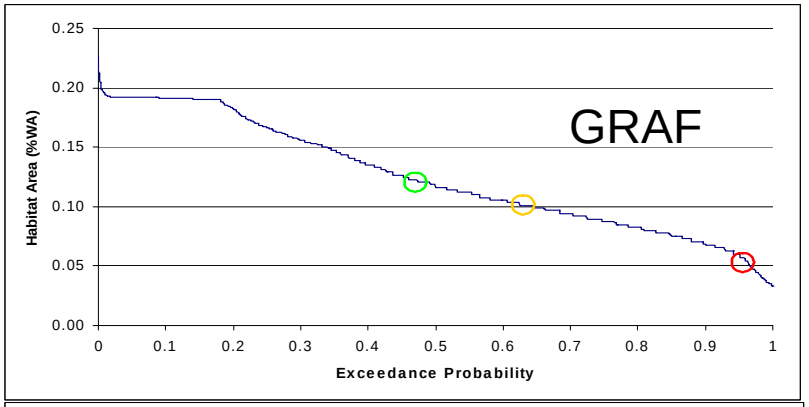
Brook trout UCUT

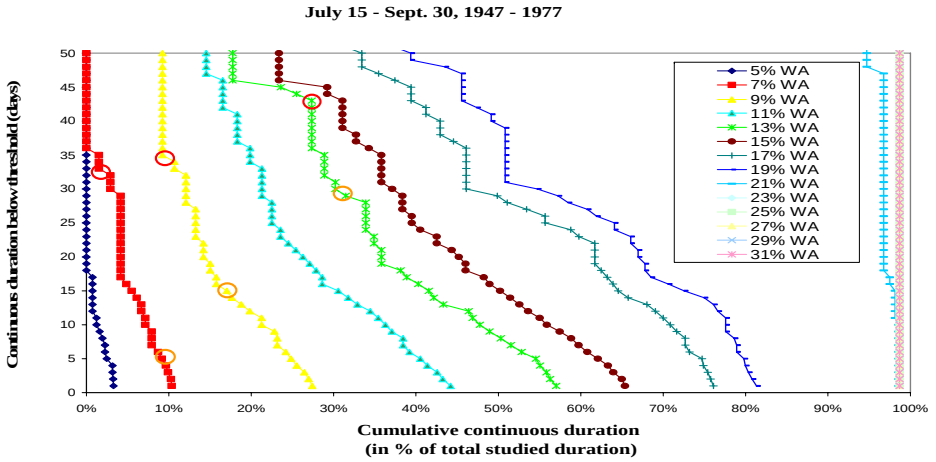
July 8 - Sept. 30, 1941 - 2003



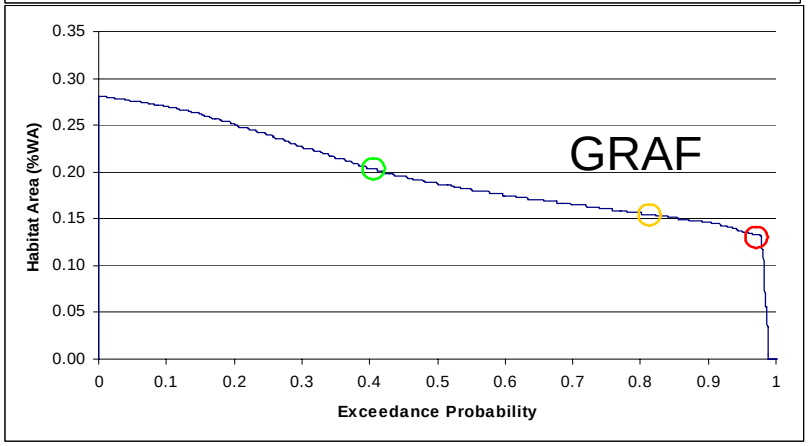
R & G

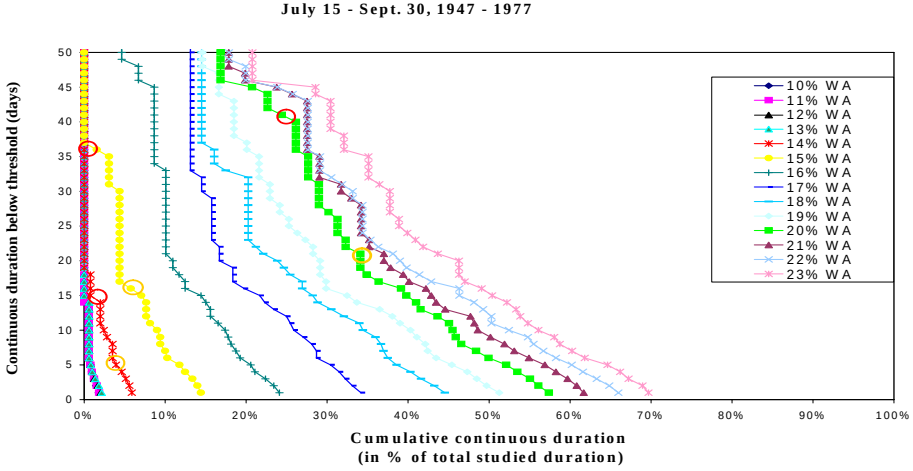
R 1


GRAF
Habitat Area (%WA)
Exceedance Probability

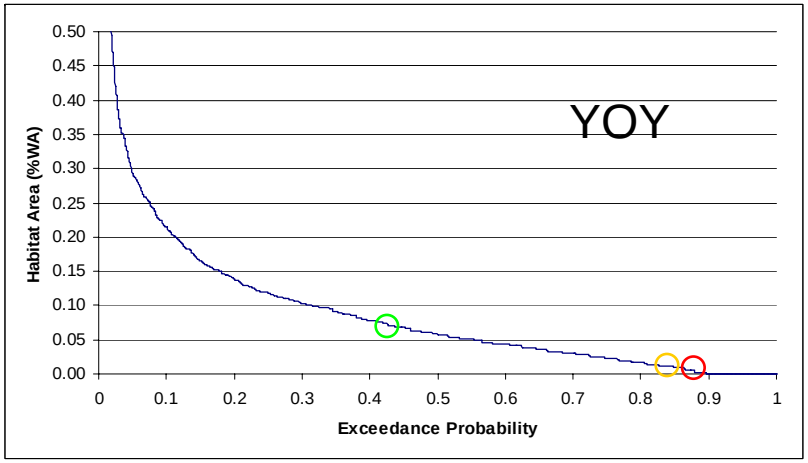

July 15 - Sept. 30, 1947 - 1977
Continuous duration below threshold (days)
Cumulative continuous duration
(in % of total studied duration)
5% WA
7% WA
9% WA
11% WA
13% WA
15% WA
17% WA
19% WA
21% WA
23% WA
25% WA
27% WA
29% WA
31% WA

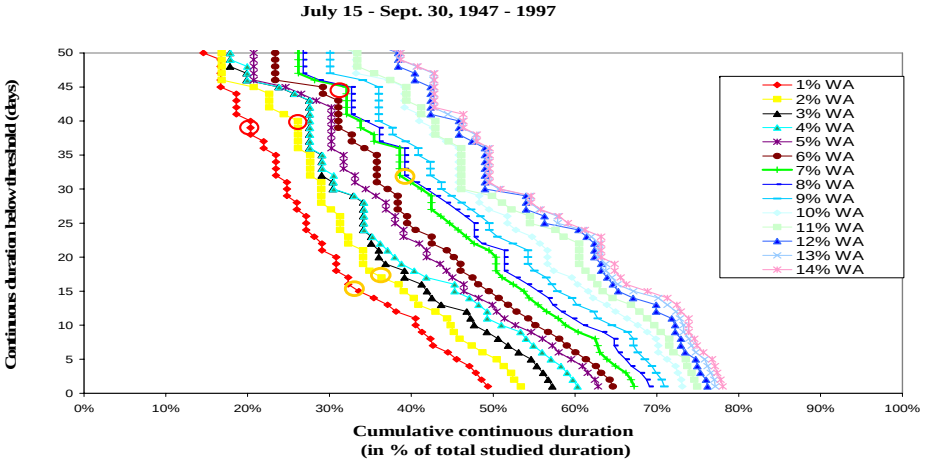
R 2


GRAF
Habitat Area (%WA)
Exceedance Probability


July 15 - Sept. 30, 1947 - 1977
Continuous duration below threshold (days)
Cumulative continuous duration
(in % of total studied duration)
10% WA
11% WA
12% WA
13% WA
14% WA
15% WA
16% WA
17% WA
18% WA
19% WA
20% WA
21% WA
22% WA
23% WA

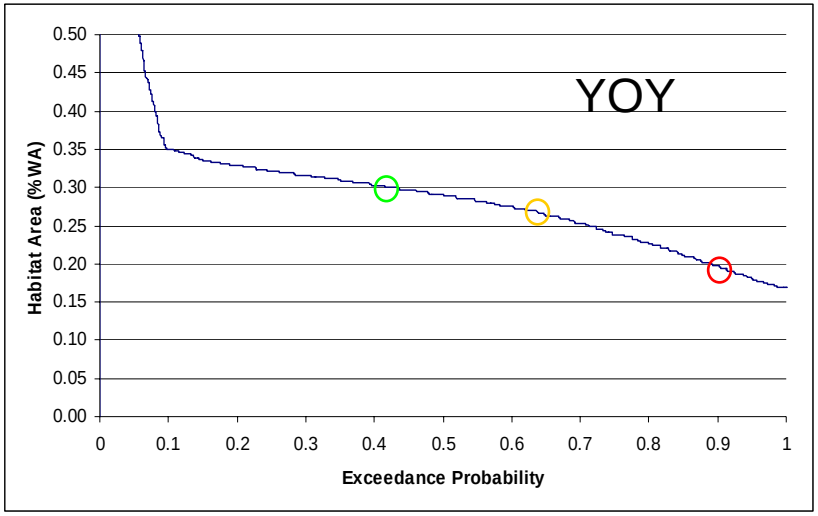
R 3

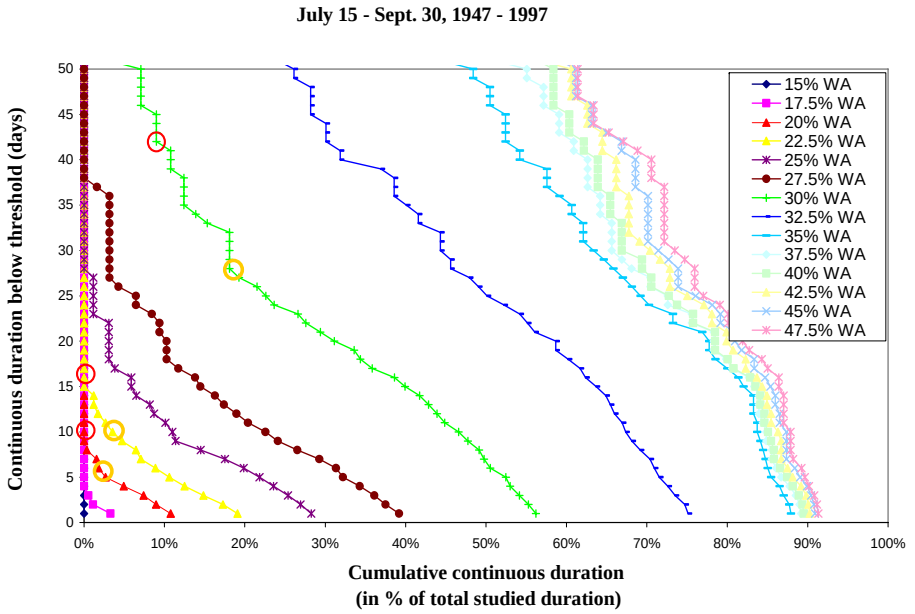

YOY
Habitat Area (%WA)
Exceedance Probability


July 15 - Sept. 30, 1947 - 1997
Continuous duration below threshold (days)
Cumulative continuous duration
(in % of total studied duration)
1% WA
2% WA
3% WA
4% WA
5% WA
6% WA
7% WA
8% WA
9% WA
10% WA
11% WA
12% WA
13% WA
14% WA

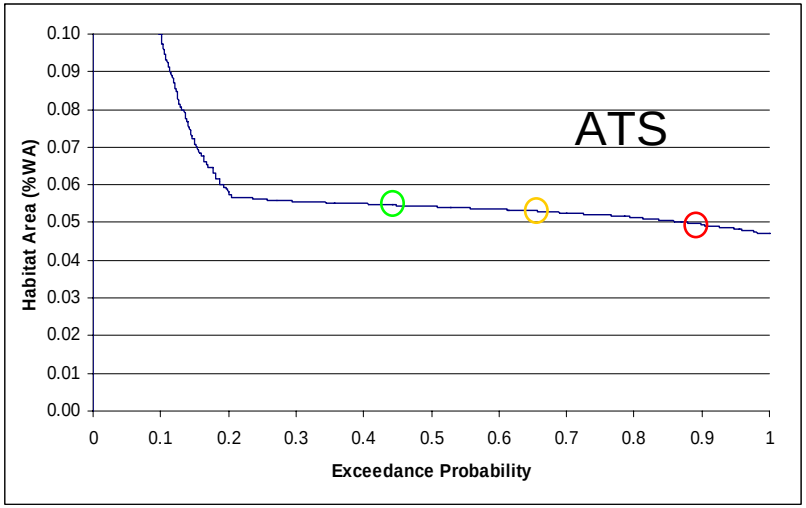
R & G

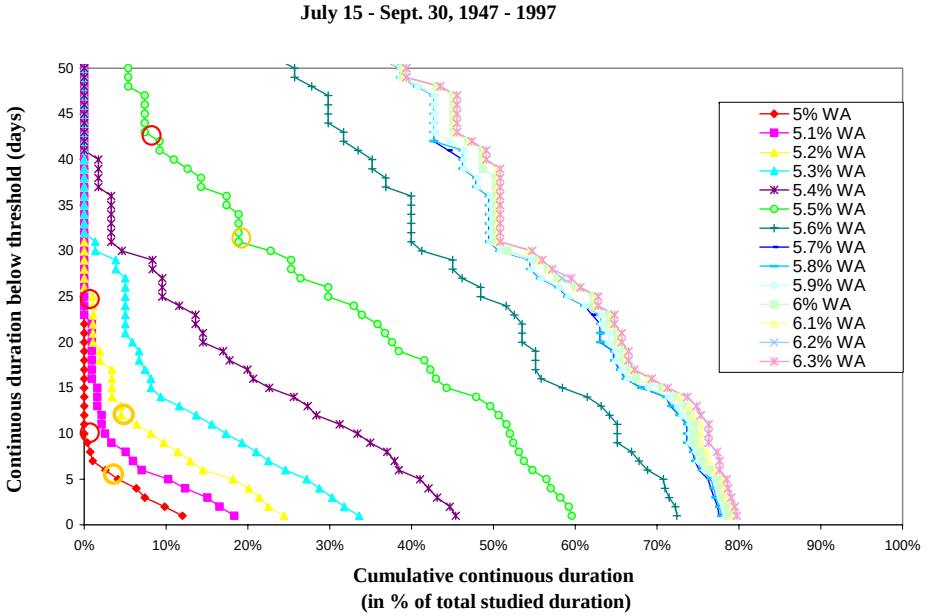
R 4


YOY
Habitat Area (%WA)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Exceedance Probability


July 15 - Sept. 30, 1947 - 1997
Continuous duration below threshold (days)
50
45
40
35
30
25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Cumulative continuous duration
(in % of total studied duration)
15% WA
17.5% WA
20% WA
22.5% WA
25% WA
27.5% WA
30% WA
32.5% WA
35% WA
37.5% WA
40% WA
42.5% WA
45% WA
47.5% WA

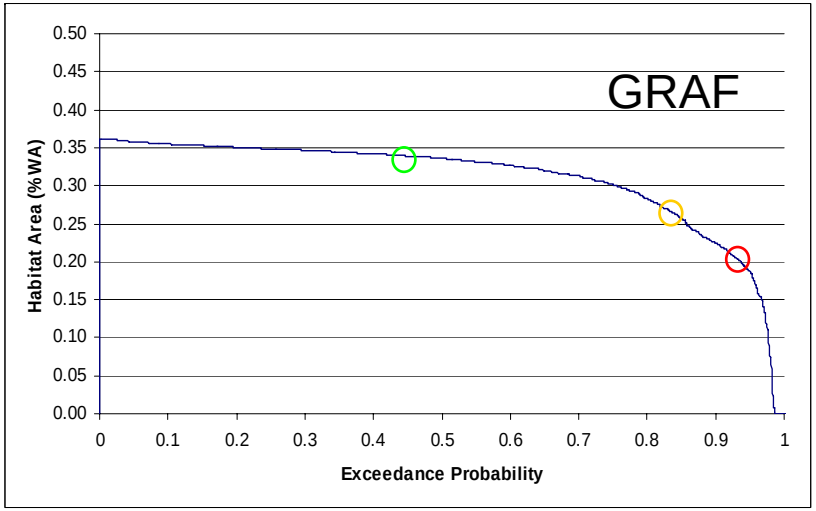
R 5

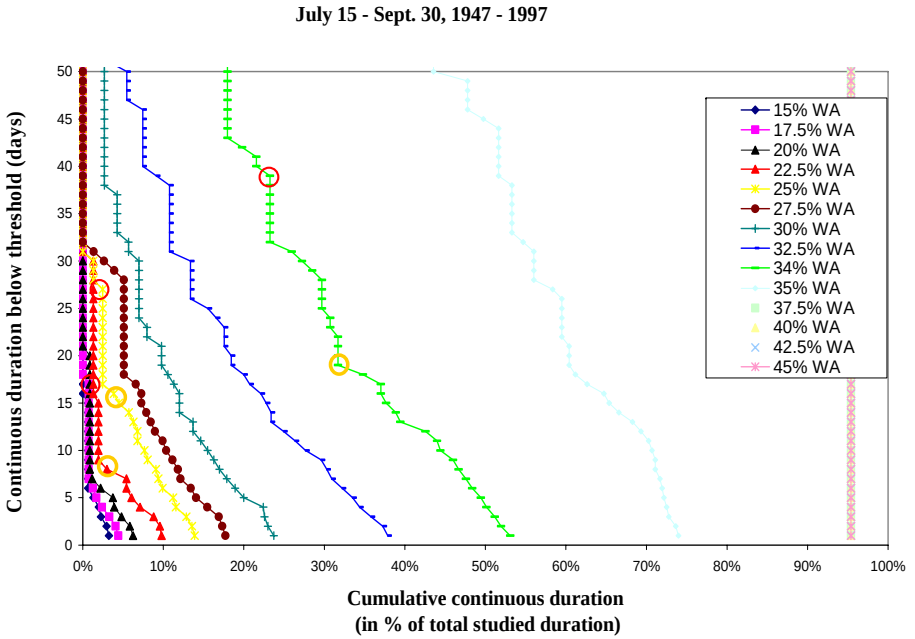

ATS
Habitat Area (%WA)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Exceedance Probability


July 15 - Sept. 30, 1947 - 1997
Continuous duration below threshold (days)
50
45
40
35
30
25
20
15
10
5
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Cumulative continuous duration
(in % of total studied duration)
5% WA
5.1% WA
5.2% WA
5.3% WA
5.4% WA
5.5% WA
5.6% WA
5.7% WA
5.8% WA
5.9% WA
6% WA
6.1% WA
6.2% WA
6.3% WA

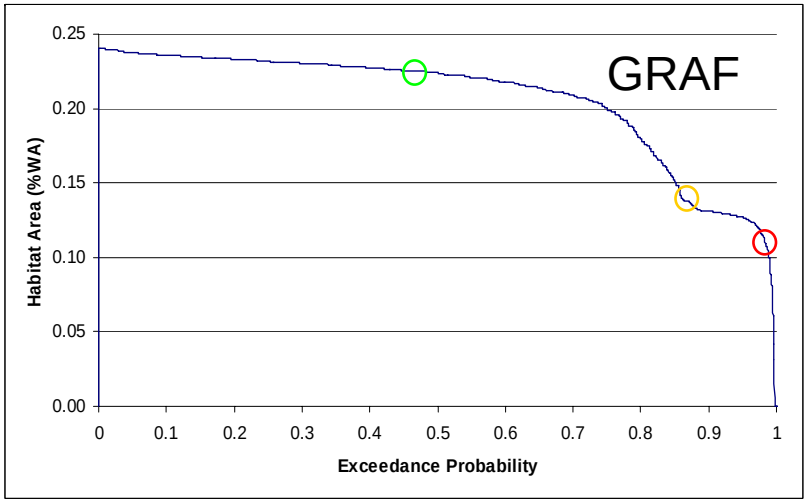
R & G

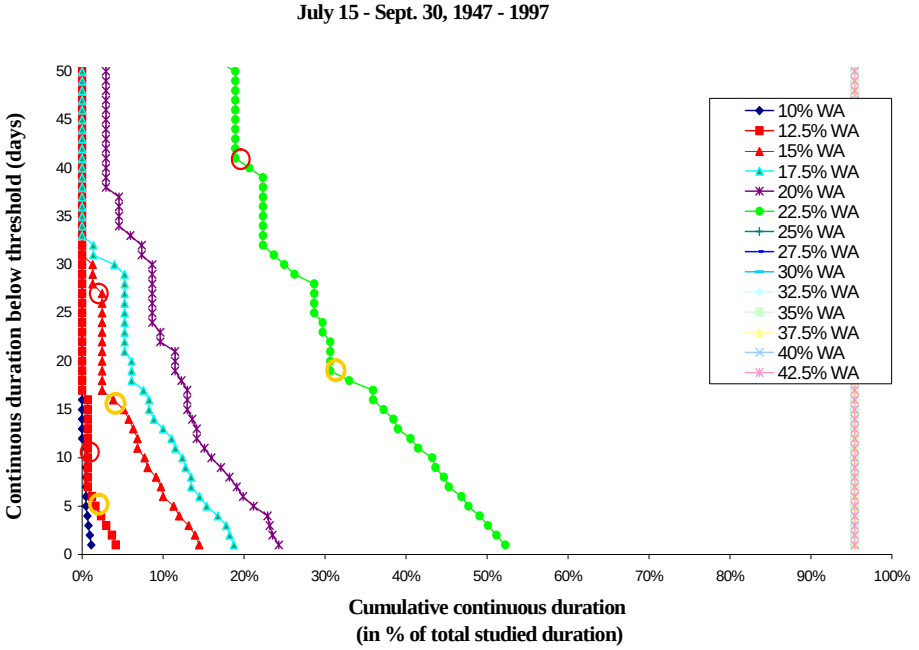
R 6


GRAF
Habitat Area (%WA)
Exceedance Probability
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


July 15 - Sept. 30, 1947 - 1997
Continuous duration below threshold (days)
Cumulative continuous duration
(in % of total studied duration)
15% WA
17.5% WA
20% WA
22.5% WA
25% WA
27.5% WA
30% WA
32.5% WA
34% WA
35% WA
37.5% WA
40% WA
42.5% WA
45% WA

R 7


GRAF
Habitat Area (%WA)
Exceedance Probability
0.25
0.20
0.15
0.10
0.05
0.00
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

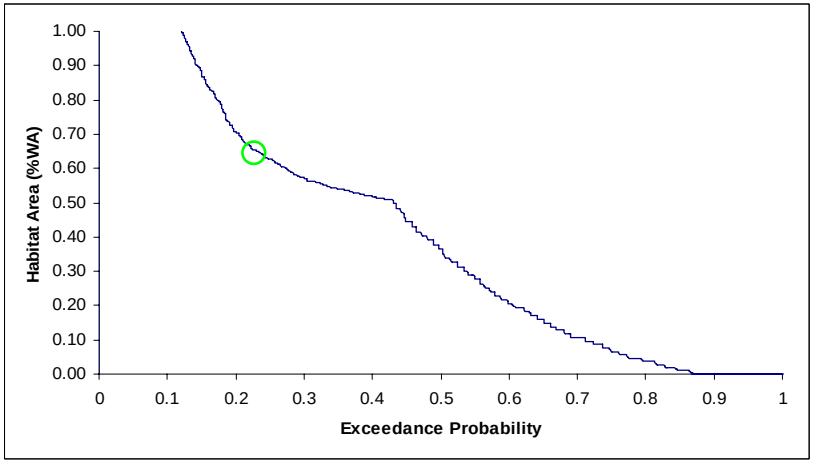

July 15 - Sept. 30, 1947 - 1997
Continuous duration below threshold (days)
Cumulative continuous duration
(in % of total studied duration)
10% WA
12.5% WA
15% WA
17.5% WA
20% WA
22.5% WA
25% WA
27.5% WA
30% WA
32.5% WA
35% WA
37.5% WA
40% WA
42.5% WA

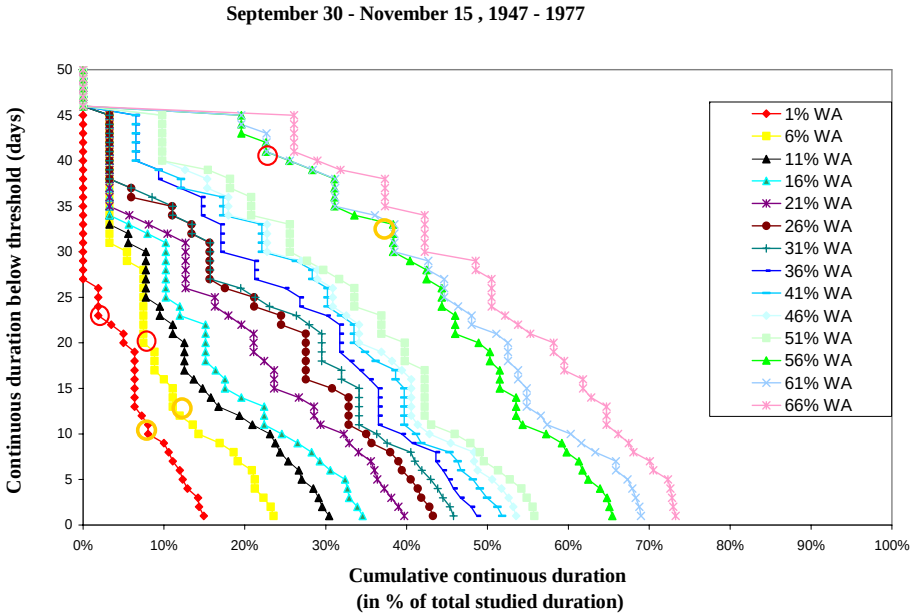
R&G (July 15 – September 30)

Indicator	GRAF	GRAF	YOY	YOY	ATS	GRAF	GRAF	Recommended flows	
Gauge (SR#)	6-12	16-18	25	31-34	31-34	50-56	50-56	25	USGS
Watershed area (mi^2)	33.9	64.6	102.3	139	139	159	159	102.3	171
Location	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**	**Reach 6**	**Reach 7**	**Upper**	**Lower**
Common habitat (% WA)	**13**	**20**	**7**	**30**	**5.5**	**34**	**22.5**		
Allowable duration under (days)	30	25	30	28	30	20	20	30	20
Catastrophic duration (days)	43	45	45	42	42	40	40	42	40
Corresponding flow (cfsm)	0.3	0.12	0.21	0.6	0.31	0.12	0.33	0.3	0.6
Habitat when restored (% WA)	33	22	7	66	7	30	30		
Critical habitat (% WA)	**10**	**15**	**1.5**	**22.5**	**5.2**	**27**	**15**		
Allowable duration under (days)	15	15	17	10	17	15	15	15	15
Catastrophic duration (days)	35	40	40	15	20	27	27	35	20
Corresponding flow (cfsm)	0.16	0.04	0.13	0.11	0.15	0.1	0.08	0.16	0.15
Habitat when restored (% WA)	28	19	1	45	5	27	22.5		
Rare habitat (% WA)	**7**	**14**	**1**	**20**	**5**	**22**	**10**		
Allowable duration under (days)	5	5	10	5	5	7	5	5	5
Catastrophic duration (days)	32	10	35	10	10	15	10	30	10
Corresponding flow (cfsm)	0.10	0.02	0.10	0.10	0.11	0.08	0.06	0.1	0.1
Habitat when restored (% WA)	22	14	1.5	40	5	22	15		
Common flow (cfs)	14	8	21	83	43	19	52	41	103
Critical flow (cfs)	5	3	13	15	21	16	13	16	26
Rare flow (cfs)	3	1	10	14	15	13	10	10	17

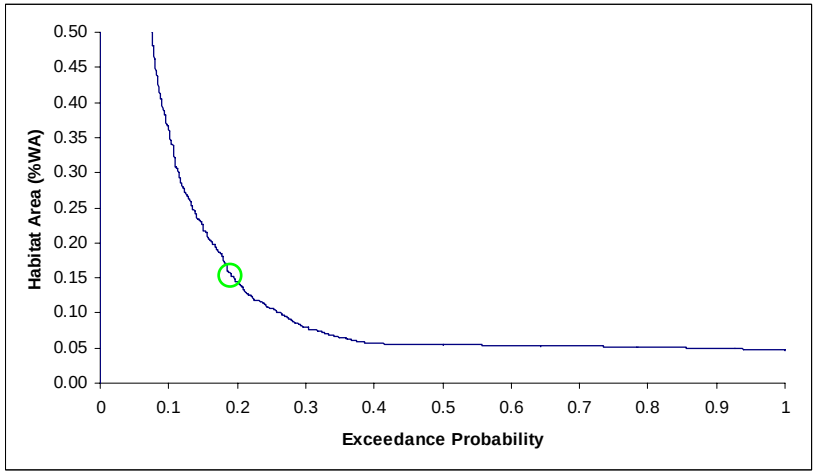
Atlantic salmon spawning

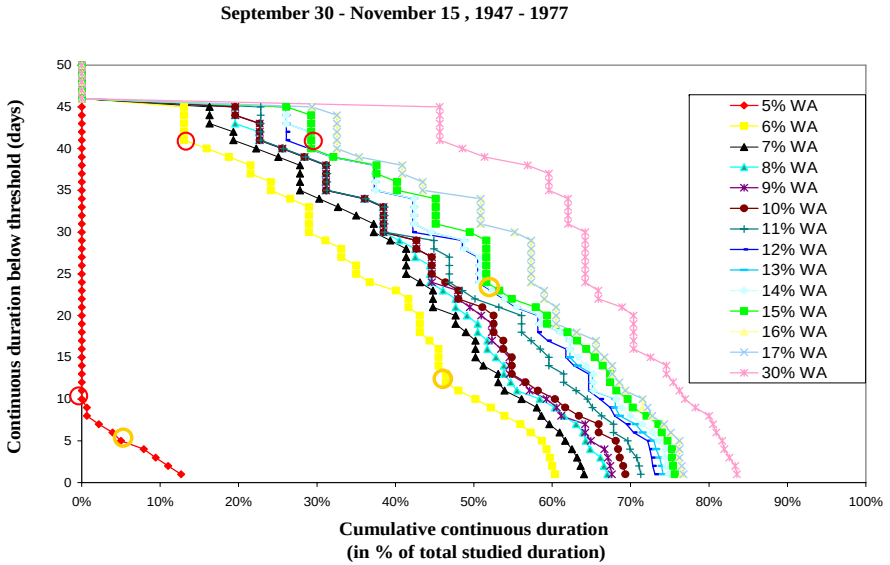
R 2





R 5





Atlantic salmon spawning (October 1 – November 15)

Indicator	ATS	ATS	**Recommended flows**	
Gauge (SR#)	16-18	31-34	25	USGS
Watershed area (mi^2)	64.6	139	102.3	171
Location	**Reach 2**	**Reach 5**	**Upper**	**Lower**
Common habitat (% WA)	**50**	**14**		
Allowable duration under (days)	25	20	25	20
Catastrophic duration (days)	40	40	40	40
Corresponding flow present (cfsm)	0.4	1.05	0.55	1.1
Critical habitat	**6**	**6**		
Allowable duration under (days)	10	12	10	12
Catastrophic duration (days)	20	40	20	40
Corresponding flow present (cfsm)	0.1	0.4	0.22	0.6
Rare habitat (%WA)	**1**	**5**		
Allowable duration under (days)	10	5	10	5
Catastrophic duration (days)	20	10	20	10
Corresponding flow present (cfsm)	0.1	0.25	0.22	0.4
Common flow (cfs)	16	146	33	184
Critical flow (cfs)	6	56	13	96
Rare flow (cfs)	6	35	13	70

Overwintering bioperiod

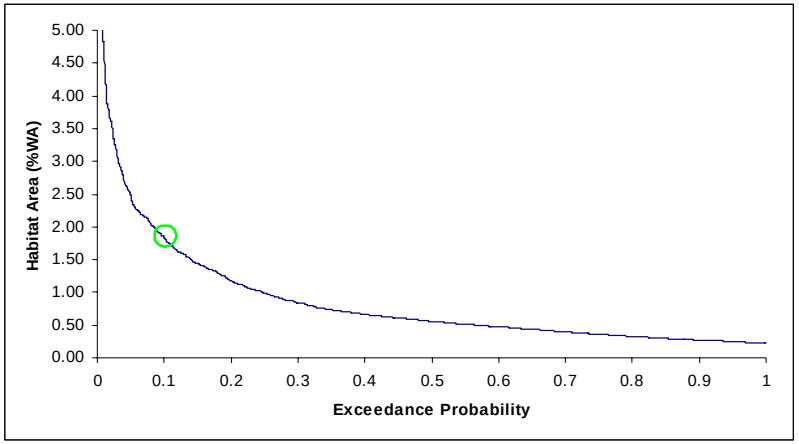
Indicator	Recommended
Gauge	USGS
Watershed area	171
Common habitat (% WA)	
Allowable duration under (days)	35
Catastrophic duration (days)	50
Corresponding flow present (cfsm)	2
Habitat when restored (% WA)	
Critical habitat	
Allowable duration under (days)	15
Catastrophic duration (days)	30
Corresponding flow present (cfsm)	0.5
Habitat when restored (% WA)	
Rare habitat (%WA)	
Allowable duration under (days)	5
Catastrophic duration (days)	10
Corresponding flow (cfsm)	0.3
Common flow (cfs)	204.6
Critical flow (cfs)	51.15
Rare flow (cfs)	30.69

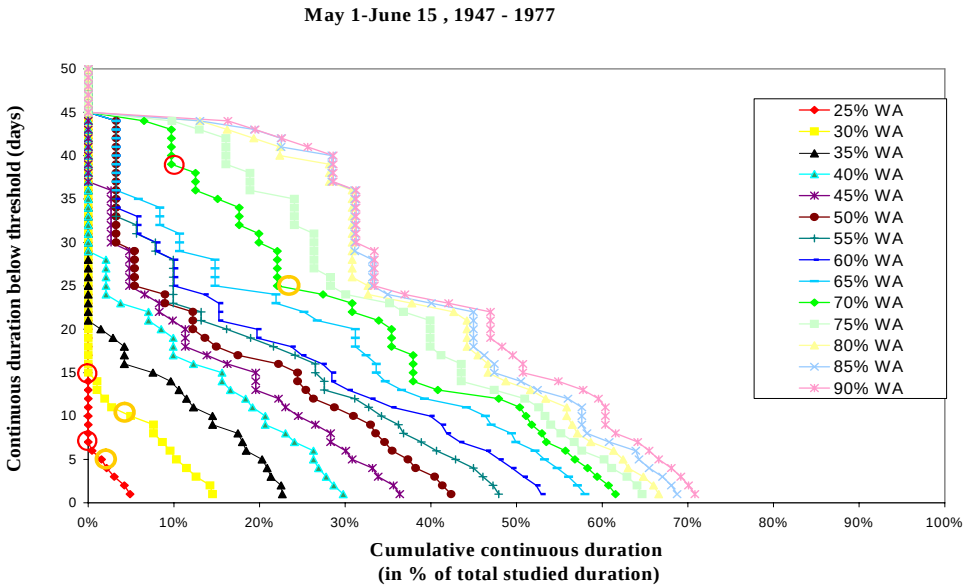
Flooding

No low flow rules
but maintenance of
channel forming flows (HQ2)

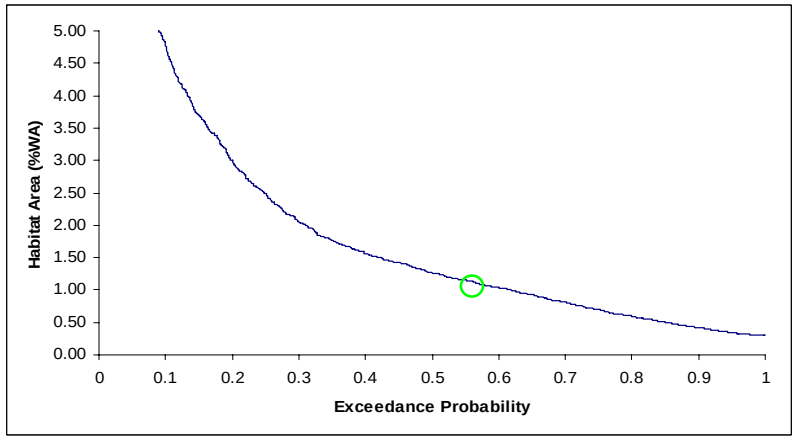
American shad spawning

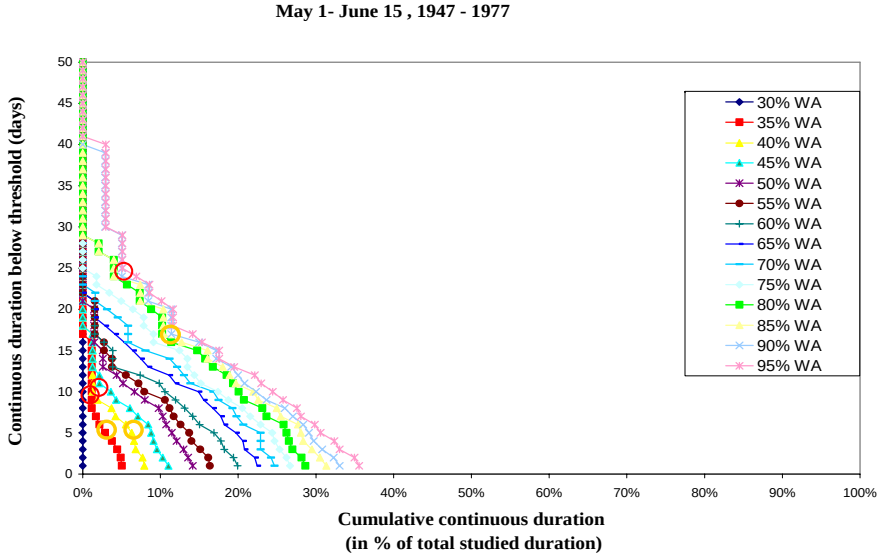
R 2





R 5



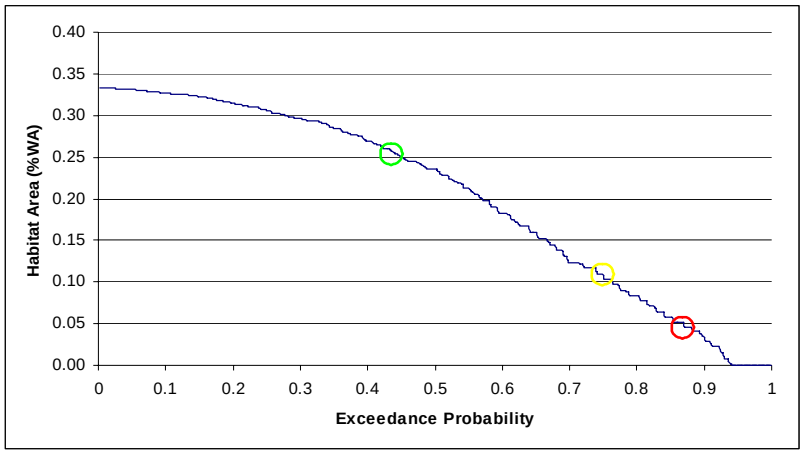


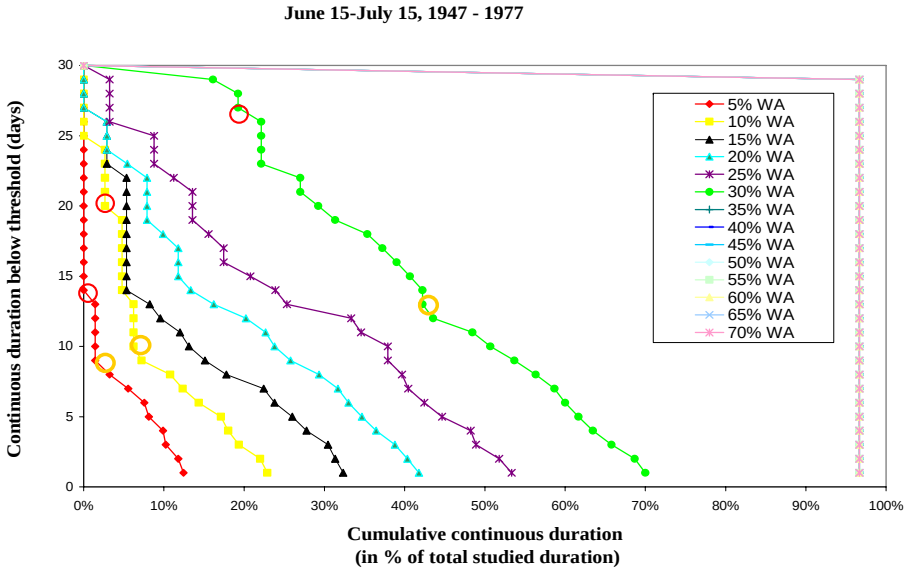
American shad spawning (May 15 through June 14)

Indicator	AS	AS	Recommended flows	
Gauge (SR#)	16-18	31-34	25	USGS
Watershed area (mi^2)	64.6	139	102.3	171
Location	**Reach 2**	**Reach 5**	**Upper**	**Lower**
Common habitat (% WA)	**70**	**80**		
Allowable duration under (days)	25	15	25	15
Catastrophic duration (days)	40	25	40	25
Corresponding flow present (cfsm)	2.1	1	2.1	1.0
Critical habitat (% WA)	**30**	**40**		
Allowable duration under (days)	10	5	10	5
Catastrophic duration (days)	15	10	15	10
Corresponding flow present (cfsm)	0.6	0.4	0.6	0.6
Rare habitat (% WA)	**35**	**35**		
Allowable duration under (days)	4	5	4	5
Catastrophic duration (days)	7	10	7	10
Corresponding flow (cfsm)	0.37	0.35	0.37	0.5
Common flow (cfs)	136	139	136	178
Critical flow (cfs)	39	56	45	96
Rare flow (cfs)	24	49	32	88

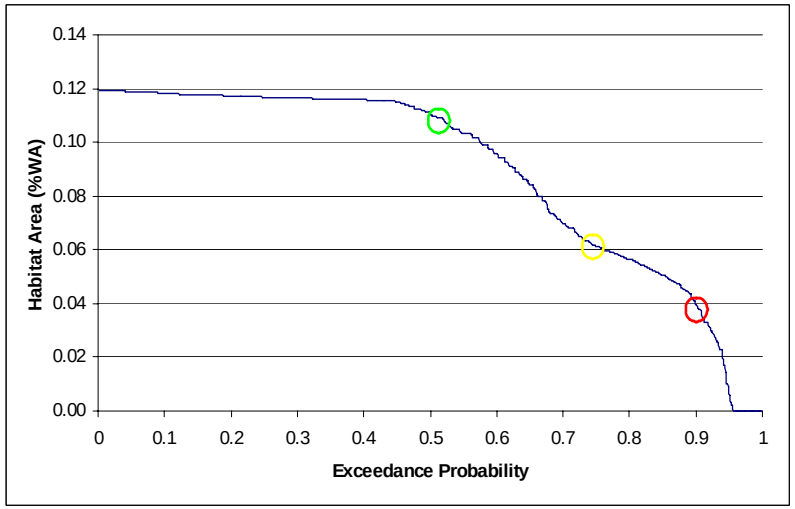
GRAF spawning

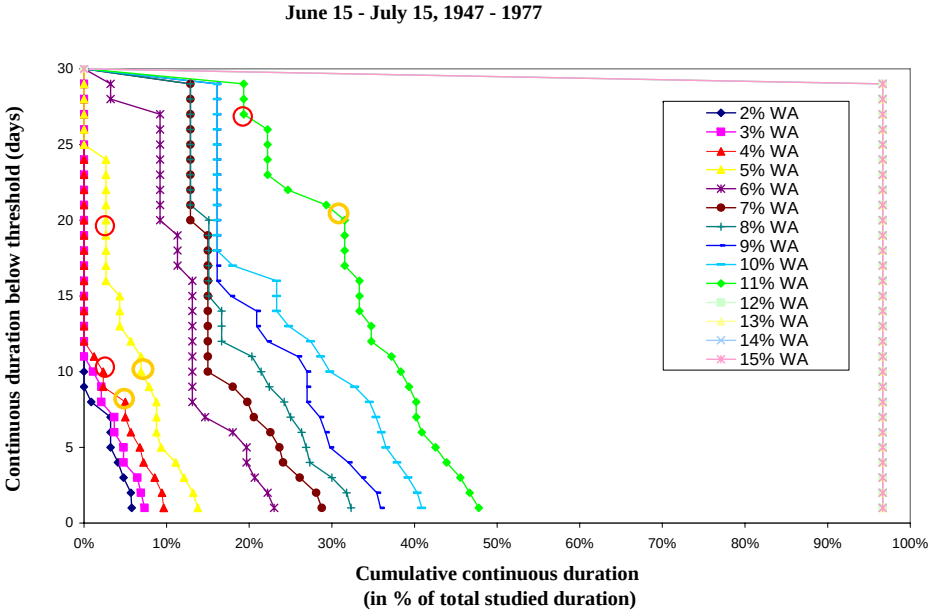
R 2





R 5

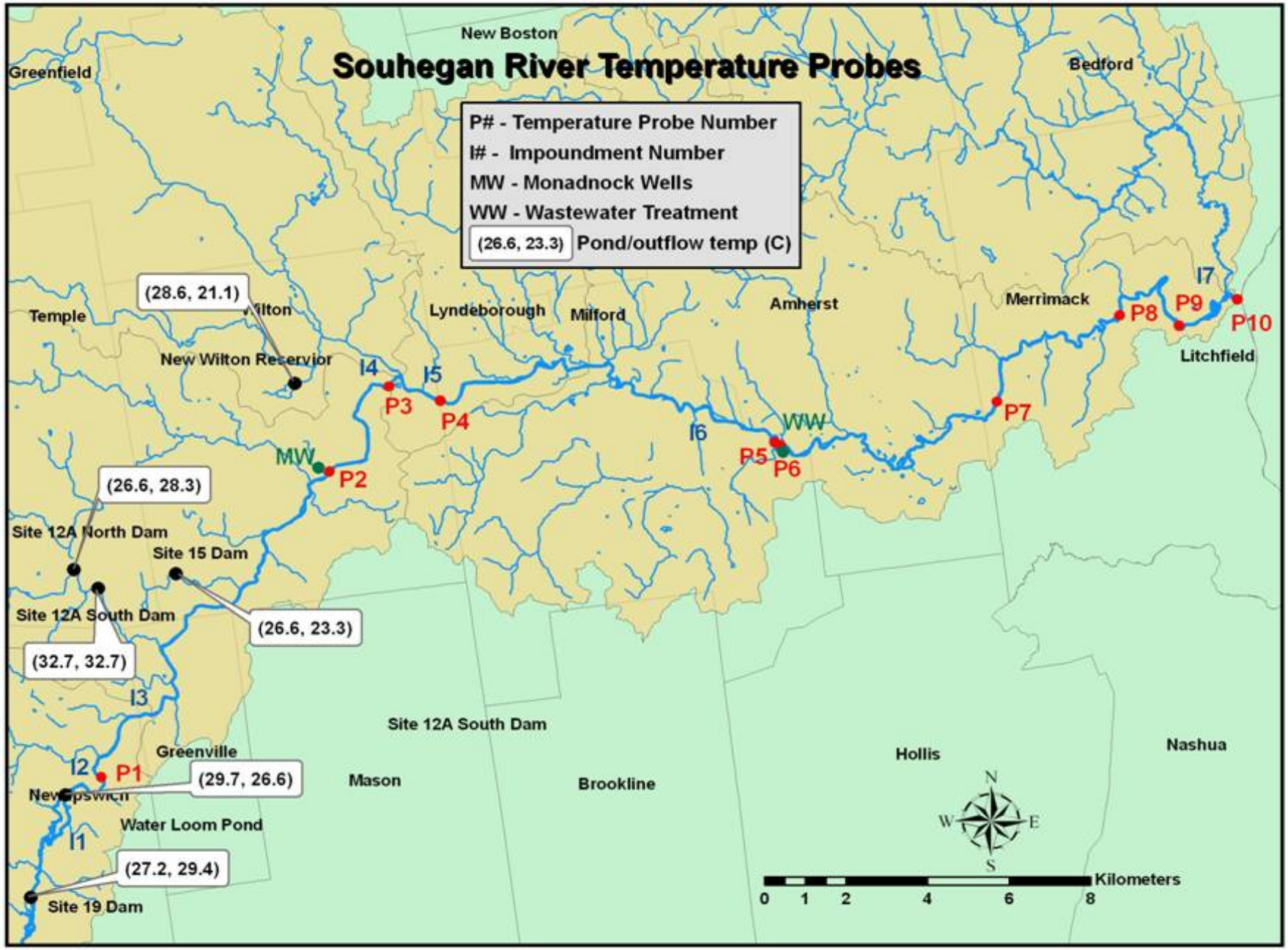


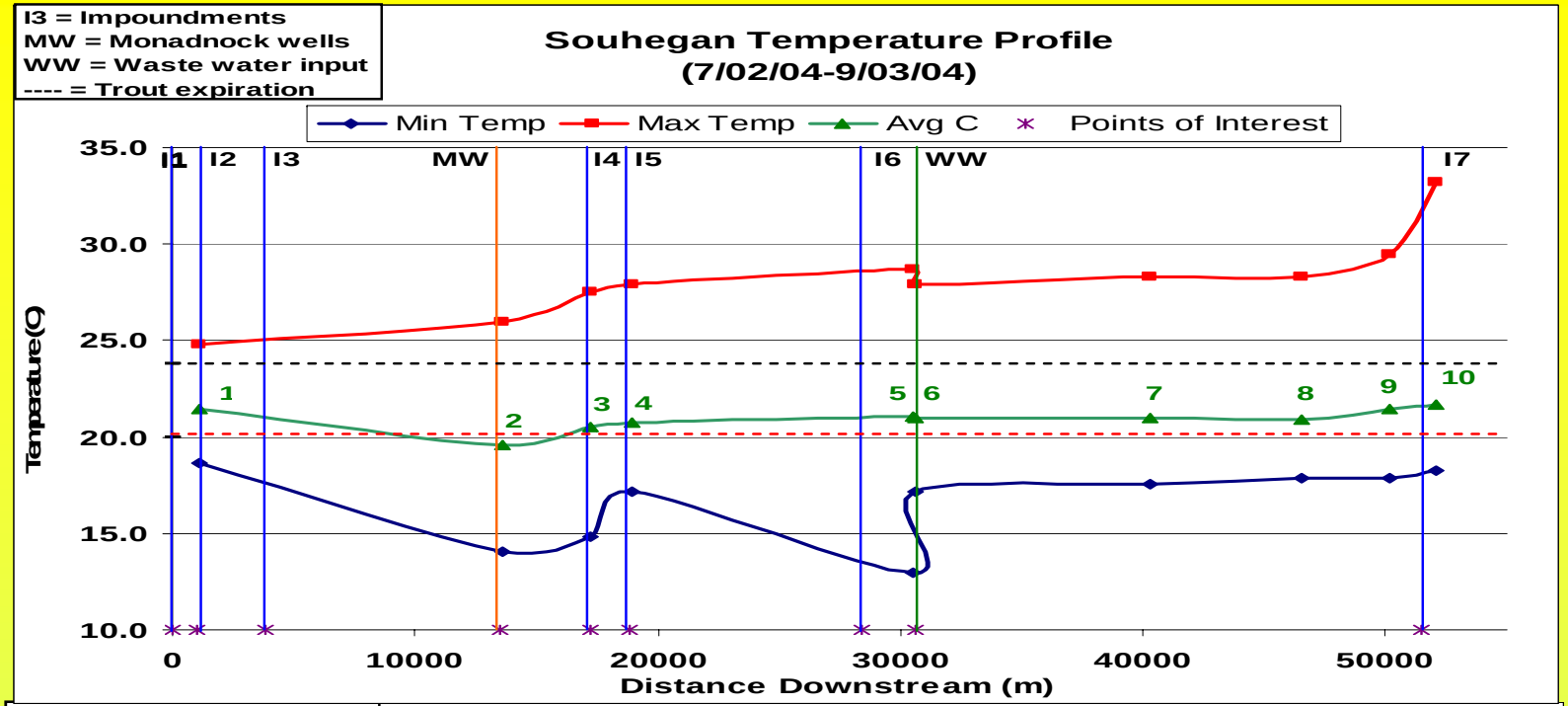


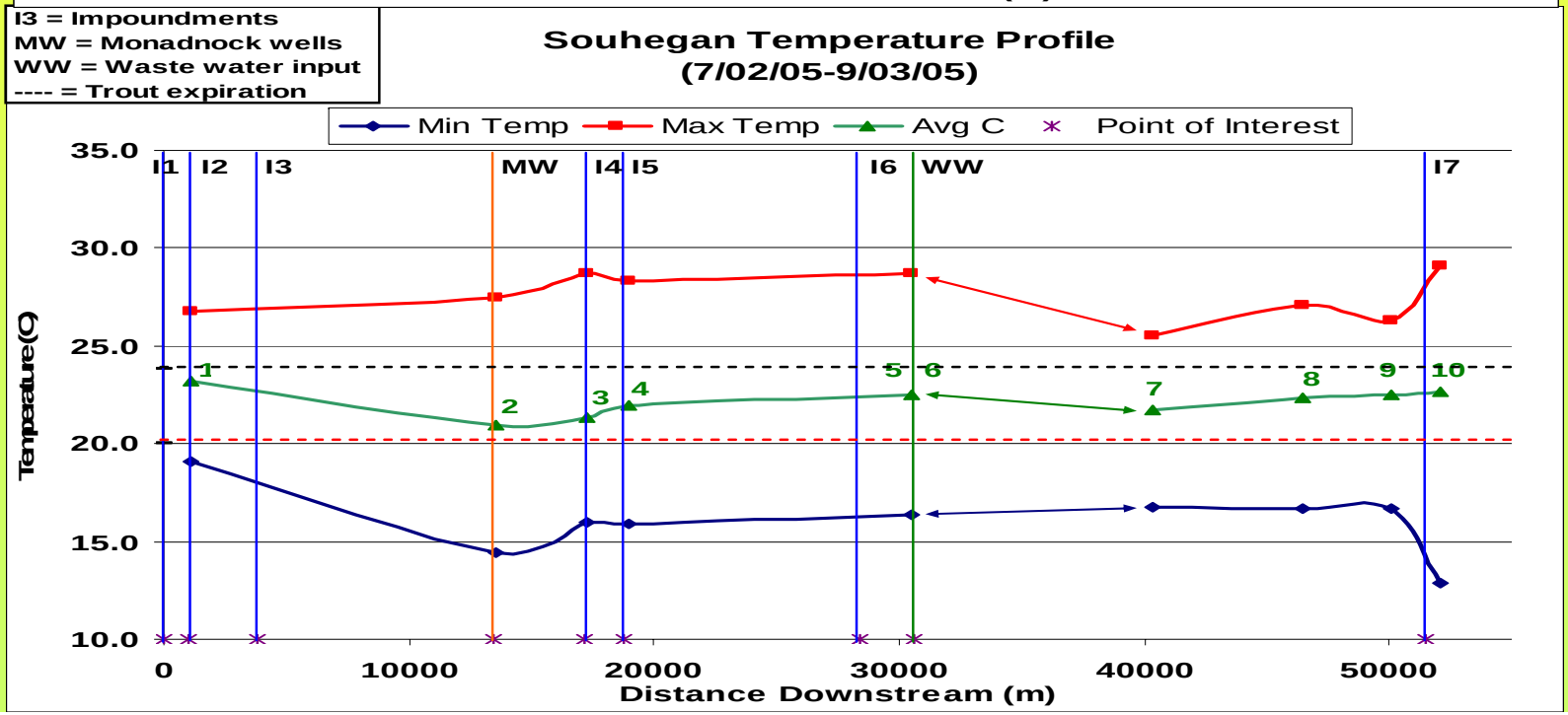
GRAF spawning (June 15 through July 14)

Indicator	GRAF	GRAF	Recommended flows	
Gauge	16-18	31-34	25	USGS
Watershed area	64.6	139	102.3	171
	Reach 2	**Reach 5**	**Upper**	**Lower**
Common habitat (% WA)	**30**	**11**		
Minimum duration under (days)	20	17	20	17
Catastrophic duration (days)	27	25	27	25
Corresponding flow (cfsm)	0.23	0.11	0.23	0.23*
Critical habitat	**10**	**5**		
Allowable duration under (days)	10	13	10	13
Catastrophic duration (days)	20	23	20	23
Corresponding flow (cfsm)	0.11	1.4	0.11	1.4*
Rare habitat (%WA)	**5**	**4**		
Allowable duration under (days)	10	10	10	10
Catastrophic duration (days)	15	10	15	10
Corresponding flow (cfsm)	0.08	1.9	0.08	1.9*
Common flow (cfs)	15	15	22	39*
Critical flow (cfs)	7	195	13	239*
Rare flow (cfs)	5	264	11	325*

* flows need to be lower than given value


Souhegan River Temperature Probes
P# - Temperature Probe Number
I# - Impoundment Number
MW - Monadnock Wells
WW - Wastewater Treatment
(26.6, 23.3) Pond/outflow temp (C)
New Boston
Greenfield
Bedford
Temple
Lyndeborough
Milford
Amherst
Merrimack
Litchfield
New Wilton Reservior
(28.6, 21.1)
I1
I2
I3
I4
I5
I6
I7
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
MW
WW
(26.6, 28.3)
Site 12A North Dam
Site 15 Dam
Site 12A South Dam
(26.6, 23.3)
(32.7, 32.7)
Greenville
(29.7, 26.6)
Mason
Brookline
Hollis
Nashua
Water Loom Pond
(27.2, 29.4)
Site 19 Dam
N
W
E
S
0 1 2 4 6 8
Kilometers


I3 = Impoundments
MW = Monadnock wells
WW = Waste water input
---- = Trout expiration
Souhegan Temperature Profile
(7/02/04-9/03/04)
Min Temp
Max Temp
Avg C
Points of Interest
I1
I2
I3
MW
I4
I5
I6
WW
I7
35.0
30.0
25.0
20.0
15.0
10.0
Temperature(C)
1
2
3
4
5
6
7
8
9
10
0
10000
20000
30000
40000
50000
Distance Downstream (m)


I3 = Impoundments
MW = Monadnock wells
WW = Waste water input
---- = Trout expiration
Souhegan Temperature Profile
(7/02/05-9/03/05)
Min Temp
Max Temp
Avg C
Point of Interest
I1
I2
I3
MW
I4
I5
I6
WW
I7
35.0
30.0
25.0
20.0
15.0
10.0
Temperature(C)
1
2
3
4
5
6
7
8
9
10
0
10000
20000
30000
40000
50000
Distance Downstream (m)

Conclusions

- Pollution and temperature sensitive species underrepresented or missing
- Brook trout and slimy sculpin not limited by physical habitat
- Diadromous species missing but enough habitat
  - American Eel lots of habitat
  - American shad spawning
  - Juvenile salmon
- TFC close to XFC but
  - White sucker underrepresented
    - In US corresponds with habitat proportions
    - In DS more habitat than fish
      - spawning limitations by dams and fluctuations
  - Common shiner underrepresented in US but not DS (corresponds with habitat)
- Mussel and Odonates abundant,
  - habitat available but not flow dependent
- US habitat is more flow sensitive
- Very low flows in the records -> maintenance of frequency and duration
- Reach 2 and 5 highest habitat,
- Reach 3 most impaired

Recommendations and priority areas

- Reduce thermal impact
  - modify impoundments
  - increase habitat diversity
- Secure natural frequency and duration of flows
- Channel improvements
- Fish passage

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7
Temperature and water pollution							
Flow augmentation							
Fish passage							
Channel improvements							