Fish Use of Floodplain Lakes, Seasonal Floodplain Wetlands, and Sloughs in the Upper Columbia River Estuary

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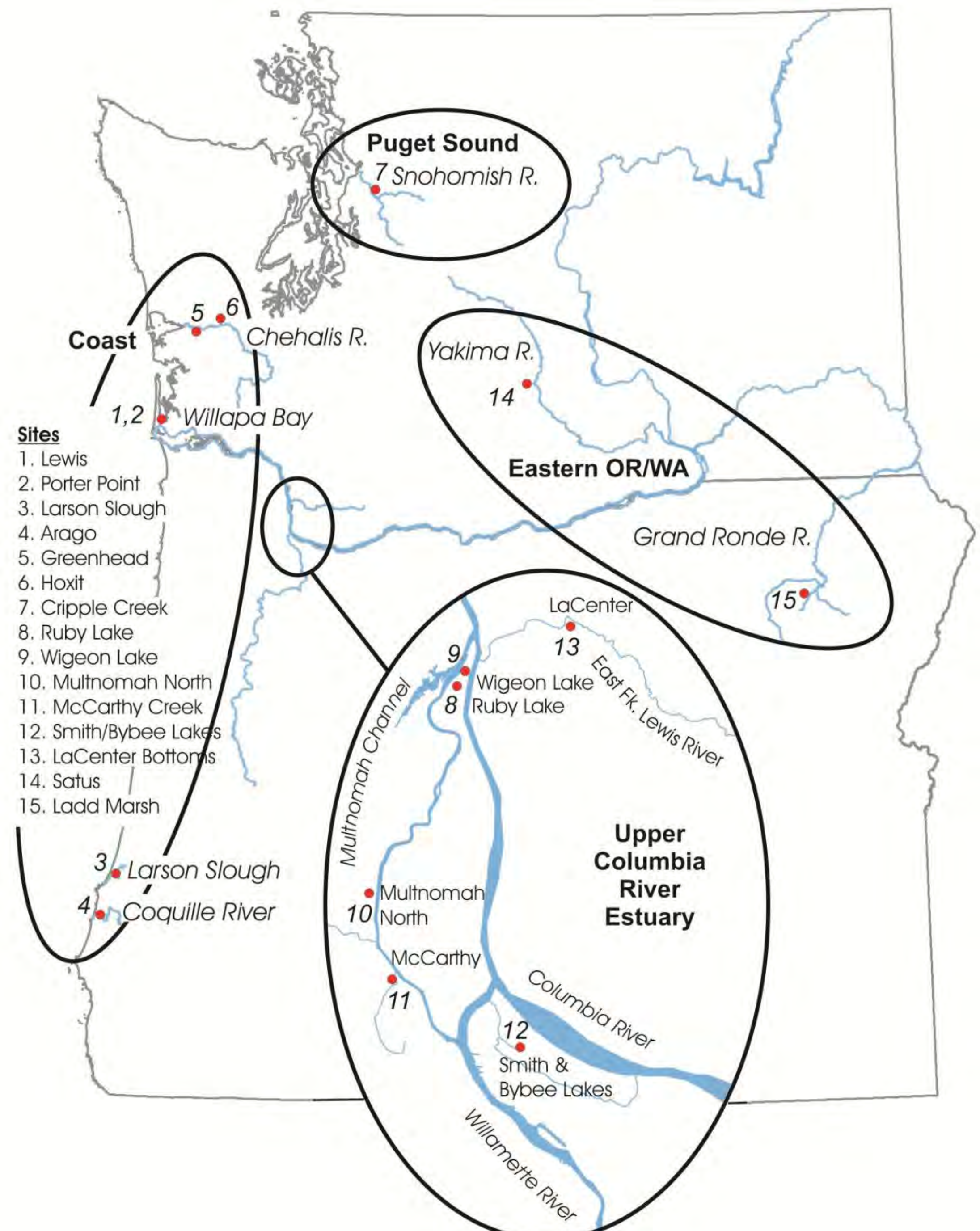
formerly with Ducks Unlimited, Inc.

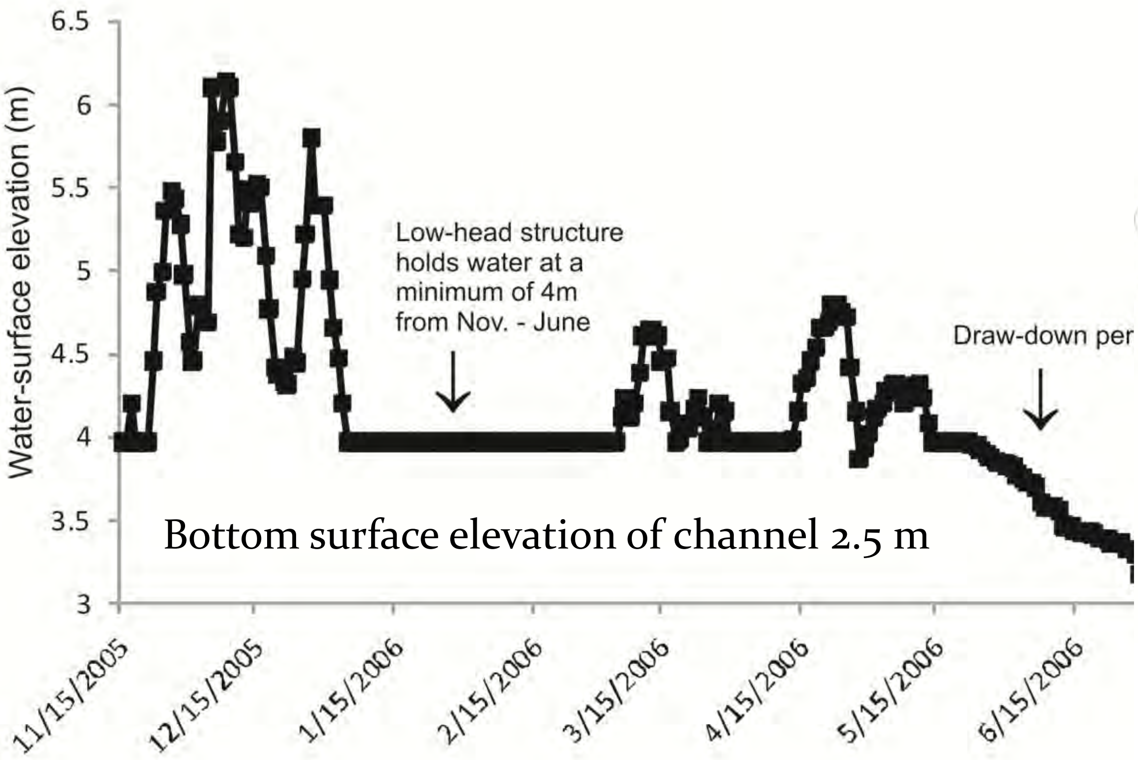
Background c

- 15 sites in seasonal flo
  across Oregon & Wasl
- Community ecology p
  - Fish assemblage late-fal
  - Movement into/out of f
- Restoration projects a
  - •Juvenile salmon use was
    - •Seasonal use of floo
    - •Fish passage capabi
    - •Risk of stranding /p
      by allowing access to
    - •Benefits to salmon
      connectivity to flood
      during winter/spring
      factor, survival)

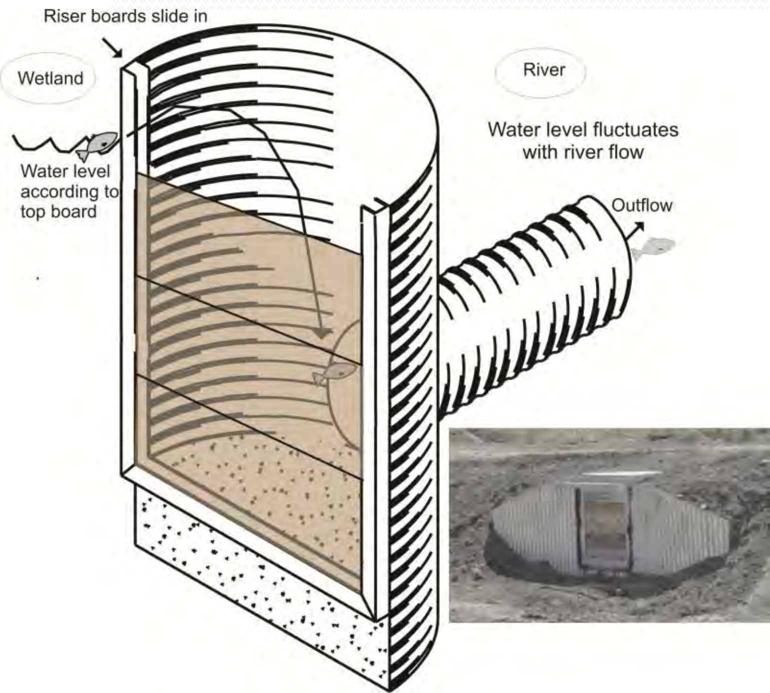


Actively managed sites

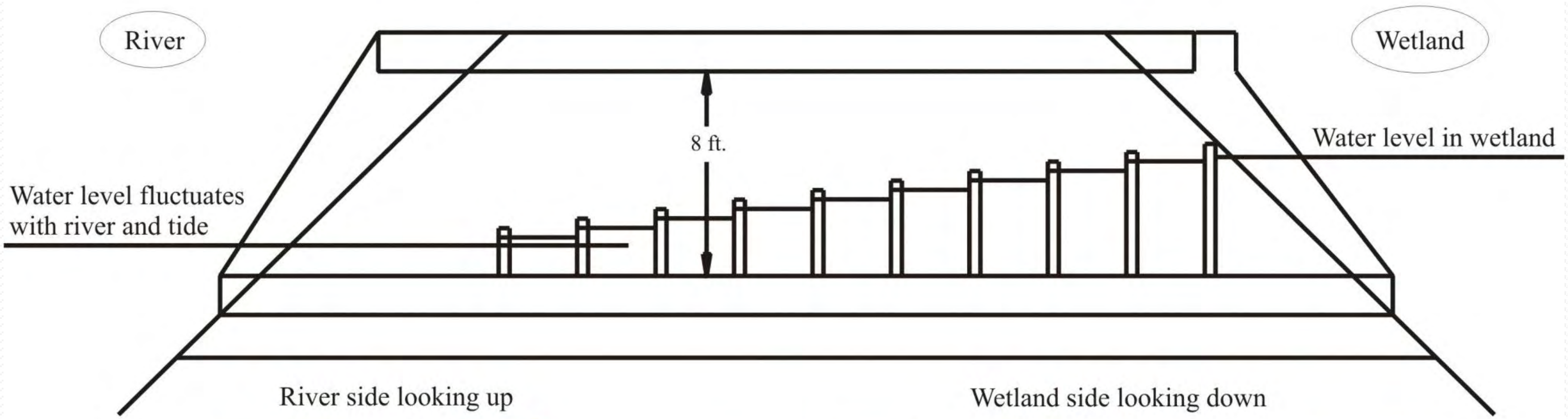
Structures increase duration and predictability of inundation



Bottom surface elevation of channel 2.5 m



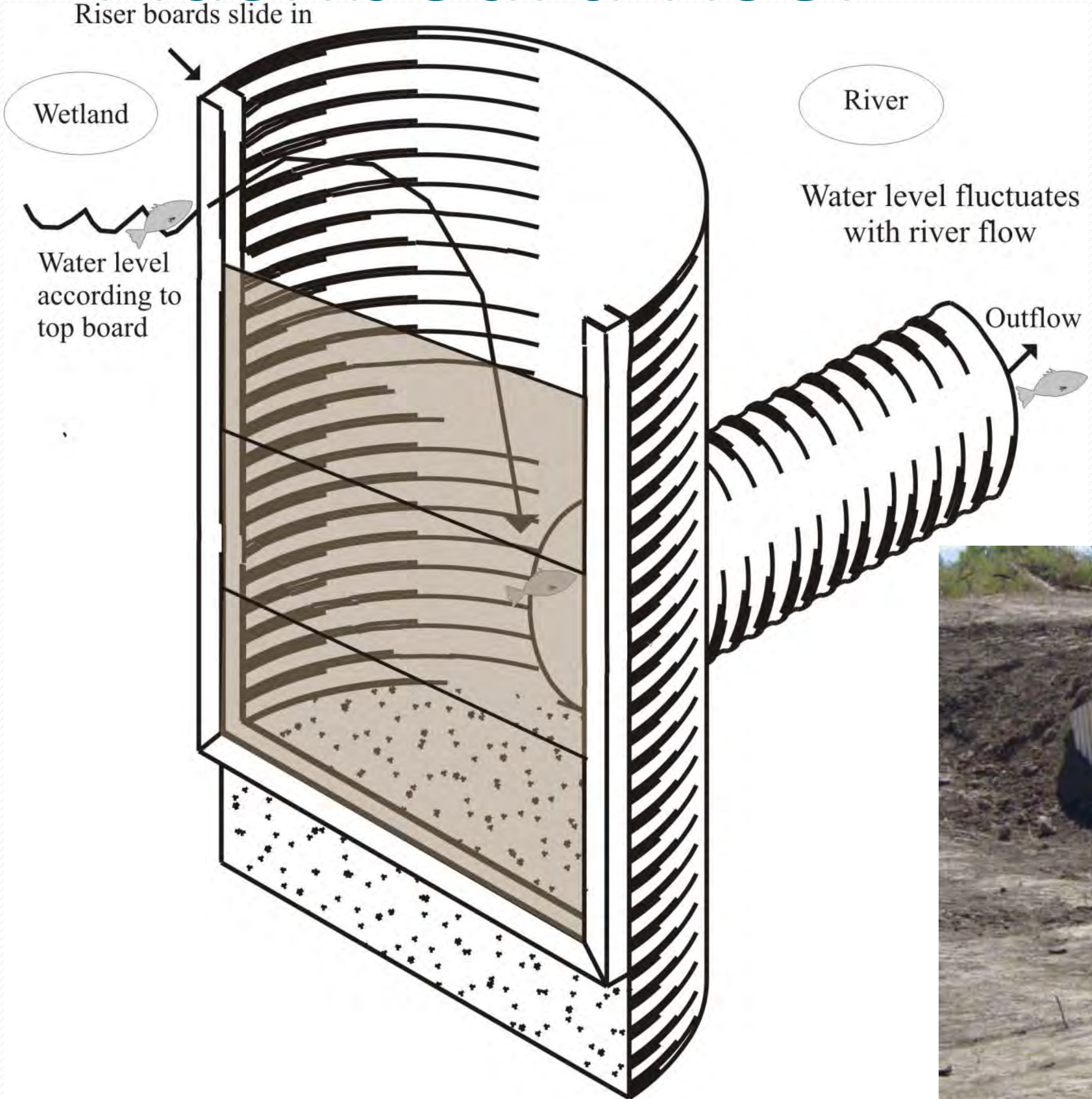
Pool-weir-chute



River side looking up

Wetland side looking down

Flashboard riser

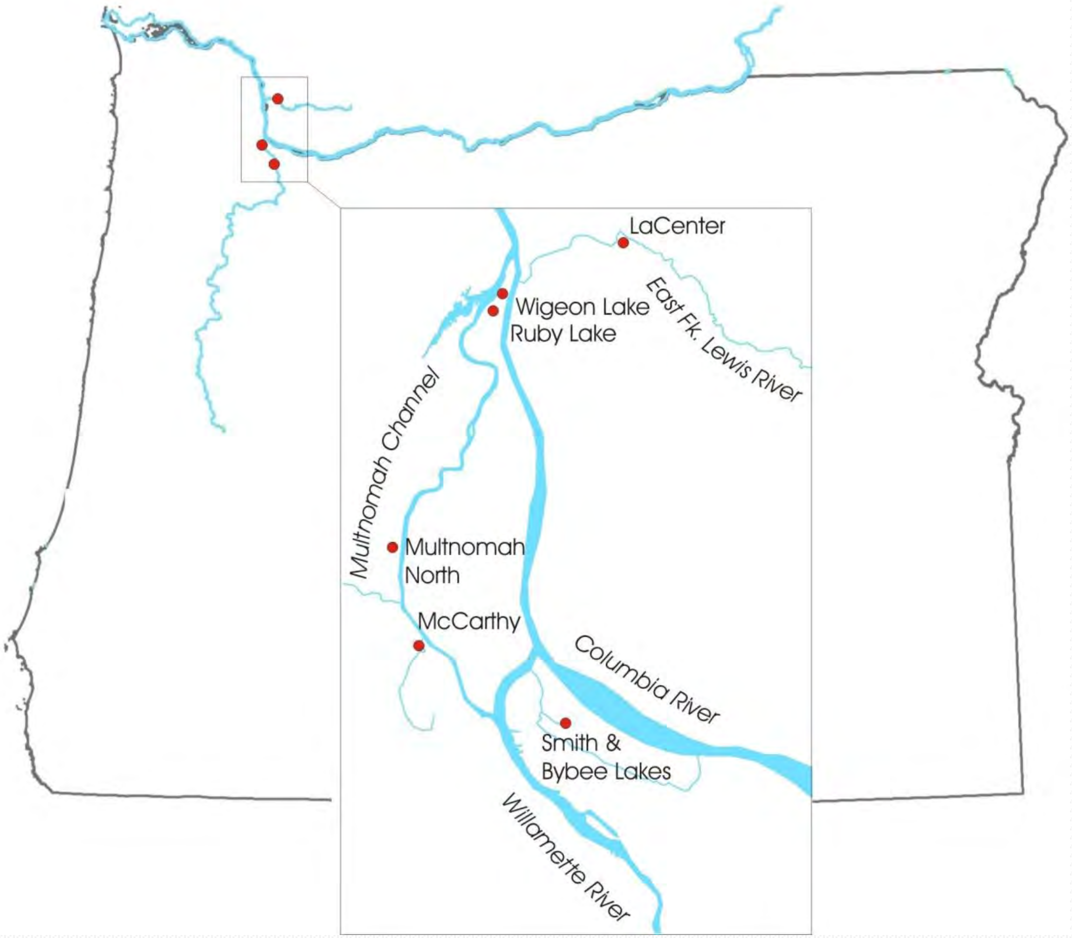


Site selection

- Opportunistic sampling at Ducks Unlimited project sites in Oregon and Washington
  - Wetlands periodically accessible to riverine fishes during period of inundation (Nov-June)
  - No salmon spawning occur in streams flowing into wetland sites (juvenile salmon must enter from adjacent river)
  - Broad geographical range across continuum of environmental conditions
  - Dispersed across PNW

Sites in Lower Willamette and East Fork Lewis rivers

- Smith & Bybee Lakes
- McCarthy Ck.
  (aka Enyart)
- Multnomah N.
- Ruby Lake
- Widgeon Lake
- LaCenter



Sampling Protocol

- Based on water year
  - November through June
  - WY 2002 to 2006 (5 yrs)
- Within wetland sampling
- Ingress/egress sampling

Environmental Variables

- Water temperature
- Water surface elevation (river vs. floodplain)
- Precipitation
- Wetland site (area, volume, average depth, distance to salmon migration route)
- Categorical (region, tidal influence, structure type, stream flow through wetland)
- Other (lunar phase, barometric pressure)

Within-wetland sampling

- Passive trap nets (4-5 nets)
- Set every 4-6 weeks
- Overnight sets
- 176 sample events (1-2 days, all nets used)




Ingress/Egress sampling

- Two-way traps – all six sites in Upper CR estuary
- Traps checked 3x/week
- 1311 sample events (trap-check days/site)



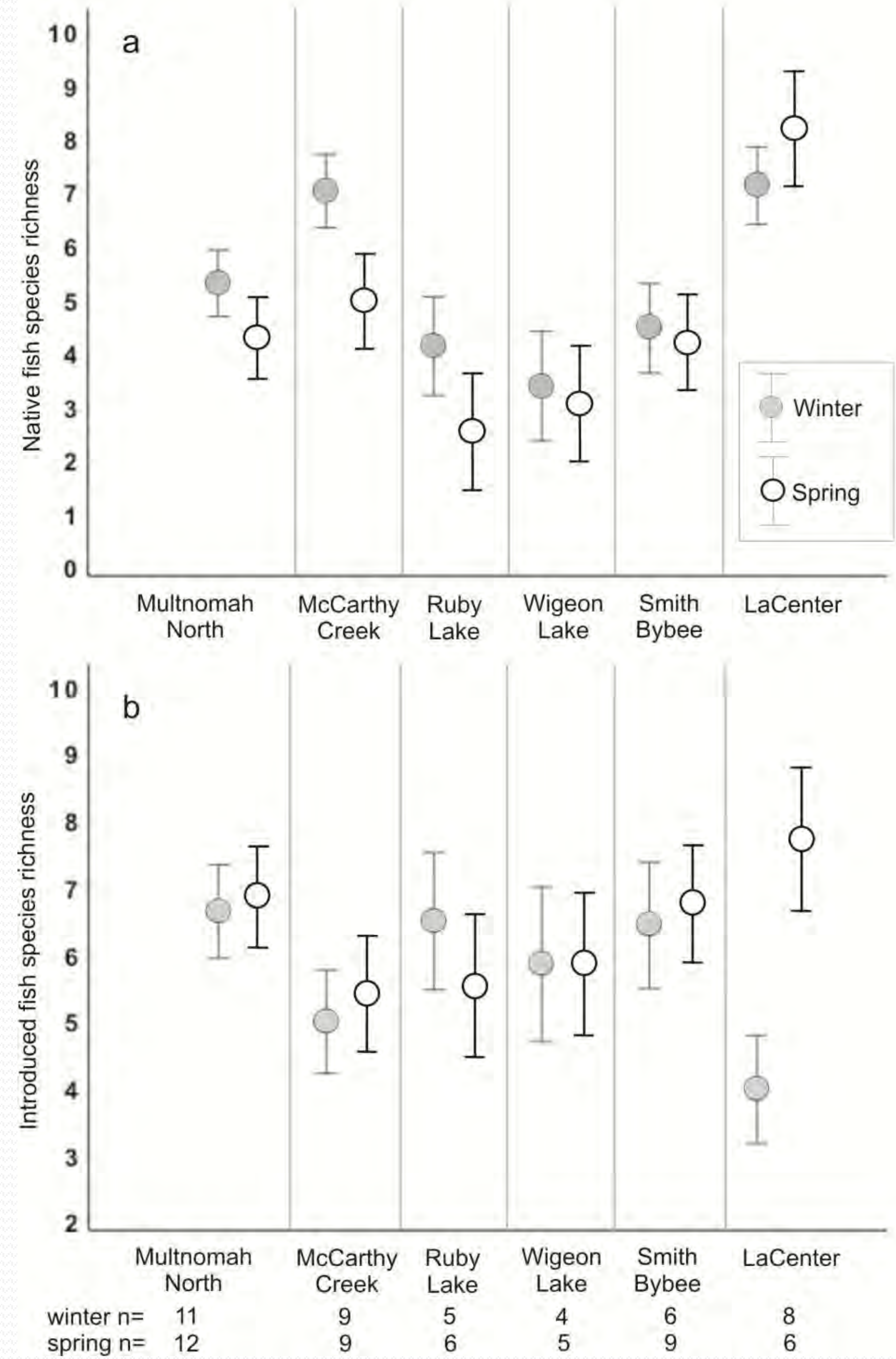

Fish Species

Comparison among six sites in upper Columbia River estuary

Fish species presence (indicated by X) at each site in UCRE (species common to all sites are shaded)

Species in order of abundance	McCarthy Ck.	Mulnomah N.	LaCenter	Smith-Bybee	Wigeon Lk.	Ruby Lk.
Native fish species						
Threespine stickleback	X	X	X	X	X	X
Northern pikeminnow	X	X	X	X	X	X
Chinook	X	X	X	X	X	X
Redside shiner	X	X	X	X	X	X
Peamouth	X	X	X	X	X	
Coho	X	X	X			X
Largescale sucker	X	X	X	X	X	X
Sculpin sp.	X	X	X	X	X	X
Lamrey sp.	X	X	X	X		
Rainbow/steelhead	X		X	X		
Cutthroat	X		X			
Chiselmouth		X				
Total native species	11	10	11	9	7	6
Introduced fish species						
Carp/goldfish	X	X	X	X	X	X
Yellow perch	X	X	X	X	X	X
Crappie sp.	X	X	X	X	X	X
Bullhead sp.	X	X	X	X	X	X
Sunfish sp.	X	X	X	X	X	X
Oriental weatherfish	X	X		X	X	X
Banded killifish	X	X	X	X	X	X
Golden shiner	X	X	X	X	X	X
Largemouth bass	X	X	X	X	X	X
Amur goby			X			
Mosquitofish	X	X	X	X	X	X
Smallmouth bass	X	X		X		
Fathead minnow	X	X				
Total introduced species	12	12	10	11	10	10
Total N+I species	23	22	21	20	17	16

Average a) native and b) introduced fish species richness among UCRE sites in winter and spring (with 95% confidence intervals).



In UCRE sites:
% of total catch
small-bodied fishes <200 mm

Of the total catch in all wetlands, small-Bodied fishes weighed 72% of the total catch and large-bodied fishes weighed the remaining 28%

Species (≤200mmFL)	fish/net-day	% of total catch
Threespine stickleback	**420.92**	**74.5**
Carp/goldfish **(<100mmFL)**	48.3	8.6
Yellow perch	18.39	3.3
Northern pikeminnow	18.04	3.2
Crappie sp.	13.53	2.4
Brown bullhead	9.71	1.7
Sunfish sp.	9.41	1.7
Chinook	6.34	1.1
Redside shiner	6.26	1.1
Peamouth	5.46	1
Coho	1.79	0.3
Carp **(>100mmFL)**	1.33	0.2
Oriental weatherfish	0.87	0.2
Sculpin sp.	0.83	0.1
Largescale sucker	0.64	0.1
Banded killifish	0.57	0.1
Golden shiner	0.39	0.1
Largemouth bass	0.26	0
Lamprey sp.	0.08	0
Amur goby	0.07	0
Mosquitofish	0.07	0
Rainbow trout (steelhead)	0.02	0
Cutthroat trout	0.01	0
Smallmouth bass	0.01	0
Fathead minnow	0	0
Chiselmouth	0	0
	total=	99.70%

27.8% of catch, by weight (all fish – large and small)

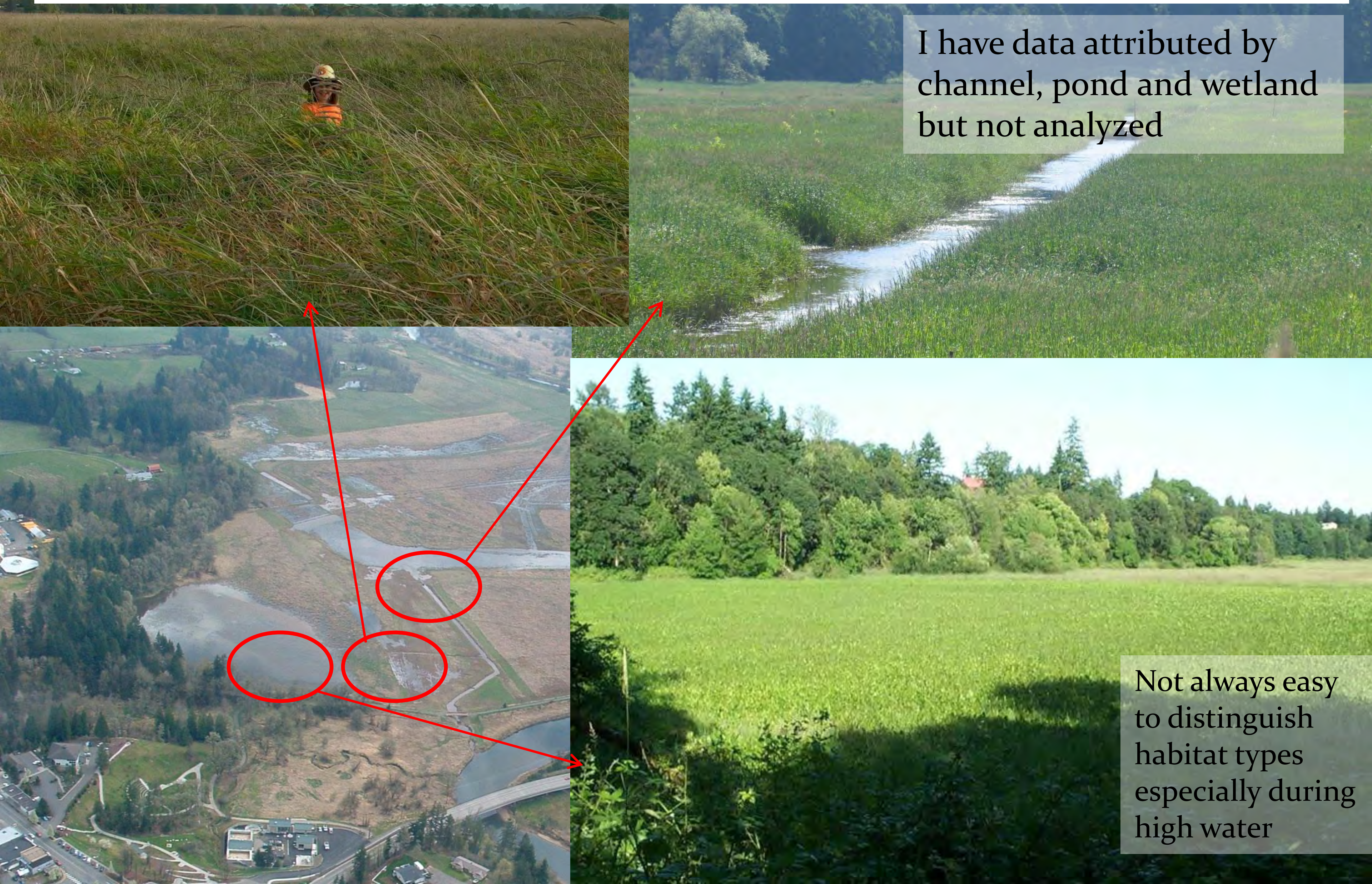
% of total catch large-bodied fishes >200 mm

Species (>200mmFL)	Max. FL (mm)	Av. FL (mm)	fish/net-day	% of total catch	
Peamouth	294	229	0.5	0.1	
Carp/goldfish (>200mmFL)	680	378	0.41	0.1	
Brown/yellow bullhead	**462**	**230**	**0.28**	**0**	69 fish
Largescale sucker	550	387	0.23	0	
Rainbow trout (steelhead)	**780**	**241**	**0.03**	**0**	
Yellow perch	**290**	**220**	**0.03**	**0**	9 fish each
Northern pikeminnow	**405**	**286**	**0.01**	**0**	
Crappie sp.	**301**	**235**	**0.02**	**0**	7 fish
Cutthroat trout	**252**	**228**	**0.01**	**0**	
Chinook	**236**	**236**	**0**	**0**	
Largemouth bass	**226**	**226**	**0**	**0**	1 fish each
Smallmouth bass	**250**	**250**	**0**	**0**	
			total=	**0.30%**	

Large bodied fishes weighed 28% of the total catch

- 24% was non-predatory fishes (carp, suckers)
- **4% of the total catch , by weight, were piscivorous fishes (bullhead, N. pikeminnow, etc.)**

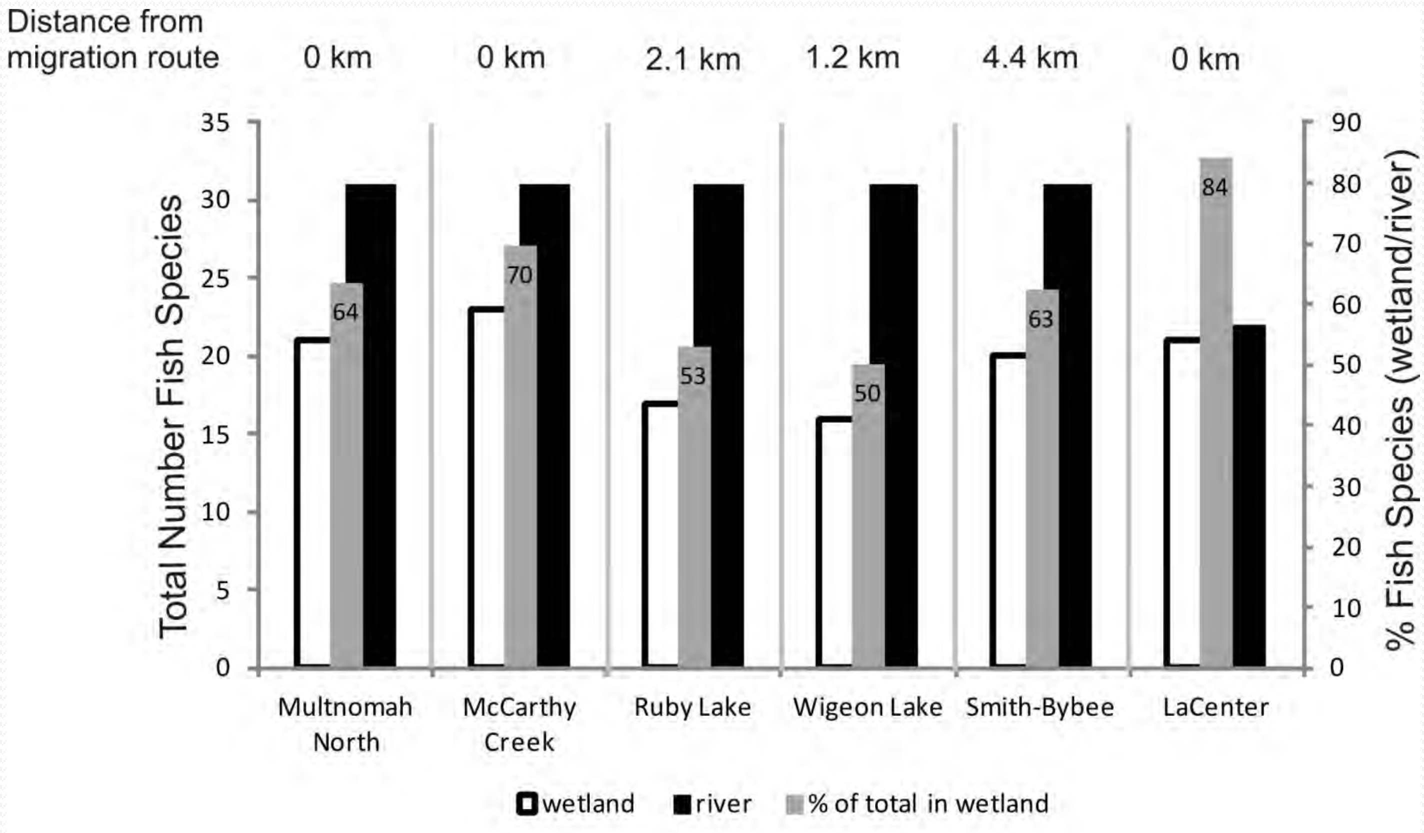
How does fish species composition differ between floodplain lakes and sloughs?



I have data attributed by channel, pond and wetland but not analyzed

Not always easy to distinguish habitat types especially during high water

How does fish species composition differ between main stem and floodplain habitats?



About 60% of fish species found in rivers were documented in the adjacent wetlands. Almost all fish species in a given wetland were present in the adjacent river (94%)

Willamette River			**East Fork Lewis River**	
1. American shad (i)	9. chiselmouth	20. peamouth	1. Chinook	13. largemouth bass
2. banded killifish (i)	10. coho	21. prickly sculpin	2. chum	14. smallmouth bass
3. black crappie (i)	11. carp (i)	22. redside shiner	3. coho	15. carp
white crappie (i)	goldfish (i)	23. sandroller	4. steelhead/rainbow	goldfish
4. bluegill (i)	12. smelt	24. smallmouth bass (i)	5. cutthroat	16. white crappie
pumpkinseed (i)	13. golden shiner (i)	25. sockeye	6. sculpin	black crappie
warmouth (i)	14. largemouth bass (i)	26. starry flounder	7. bridgelip sucker	17. banded killifish
5. bridgelip sucker	15. longnose dace		largescale sucker	18. yellow perch
largescale sucker	speckled dace	27. steelhead/rainbow	8. peamouth	19. pumpkinseed
6. brown bullhead (i)	16. mosquitofish (i)	28. threespine stickleback	9. northern pikeminnow	20. brown bullhead
yellow bullhead (i)	17. mountain whitefish	29. walleye (i)	10. smelt	yellow bullhead
7. channel catfish (i)	18. northern pikeminnow	30. sturegon	11. sandroller	21. white sturgeon
8. Chinook	19. Pacific lamprey	31. yellow perch (i)	12. redside shiner	22. threespine stickleback

i=introduced   exclusive to river

In Willamette River floodplain sites, only fathead minnow & oriental weatherfish exclusive to wetlands

In LaCenter wetland, Amur goby, golden shiner & Mosquitofish exclusive to wetland

Community analyses

Find patterns in fish communities and relate to environmental variables

PC-ORD

– cluster analysis - assign species to functional groups and validate group membership

–non-metric multidimensional scaling - ordination method used to correlate groups with species trait characteristics

and for graphical representation displaying the association between fish species and species traits

HyperNiche

– non-parametric multiplicative regression

- used to identify relationships between individual fish species and variables from the environmental matrix

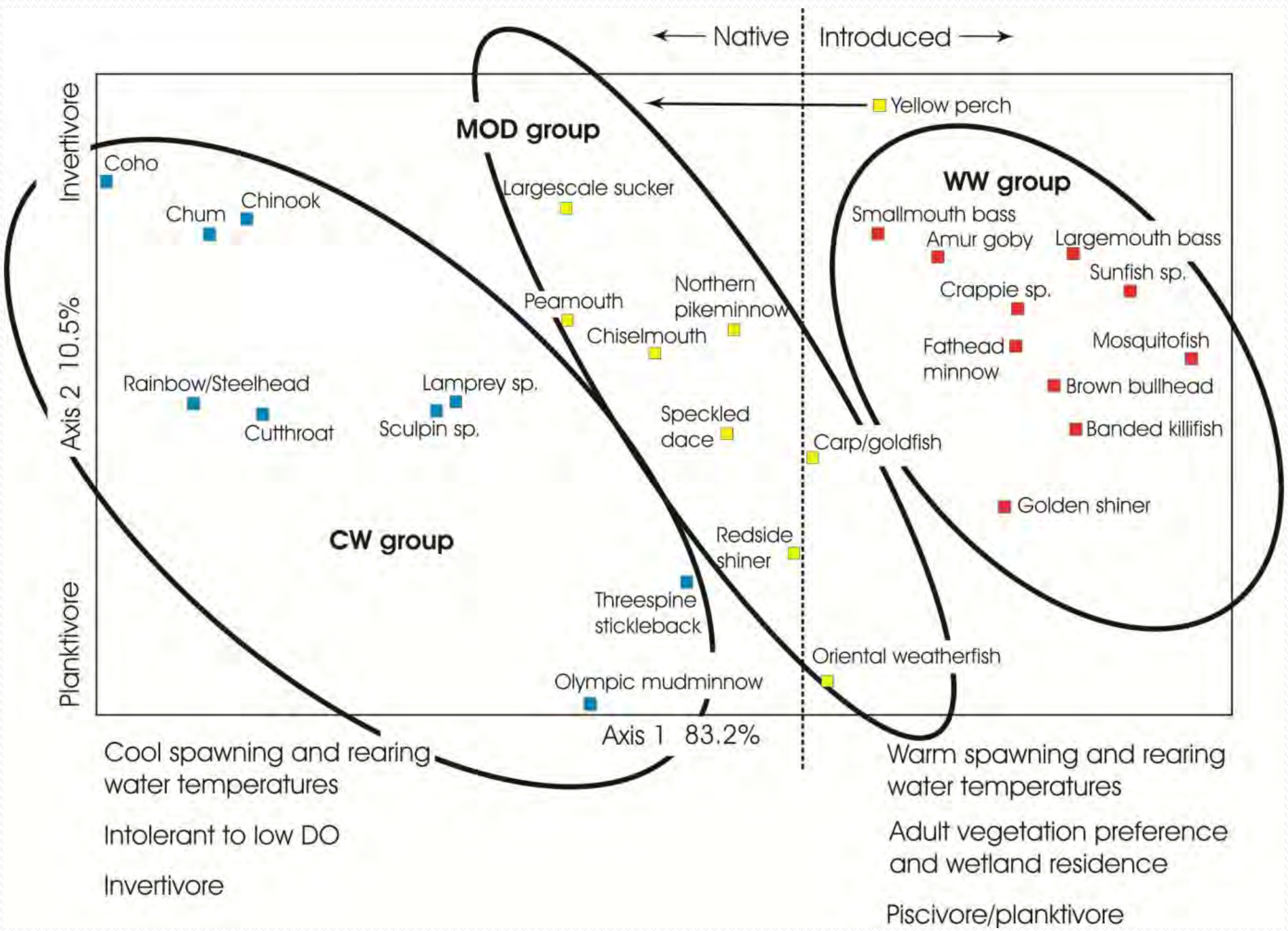
Species traits	brown bullhead	carp/ goldfish	chiselmouth	coho
trophic category (see below)	pisc	macro	plank	macro
adult vegetation preference (y/n)	y	y	n	n
preference for clear water (y/n)	n	n	y	y
prefer mud feeding substrate (y/n)	y	y	n	n
typically reside in wetlands as adults (y/n)	y	y	n	n
spawning water type (stream/wetland)	wetland	wetland	stream	stream
spawning substrate/structure (see below)	mud	veg	gravel	gravel
min water temp spawn ˚C	20.4	14.5	15	4.4
max water temp spawn ˚C	21.7	20	17	9.4
current required for spawning (y/n)	n	n	y	y
range for spawning timing	Apr-Jun	Apr-Jul	May-Jul	Sep-Jan
multiple spawning per season (y/n)	n	n	n	n
juv min water temp preference ˚C	21	14.5	15	12
juv max water temp preference ˚C	27.3	18.5	20	15
juv current preference (still, low, mod)	still	still	mod	low
juv preference structure/substate (see below)	veg	veg	log/rock	pool/ch
typically rear in wetlands (y/n)	y	y	n	y
tolerance to low DO (low, med, hi)	hi	hi	low	low

trophic category is according to the most common size class in the catch (macroinvertebrate, piscivore, planktivore)

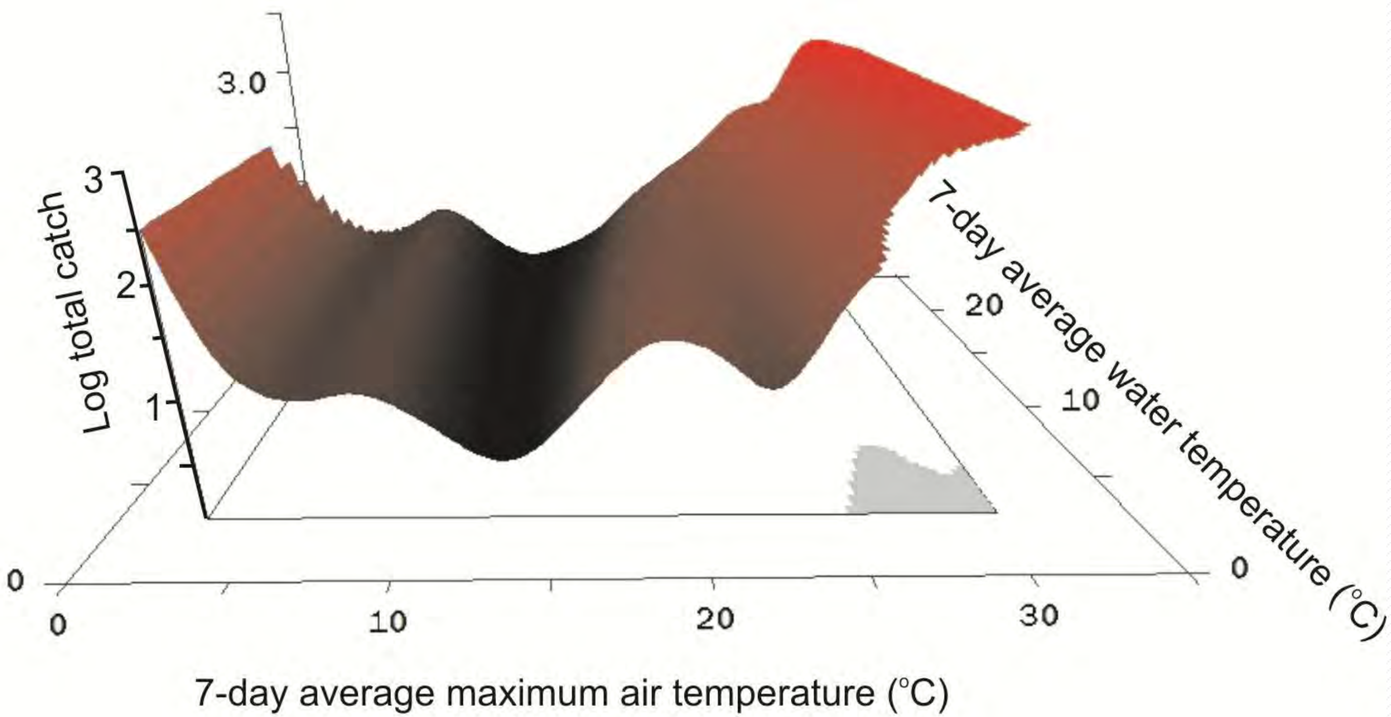
spawning substrate/structure (log, vegetation, mud, gravel, sand)
juvenile preference for structure/substate (log/rock, veg, mud, pool/channel)

Group WW: Introduced, warm-water spawning and rearing temperatures	Group MOD: Native and introduced*, moderate spawning and rearing water temperatures	Group CW: Native, cool-water spawning and rearing temperature
Amur goby (GOB)	Chiselmouth (CHM)	Chinook (CHI)
Banded killifish (BAK)	Largescale sucker (LGS)	Coho (CHO)
Brown bullhead (BRB)	Northern pikeminnow (NPM)	Chum (CHU)
Crappie (CRP)	Peamouth (PEA)	Cutthroat (CUT)
Fathead minnow (FHM)	Redside shiner (RSS)	Rainbow trout (RBT)
Golden shiner (GOS)	Speckled dace (SKD)	Sculpin (COT)
Largemouth bass (LMB)	Carp/goldfish* (CAP)	Lamprey (LAM)
Mosquitofish (MOF)	Oriental weatherfish* (OWF)	Olympic mudminnow (OLY)
Smallmouth bass (SMB)	Yellow perch* (YEP)	Threespine stickleback (TSS)
Sunfish (SUN)		

Ordination displaying the association between fish species and species traits

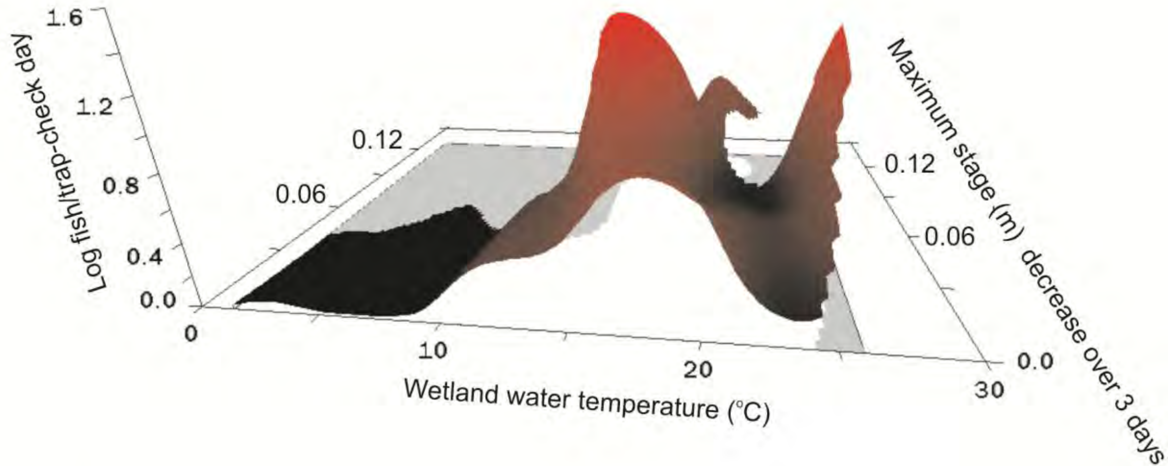


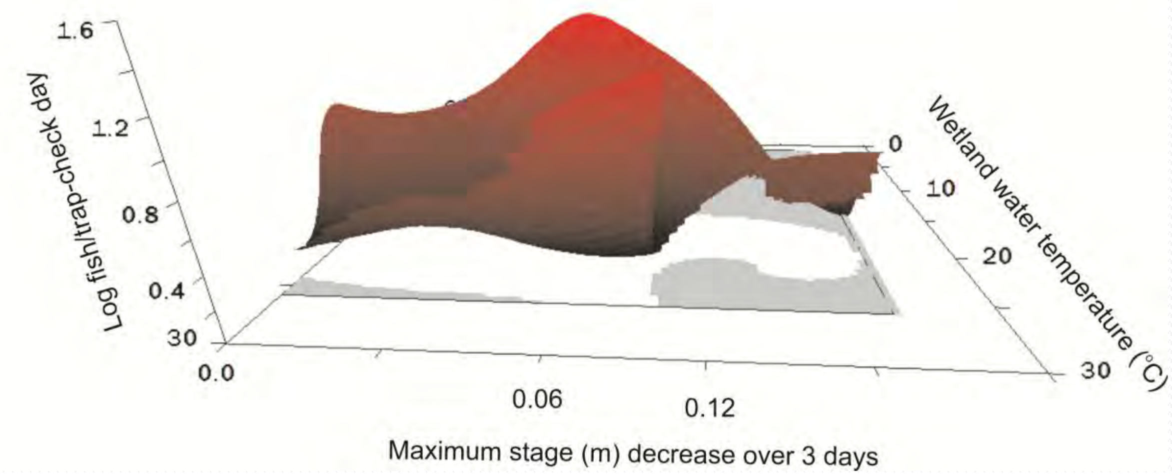
Response surface of introduced, warm-water fish functional group to environmental variables



Predictor	Sensitivity	Tolerance
7-d avg max air temp	0.6580	1.370
7-d avg water temp	0.0333	7.315

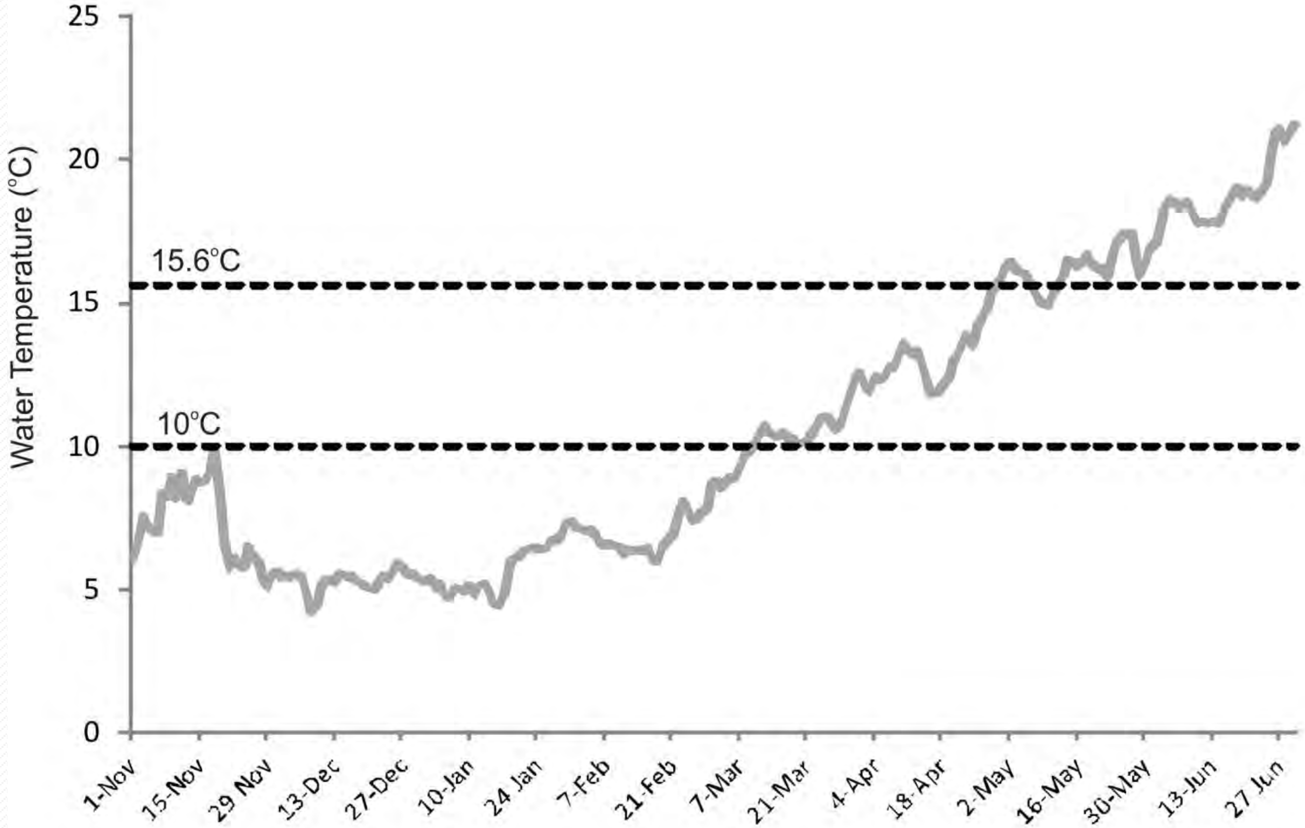
Two views of response surfaces of inbound WW fish (log fish/trap-check day) at Smith-Bybee wetland to wetland water temperature (ºC) and maximum 3-day stage (m) decrease, 2005-2006





Site	Trap direction	Predictor 1 (sensitivity)	Predictor 2 (sensitivity)	xR^2	# SU
		WW			
SB	IN	WetWt (1.0069)	WM3dSD (0.3391)	0.4671	115

Average Daily Average Water Temperatures in Six UCRE Floodplain Wetlands Nov-June, 2002 - 2006



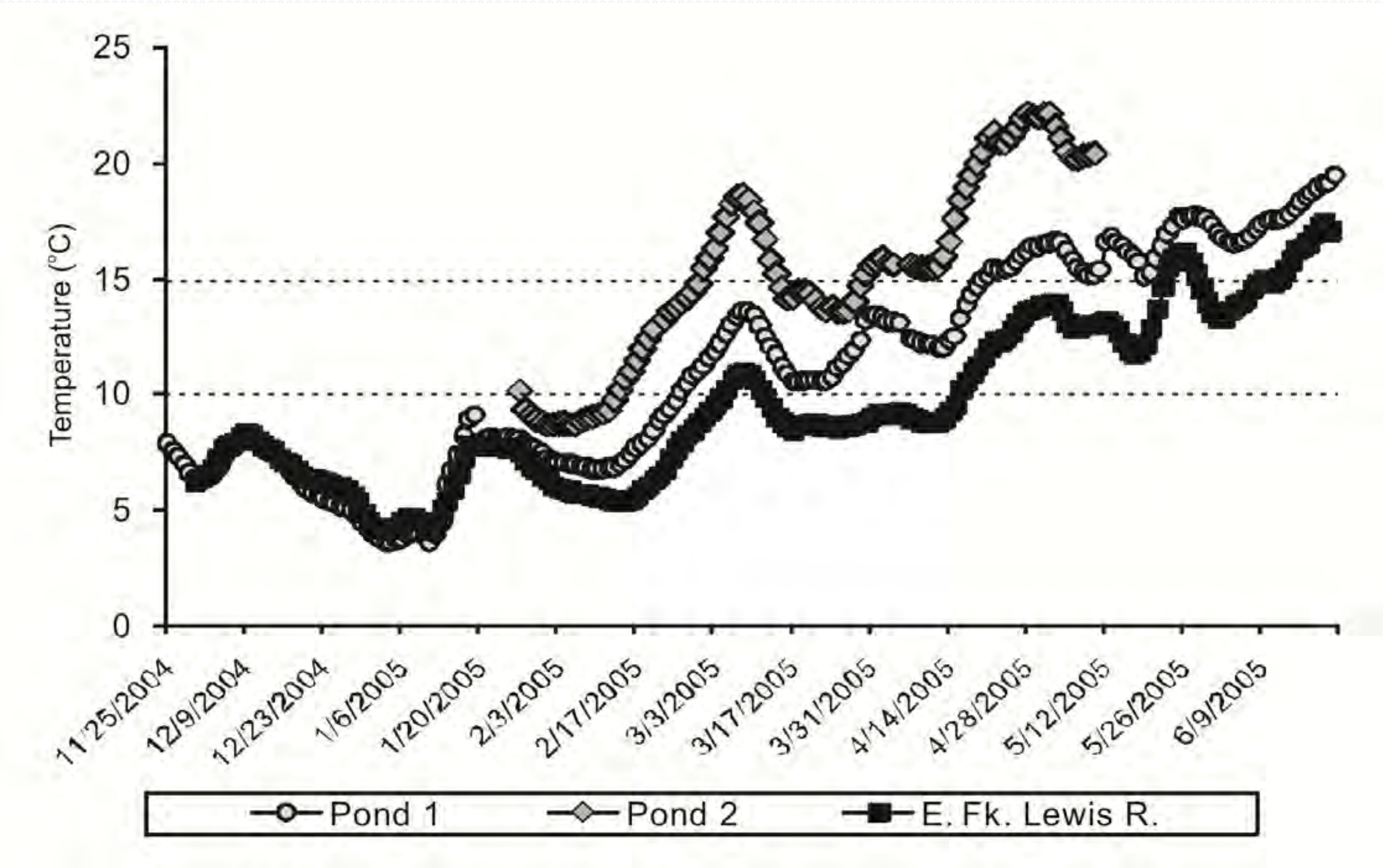
Daily average water temperature at six upper Columbia River estuary floodplain wetland sites, 2002-2006

Species	Water temperature (°C) minimum	maximum	References
Chinook	10	15.6	(Armour 1991)
	12	14	(Scott and Crossman 1998)
Chum	12	14	(Scott and Crossman 1998)
Coho	12	15	(Bjornn and Reiser 1991)
Cutthroat trout	12	15	(Hickman and Raleigh 1982)
Rainbow trout	10	16	(Benke 1992)

Preferred water temperatures for juvenile salmonid rearing

Water temperature in the East Fork Lewis River and two ponds within LaCenter Bottoms wetland, Nov. 2004-June 2005

- Behavioral thermo-regulation - move through temperature gradients to find preference
- Hydrologic connectivity allows fish to move between river and floodplain to find most suitable habitat

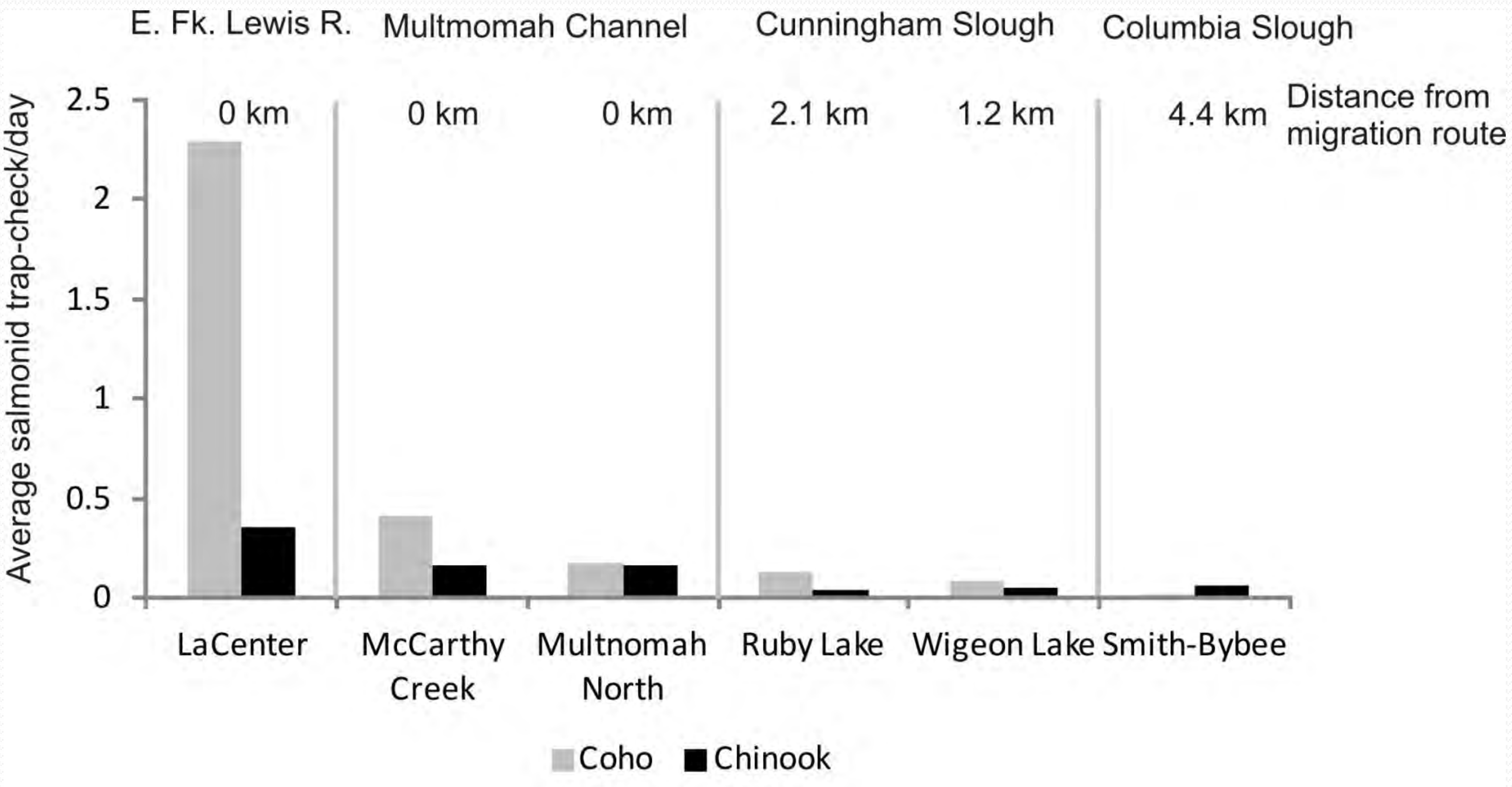


LaCenter Floodplain Restoration Area and East Fork Lewis River

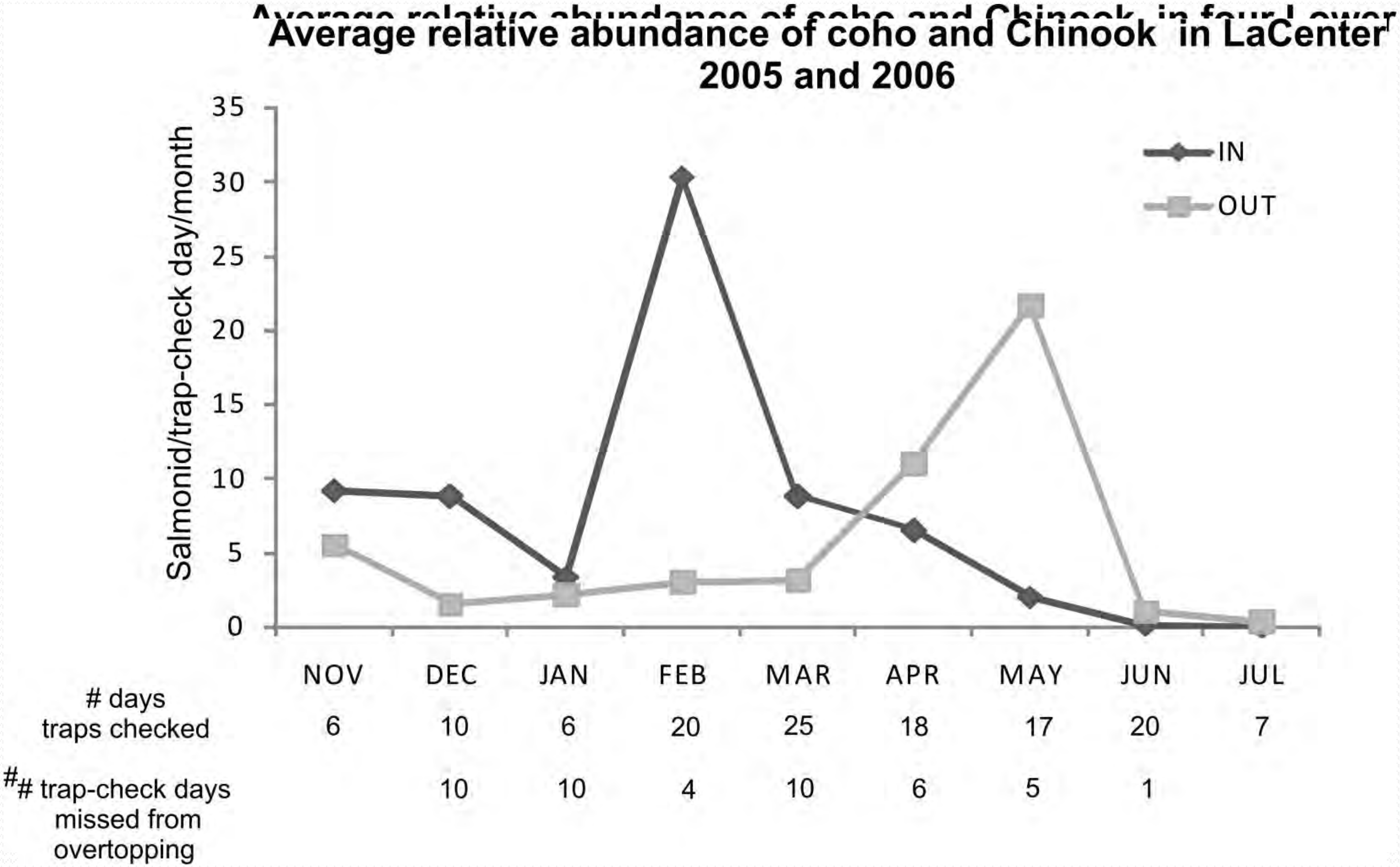
Juvenile coho and Chinook ingress/egress

What factors influence movement in and out of floodplain habitats

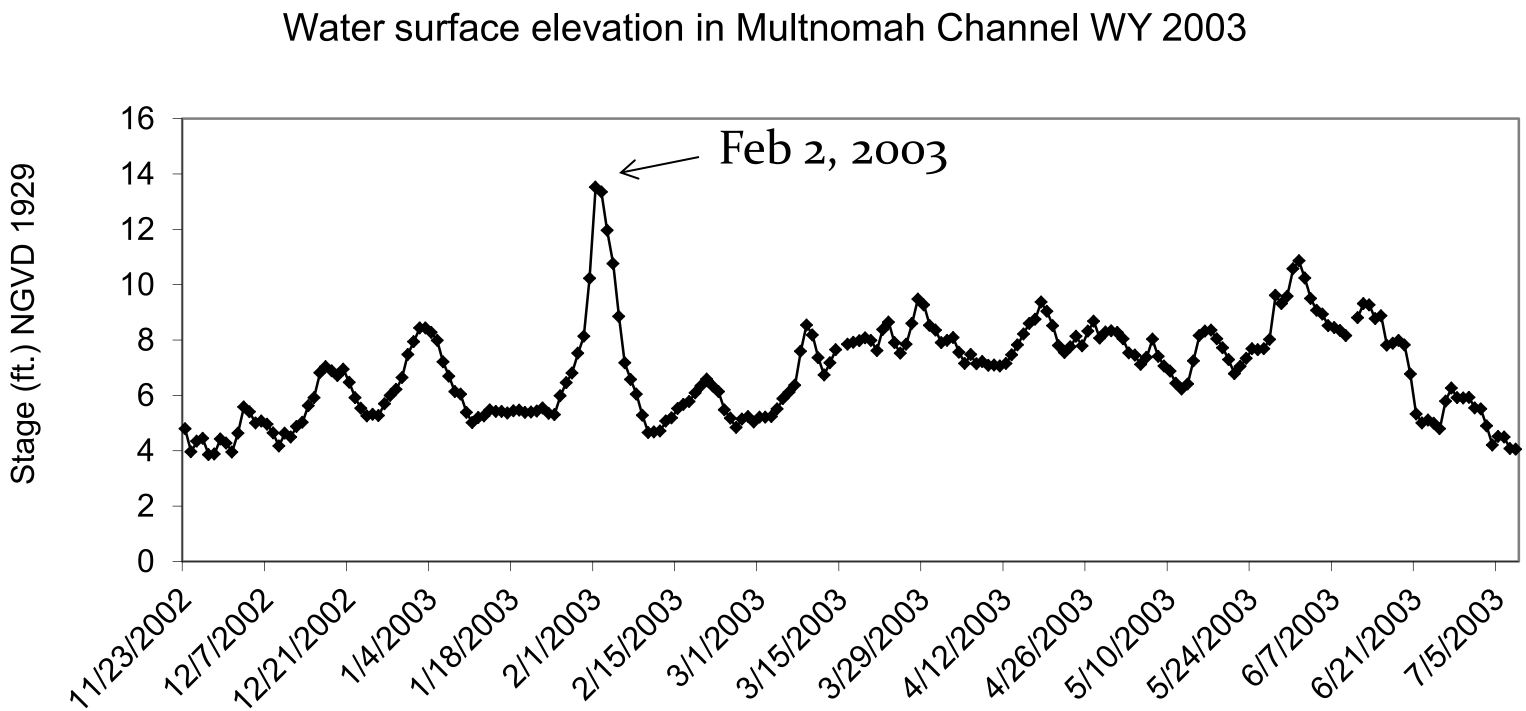
Average catch of coho and Chinook in two-way traps



Ingress/Egress

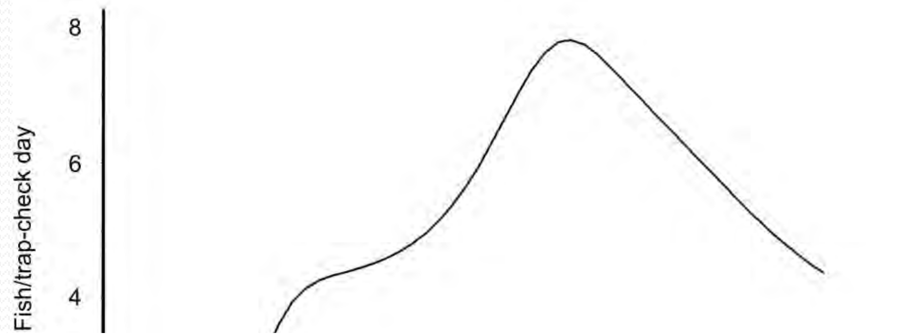


Two-way traps missed ingress of juvenile salmonids during high water events – McCarthy Ck. Wetland after high water event



- High water event in Mulnomah Channel 2/2/03
- Sampled floodplain on 2/11/03: 1,012 0+ Chinook caught (34-52 mm and 52 coho (67-108mm)
- In April, only 10 0+ Chinook were caught

LaCenter coho i



Hyp

- W
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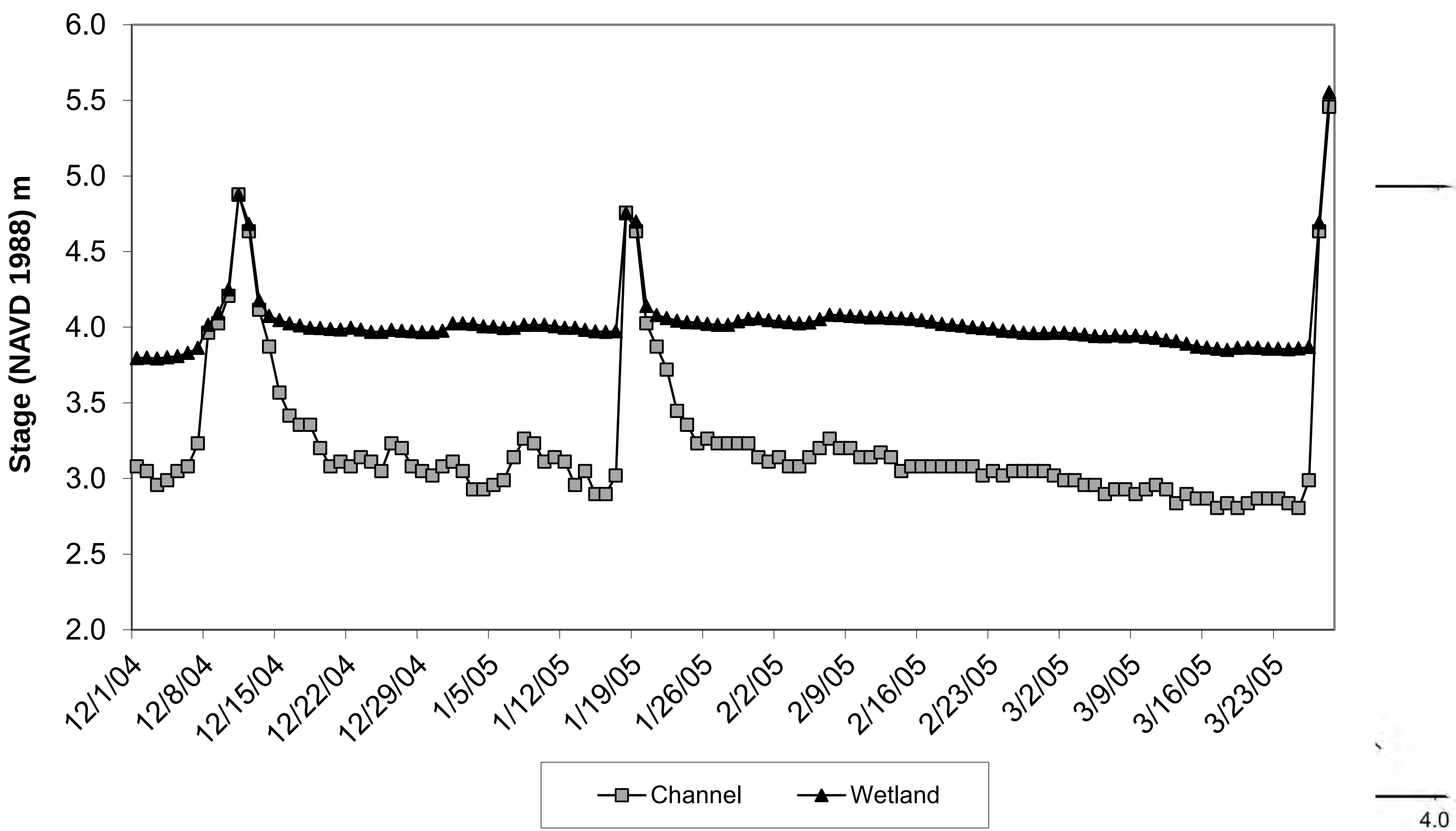
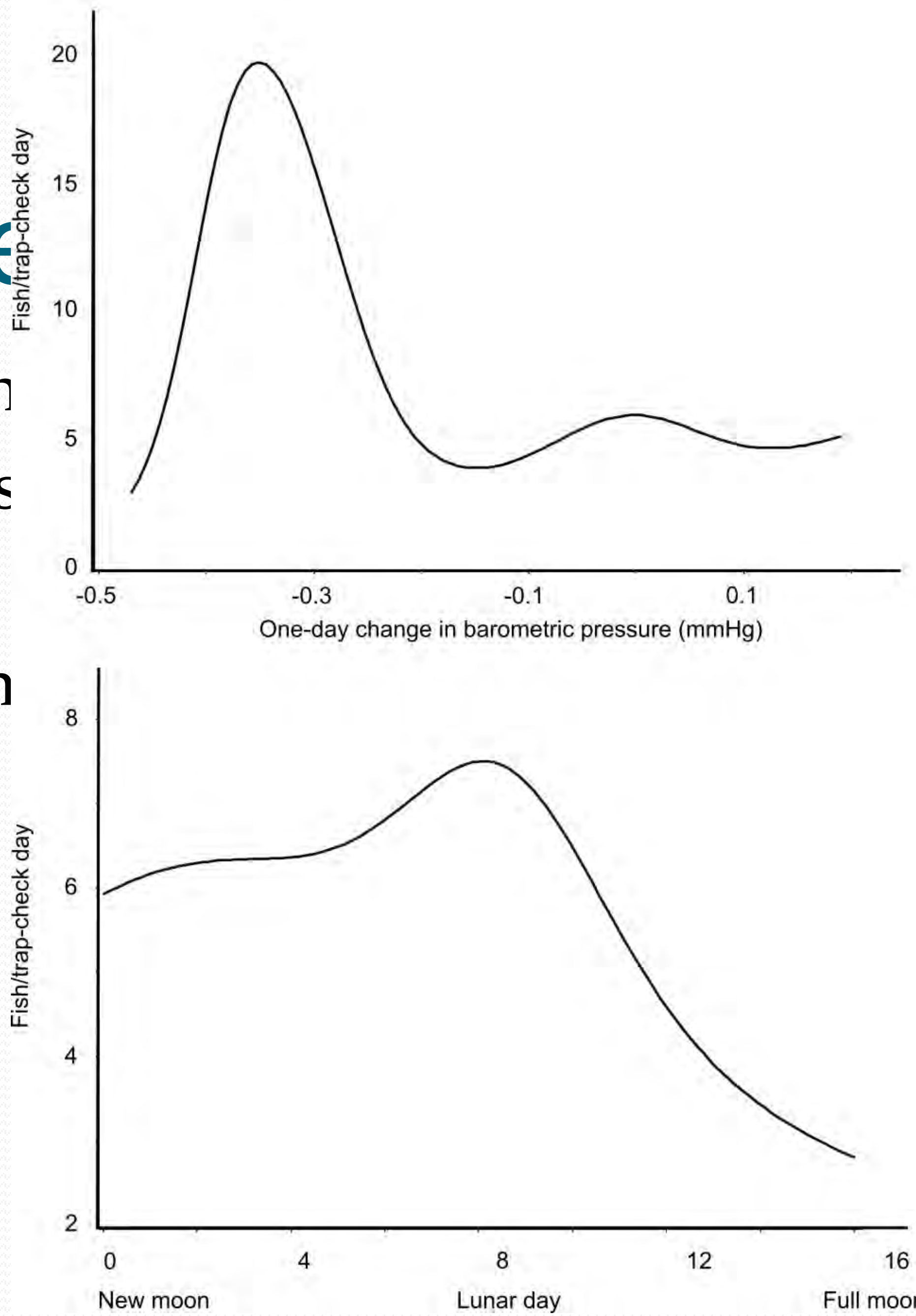


East Fork Lewis River daily average water level (National Geodetic Vertical Datum, 1988)

LaCente egress

- One day ch .35 mm Hg)
- Lunar phas

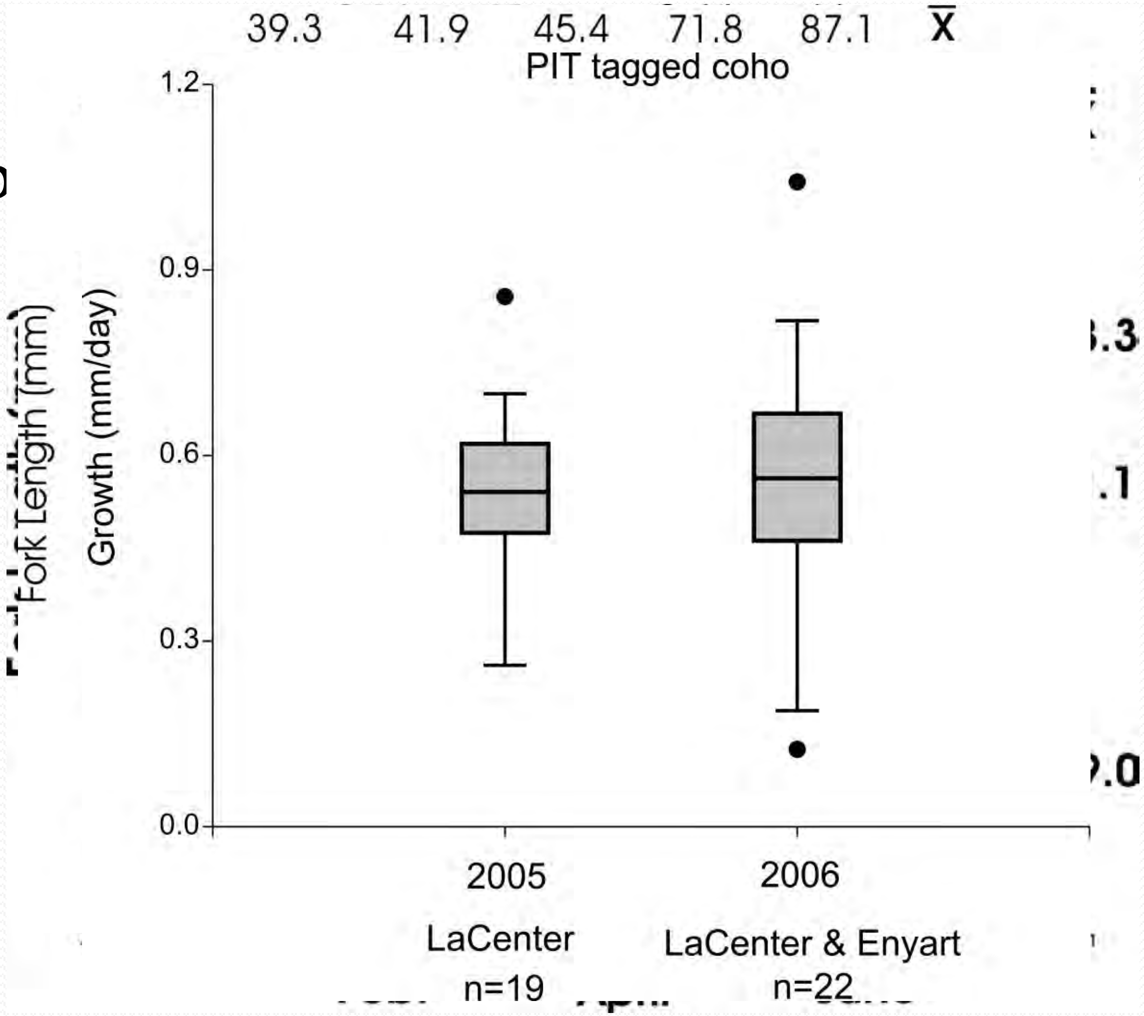
HyperNich 66)



Potential benefits for salmonids using floodplain habitats

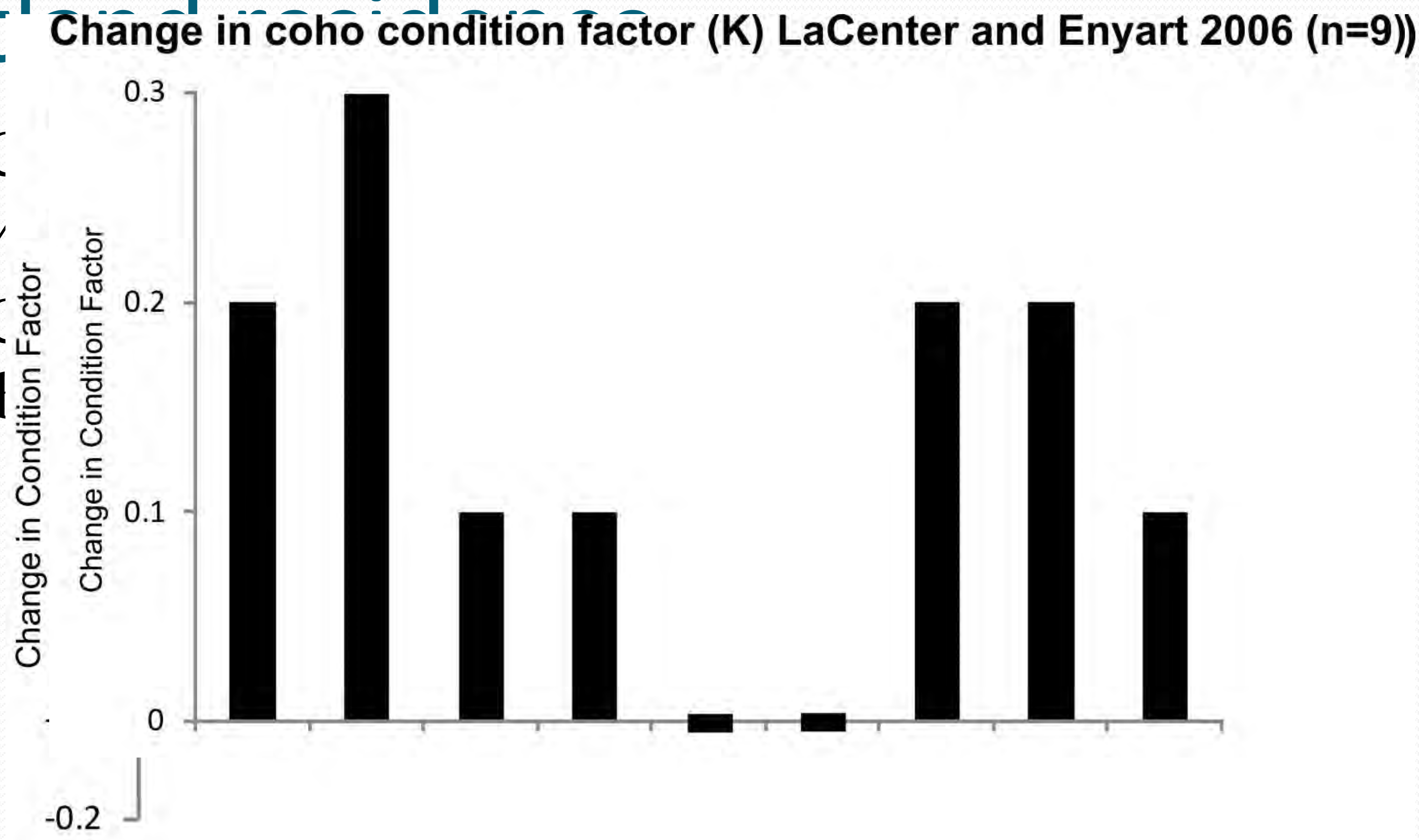
Juvenile salmon growth in wetlands

- Data sparse b
  Chinook and



Change in condition factors after wet

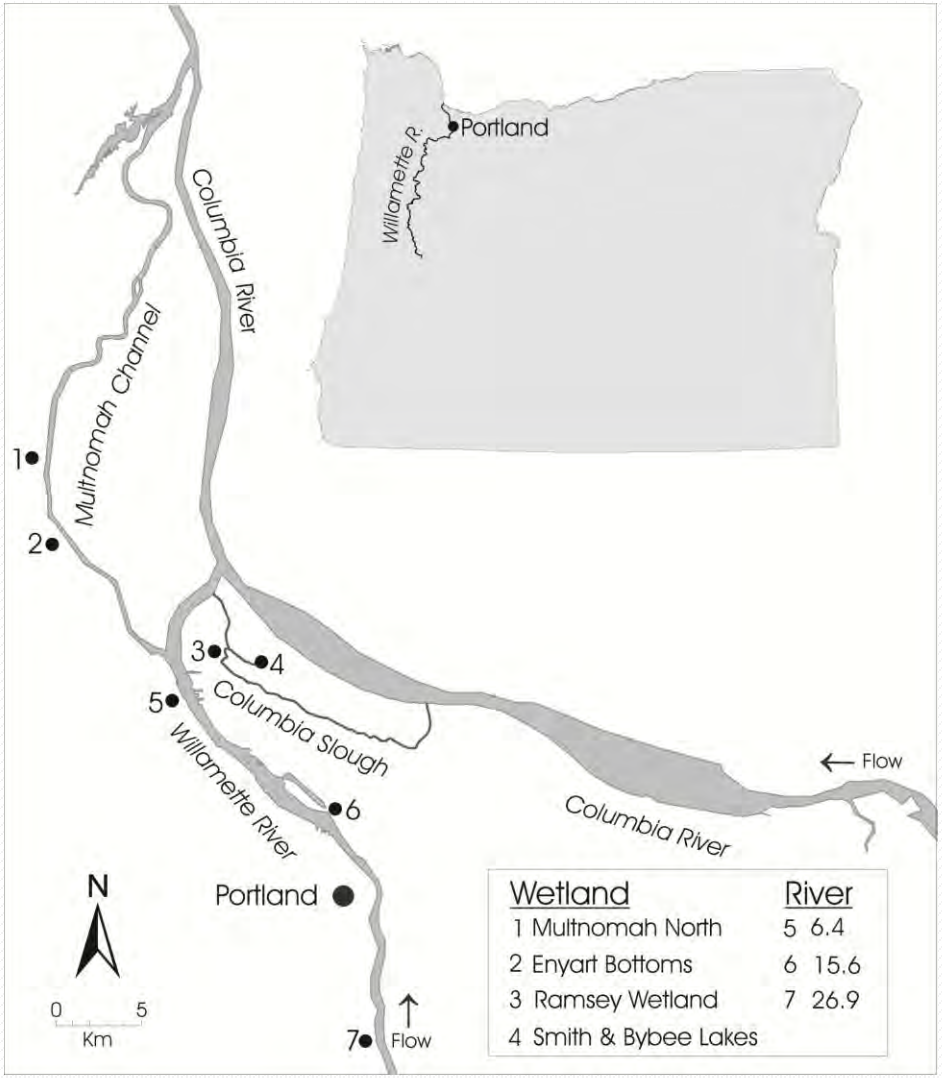
- LaC
  30%
- LaC
  stal



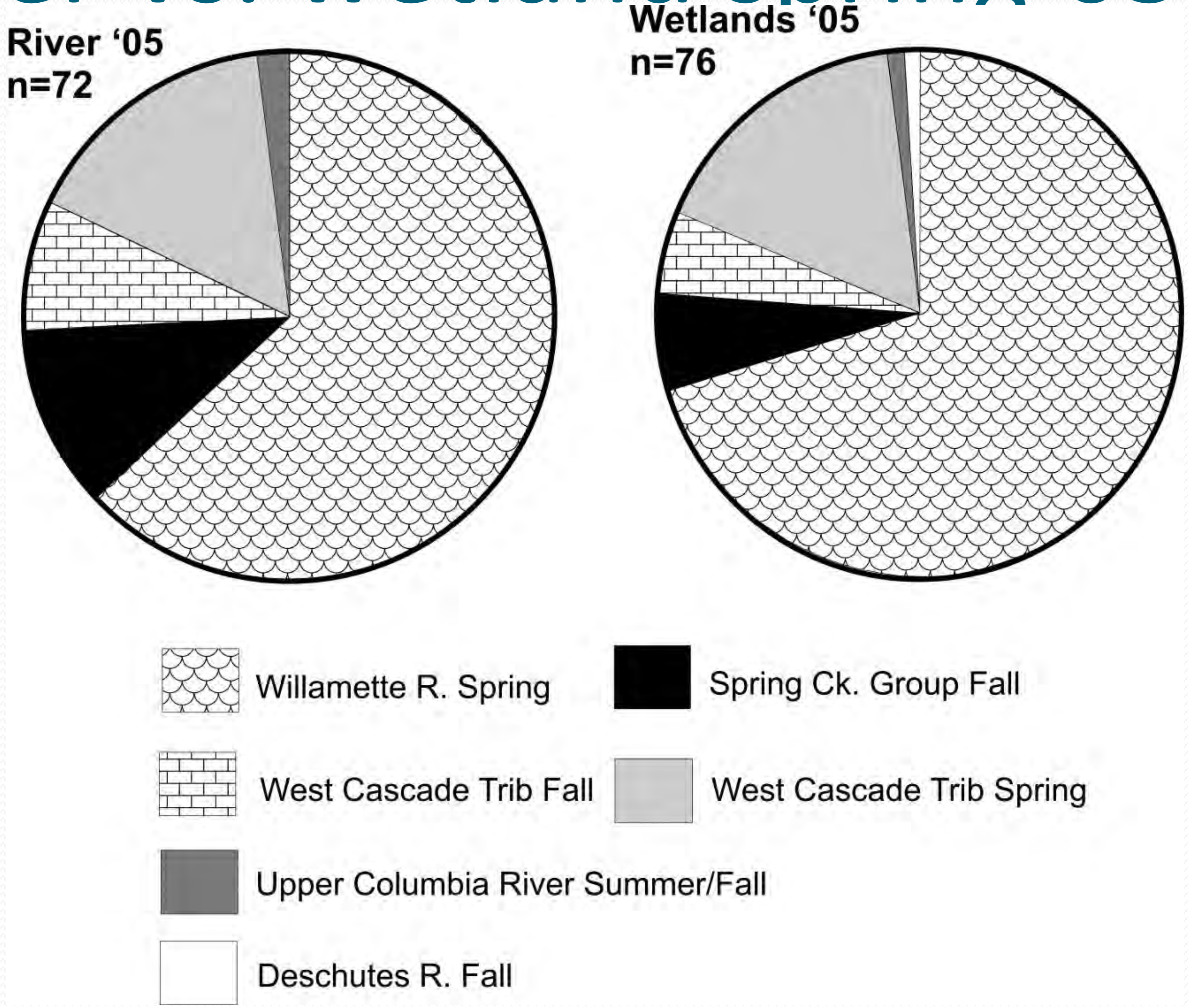
Stock composition of juvenile Chinook in lower Willamette floodplains and river

Chinook fry stock and origin

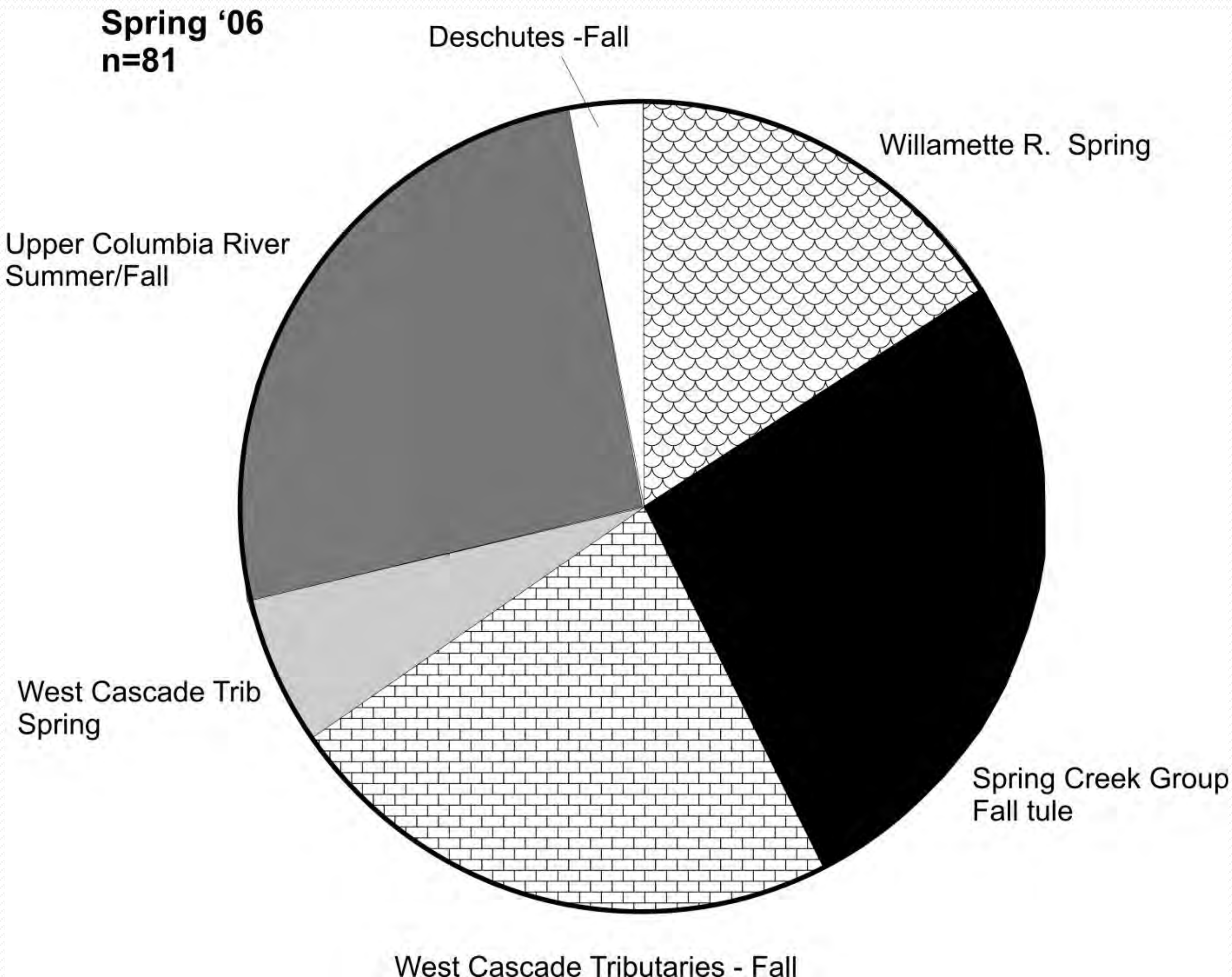
- DU and ODFW observe Chinook fry in Willamette R. and wetlands winter/spring
- DU collected fin clips winter/spring 2005 and 2006
- David Teel, NOAA Fisheries,
- microsatellite DNA analysis



river vs. wetland spring‘05



Wetlands – spring '06



Summary 1

- Juvenile salmonid use of seasonal floodplain wetlands was widespread across the region.
- Salmonids were caught in every wetland sampled, although relative abundance varied greatly.

Summary 2

- Risk of juvenile salmonid predation in seasonal floodplain wetlands may be small judging from
- the low relative abundance of potential piscivores in the catch,
- high relative abundance of other species more prone to predation (threespine stickleback), and
- the increase in rearing area following inundation may reduce the probability of encountering a predator.

Summary 3

- Moderate to high growth rates (up to 1.04 mm/d) of salmonids rearing in wetlands and higher condition factors after wetland rearing compared with wetland entry indicated that juvenile salmon received some benefit by inhabiting floodplain wetlands.

Summary 4

- Wetland water temperatures were in the optimal range for juvenile salmonid growth during the late winter and early spring.
- Juvenile salmon egressed from wetland sites as water temperatures warmed in the spring.

Summary 5

- Juvenile salmon caught in traps as they entered wetlands from adjacent rivers indicated volitional entry.
- Patterns of inbound and outbound movement of juvenile salmon at wetland sites varied seasonally.
- Movements were prompted by different environmental variables depending on site, species, and whether juvenile salmon were entering or leaving wetland sites.

Implications for restoration and management: A

- Despite alterations to habitat and hydrologic regime, juvenile coho and Chinook use floodplain habitats in winter and spring when they have access
- Will providing ingress/egress opportunity benefit salmon?
  - Growth, early indications suggest yes
  - Survival? Life history diversity?

Implications for restoration and management: B

- Design and management of projects effect ingress/egress and stranding
- Must choose appropriate design according to hydrology and management capability

Implications for restoration and management: C

- Restoration projects in lower river reaches may benefit juveniles from stocks other than those that spawn upstream in that river


HIKE ALASKA

Support provided by:

- Ducks Unlimited
- MJ Murdock Charitable Trust
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- Pacific Joint Venture
- David and Lucille Packard Foundation
- The Wertheimer Family Trust
- National Fish and Wildlife Foundation
- EPA Wetland Program
- US Forest Service
- Oregon SeaGrant