USGS
science for a changing world

Assessing limitations to life history diversity to help prioritize actions for restoring steelhead

Patrick J. Connolly[1], Kyle D. Martens[1],
Michael A. Newsom[2], and Dana Weigel[2]

[1] USGS, Western Fisheries Research Center,
Columbia River Research Laboratory

[2] US Bureau of Reclamation

U.S. Department of the Interior
U.S. Geological Survey

I. Know thy fish well

(before you mess with their home)

II. Is a moving fish a dead fish?

(not talkin' about their emotional state)

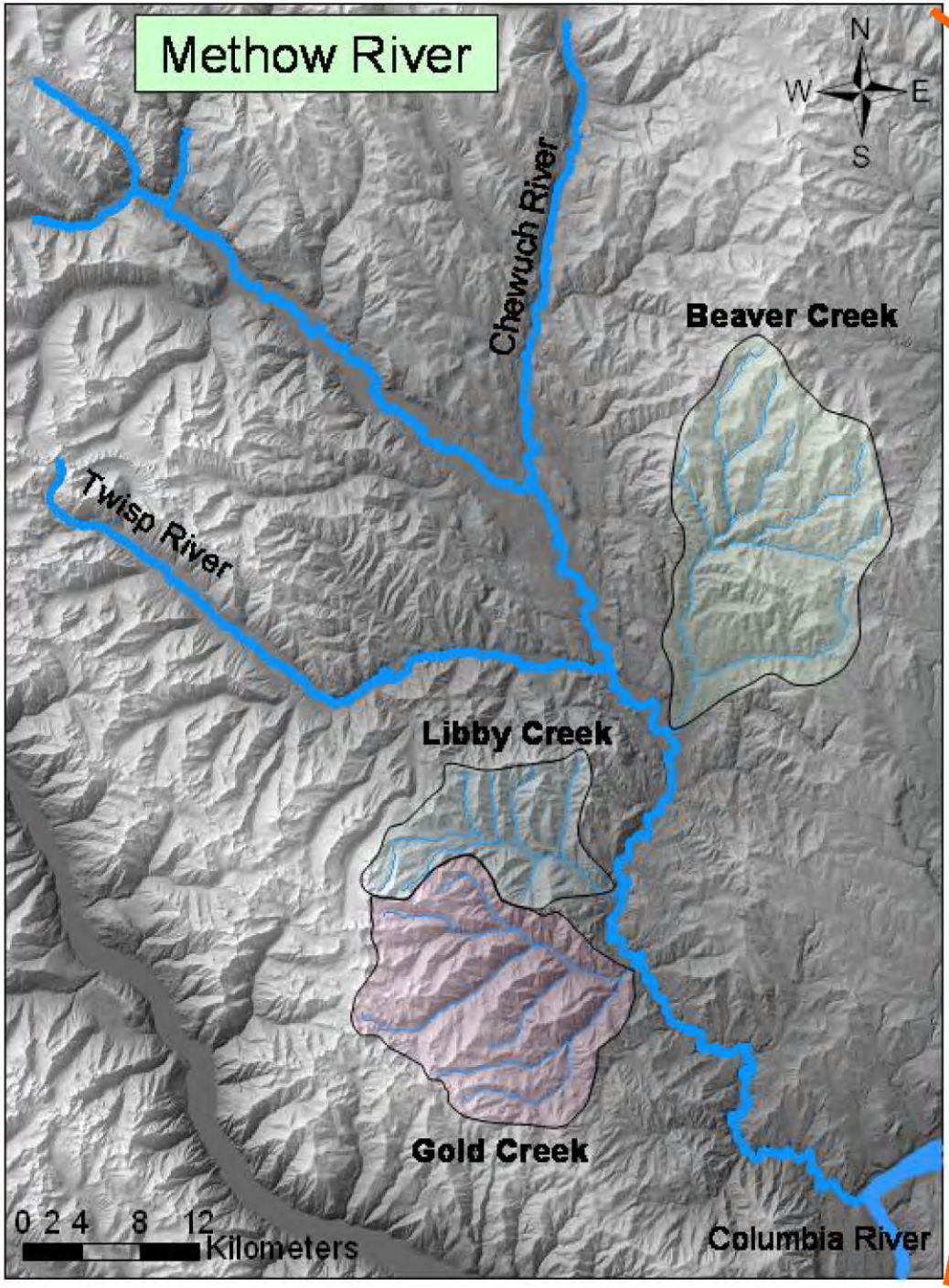
USGS

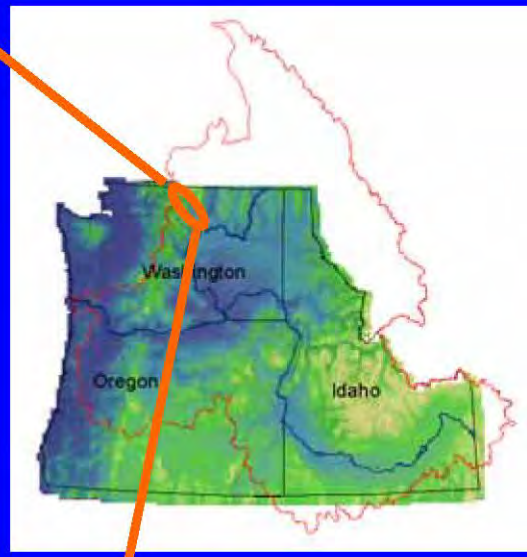
Steelhead, AKA: anadromous rainbow trout
Oncorhynchus mykiss

Methow River Watershed
Upper Columbia River ESU, ESA "Threatened"

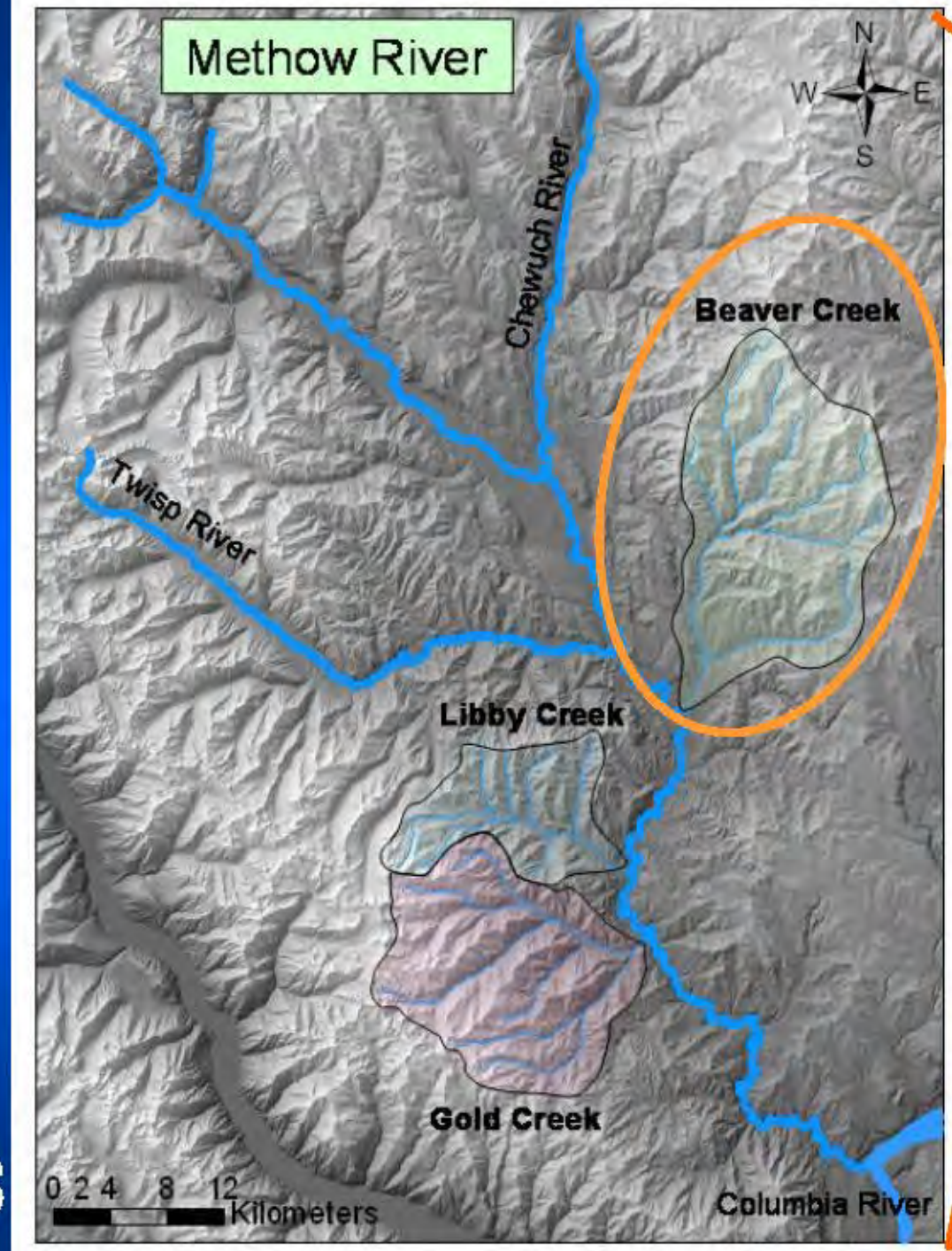
==> Freshwater ==========> Saltwater ==>
Adult ==> Egg ==> Fry ==> Parr ==> Smolt ==> Adult

USGS


Methow River
N
W
E
S
Chewuch River
Beaver Creek
Twisp River
Libby Creek
Gold Creek
0 2 4 8 12
Kilometers
Columbia River


Oregon
Idaho

USGS


Methow River
N
W
E
S
Chewuch River
Beaver Creek
Twisp River
Libby Creek
Gold Creek
0 2 4 8 12
Kilometers
Columbia River

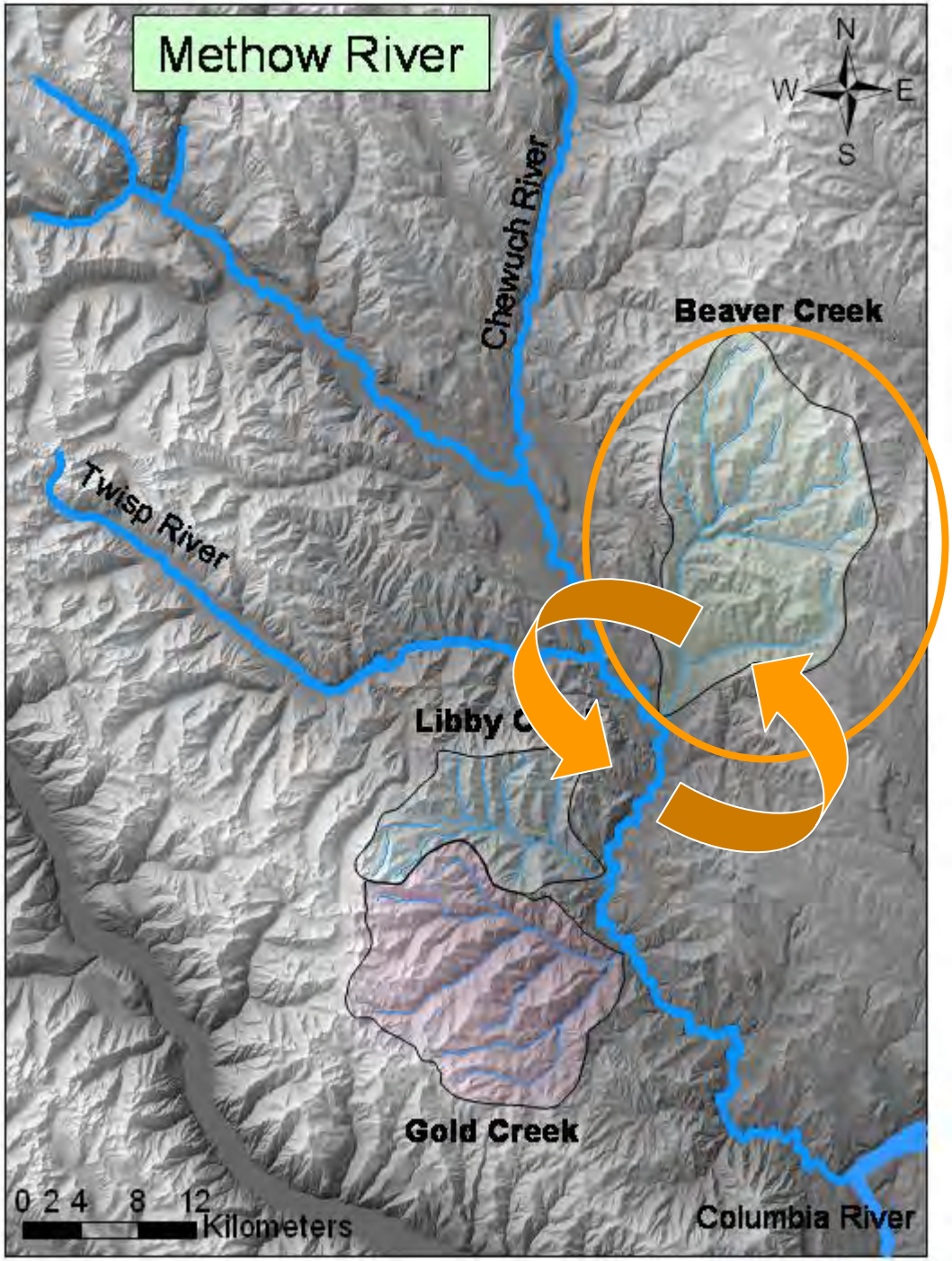

Oregon
Idaho

USGS

Barrier removals in Beaver Creek 2000-2005

Small dams
Culverts
(Reclamation, USFS)

USGS



Recolonization by steelhead

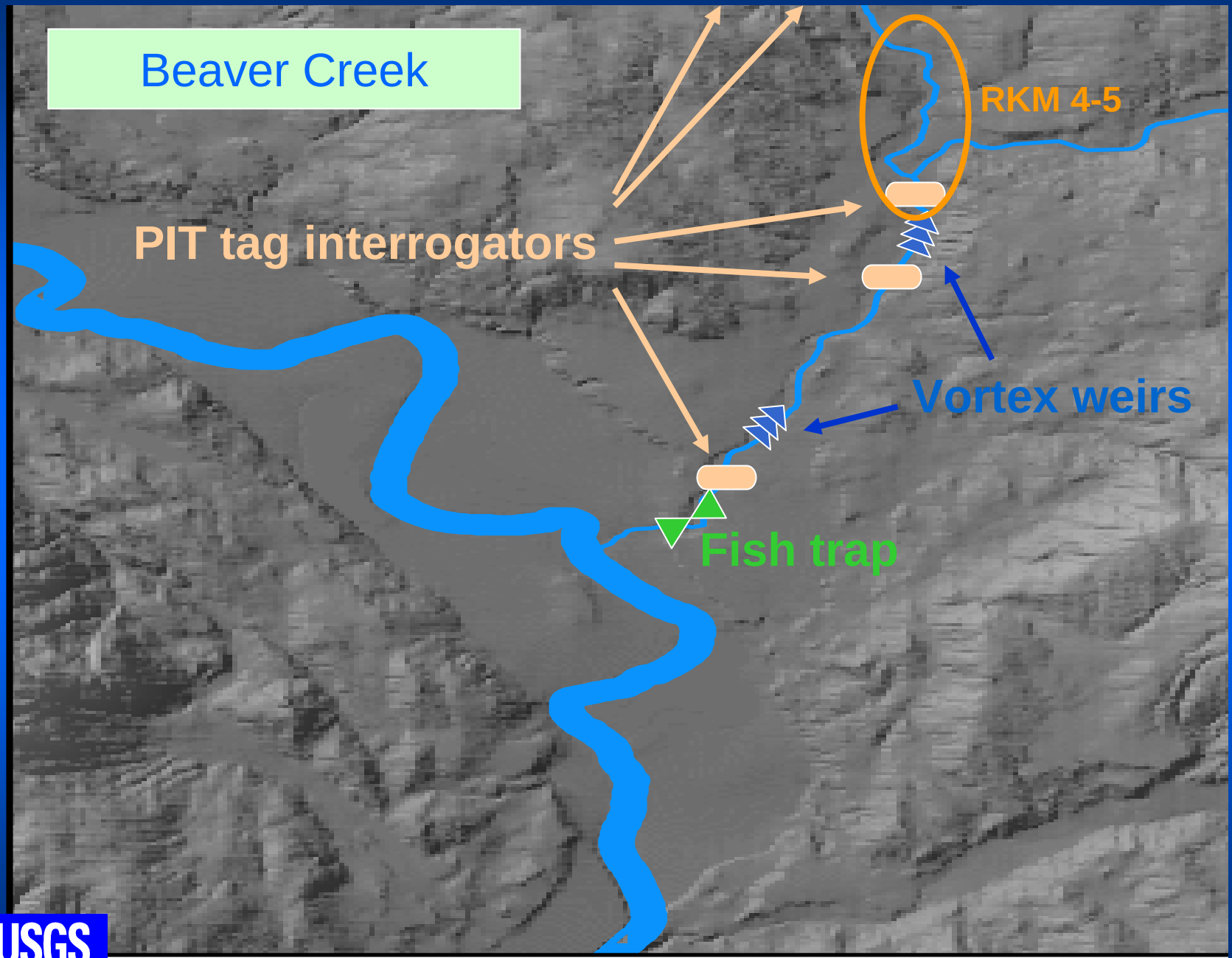
and/or

Enhancing expression of steelhead life history from within

Genetic aspects:
Focus of
Dana Weigel's
doctoral work
(U. of Idaho)

USGS

USGS


Beaver Creek
RKM 4-5
PIT tag interrogators
Vortex weirs
Fish trap

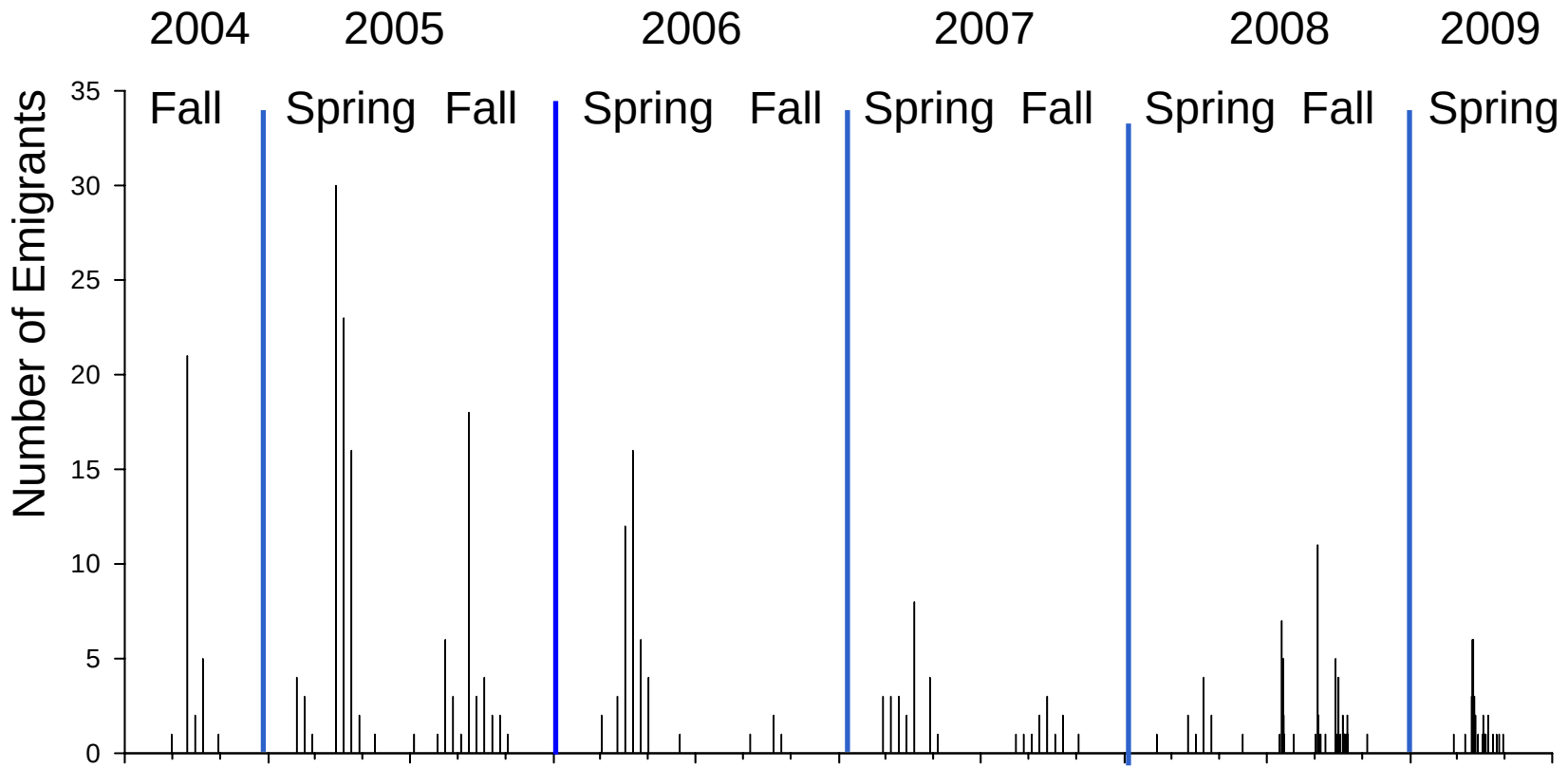
Number of age-1 *O. mykiss* PIT tagged near rkm 5, and then detected moving downstream past our PIT tag interrogator system at rkm 4.

Year	Number PIT tagged	Number detected					
		2004	2005	2006	2007	2008	2009
2004	150	27	53	15	0	0	0
2005	140	--	31	30	1	0	0
2006	104	--	--	1	15	5	0
2007	50	--	--	--	13	8	1
2008	279	--	--	--	--	60	32

Emigrating at age 1-3 years old

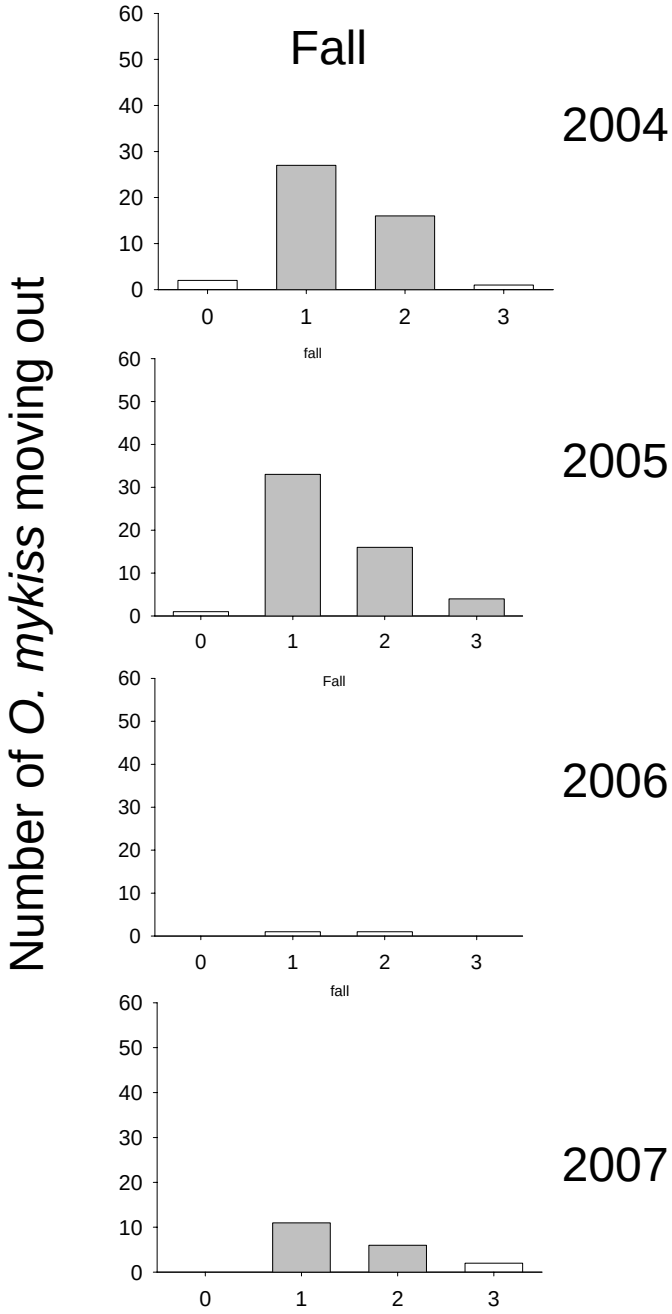
USGS

Pattern of *O. mykiss* downstream movement, Beaver Cr.



Spring: mostly age-2 and age-3 smolts;

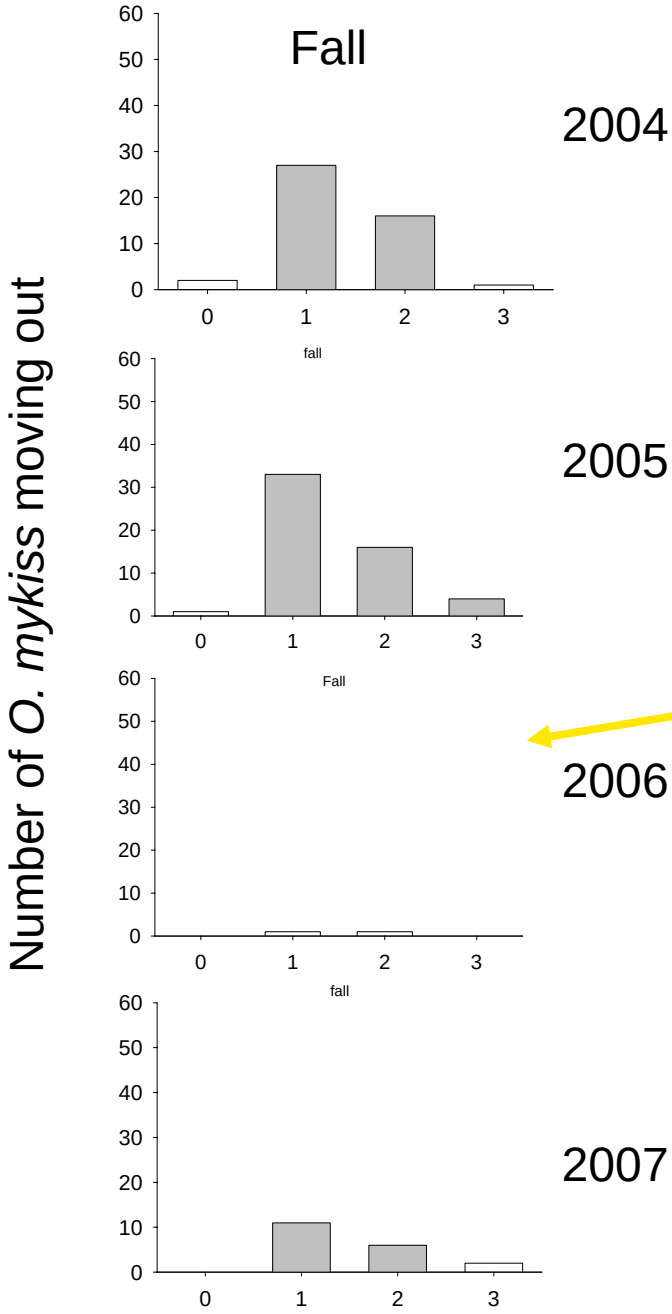
USGS

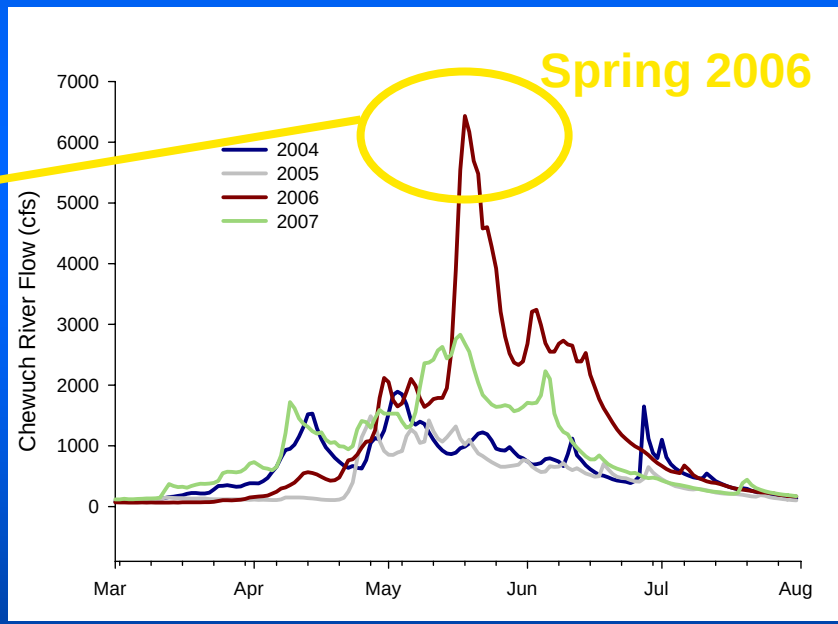


Numbers by age of juvenile *O. mykiss* moving out of Beaver Creek in fall, 2004-2007 (weir trap counts).

USGS

Numbers by age of juvenile *O. mykiss* moving out of Beaver Creek in fall, 2004-2007 (weir trap counts).





USGS

II. Is a moving fish a dead fish?

Upon leaving its natal area, or the area being evaluated, is an assumption of mortality valid?

USGS

A comparison of fate :

a) Parr that STAY in natal area
(Beaver Creek) until smolting in spring

vs

b) Parr that MOVE downstream
(mainstem Methow R) until smolting in spring

USGS

Chief Joseph

Wells

Rocky Reach

Grand Coulee

Rock Island

Wanapum

Priest Rapids

Ice Harbor

Lower Monumental

Little Goose

Lower Granite

Bonneville

The Dalles

John Day

McNary

Hells Canyon

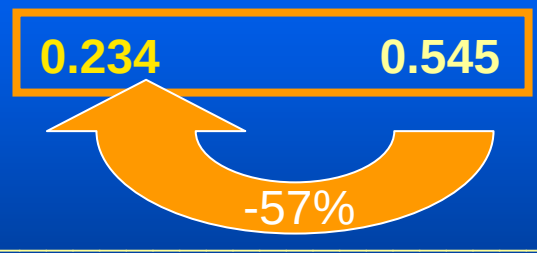
Oxbow

Brownlee

N

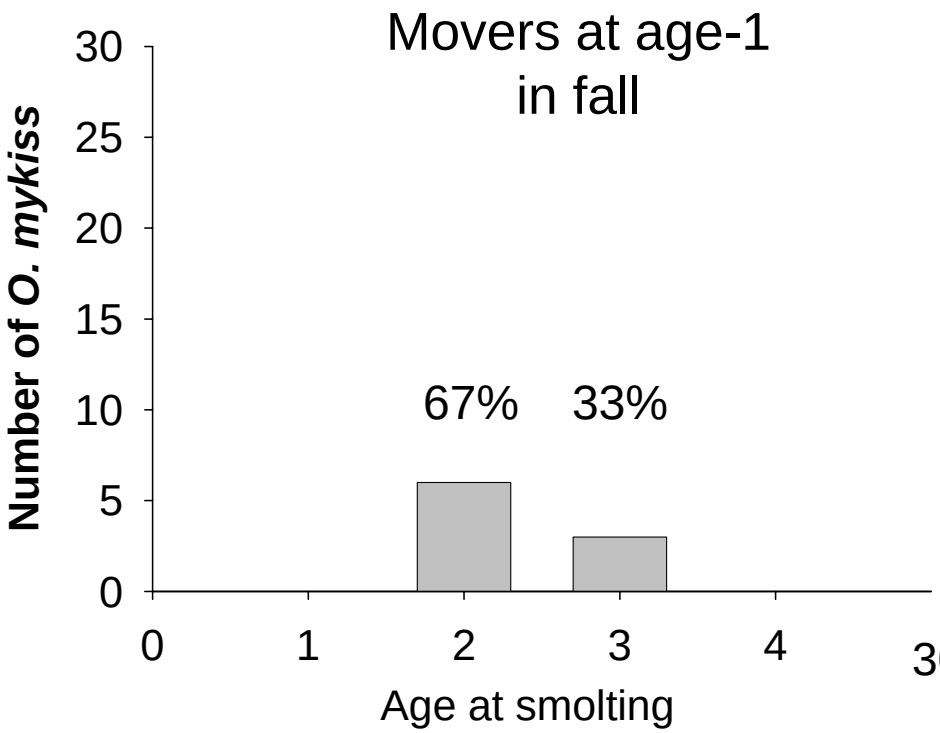
Fate of PIT tagged age-1 *O. mykiss* in lower Beaver Creek, 2004-2007: Contribution to smolt production

Year	Number PIT tagged	Life history strategy: Move in fall (age-1 parr)	Life history strategy: Stay (until smolting)
Detection probabilities			
At Beaver Cr detector		1.000	1.000
At Beaver Cr weir		0.346	0.346
At McNary Dam detector		0.176	0.176
Survival from: Beaver Cr to McNary Dam		0.234	0.545



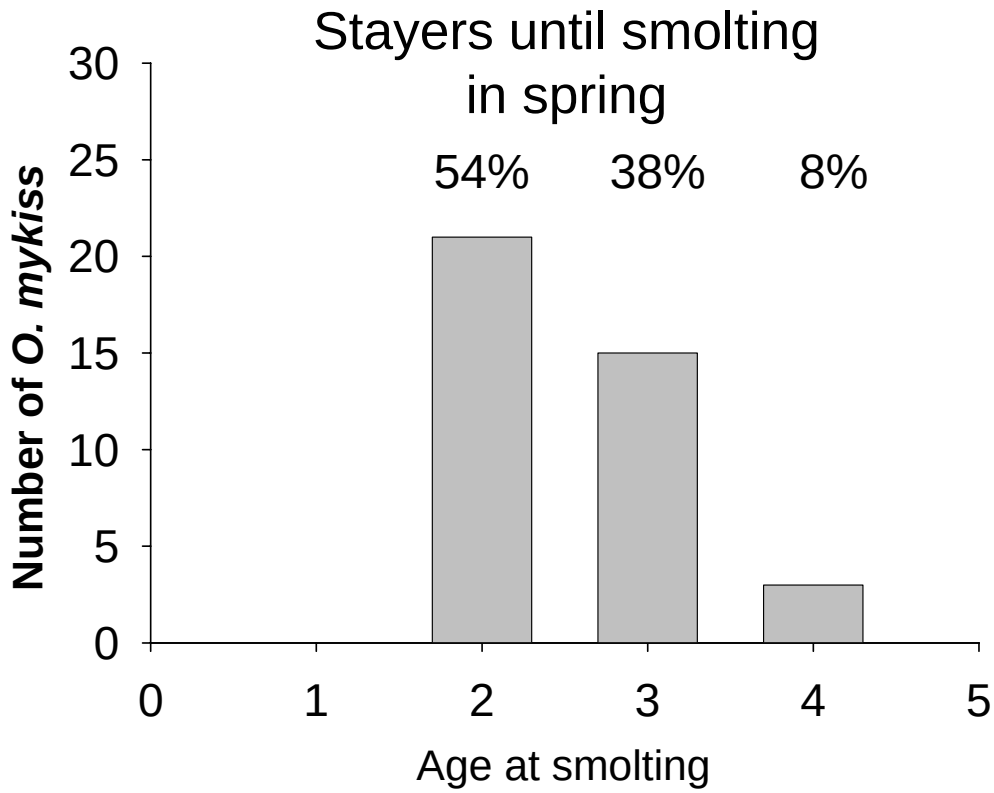
Multi-state mark-recapture modeling by: Russell Perry, USGS

USGS



Lower Beaver Creek

Age at smolting, as detected in the Columbia River PIT tag interrogation network, for age-1 *O. mykiss* tagged in 2004-2007



Currently the subject of an ongoing foodweb study and a bioenergetic modeling effort

USGS

Modeling inputs to answer:

What is the contribution of age-1 fall movers to total steelhead smolt production from Beaver Creek given:

	Movers	Stayers
Observed parr-smolt survival:	23.4%	54.5%
Smolt age distribution (age 2,3,4):	67%, 33%, 0%	54%, 38%, 8%

Over three levels of percent stayer values: 30%, 50%, 70%

Solving for egg-to-parr survival to stablize: 6.4%, 3.9%, 2.8%

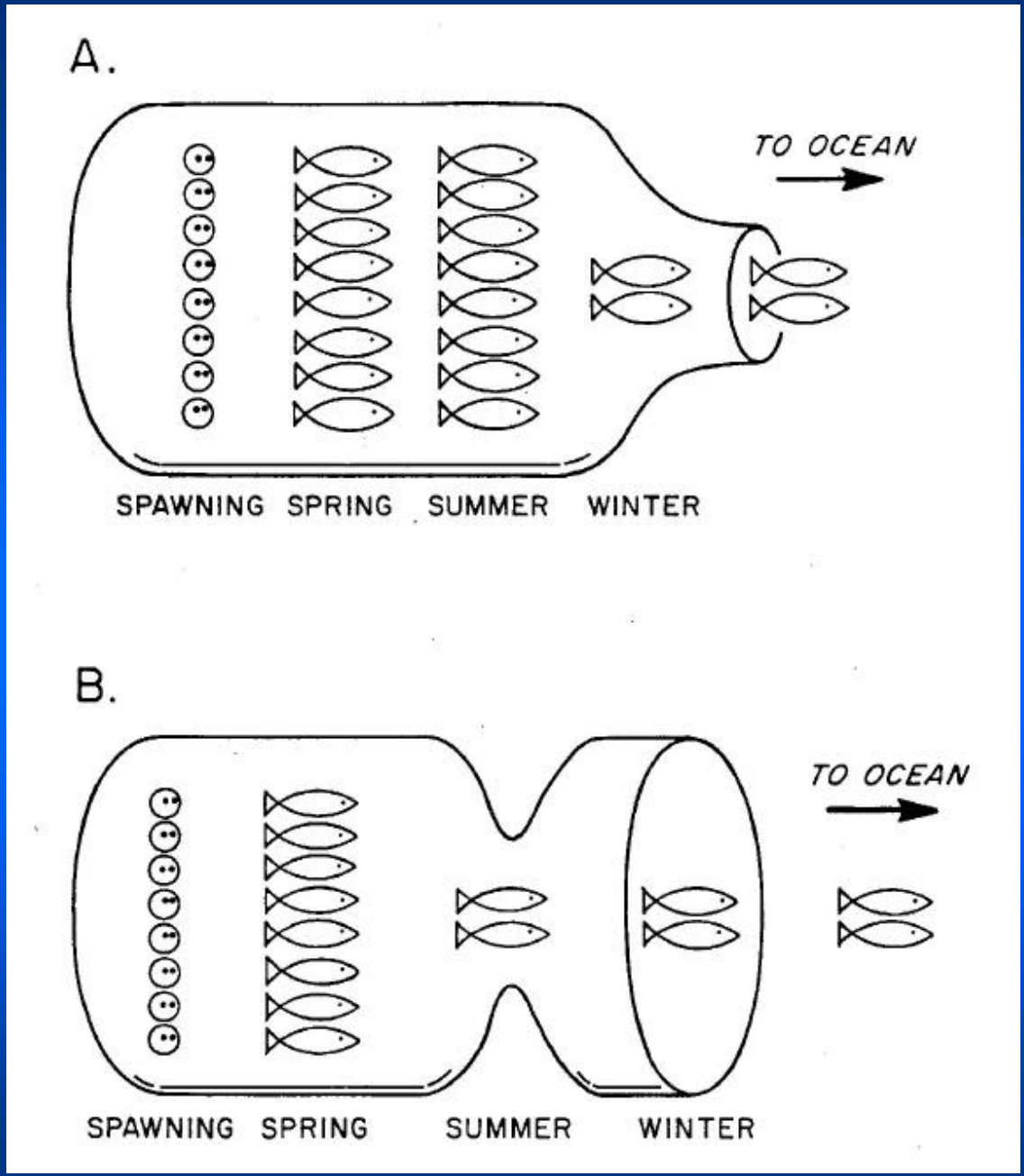
USGS

Modeling results: Contribution of age-1 fall movers to total steelhead smolt production from Beaver Creek.

Percent age-1 MOVERS	30%	50%	70%
Percent age-1 STAYERS	70%	50%	30%
Percent contribution of MOVERS to total output of smolts	16%	30%	50%
Percent smolt "increase" due of MOVERS (those typically not recognized)	18%	43%	100%

Caveat: Preliminary modeling exercise that needs, and will get, more data.

USGS



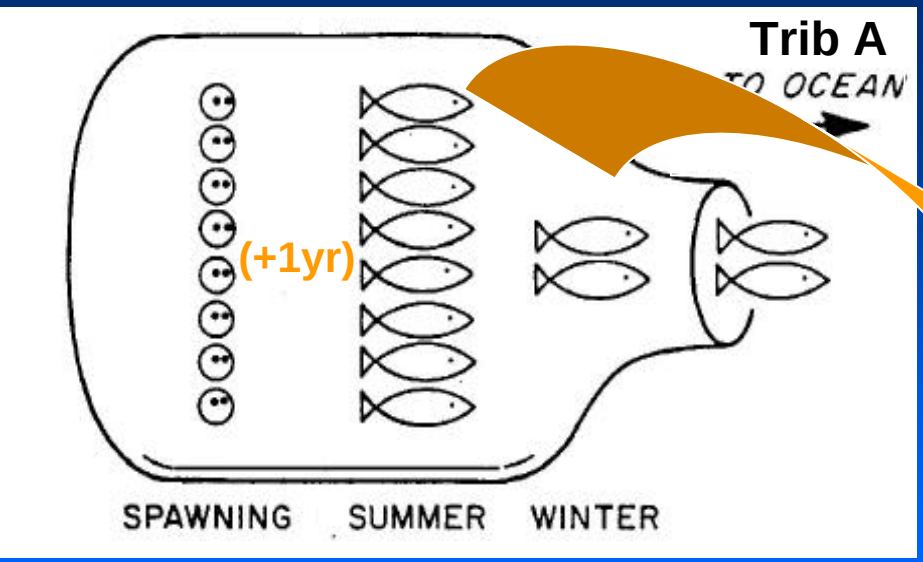
Revisit:

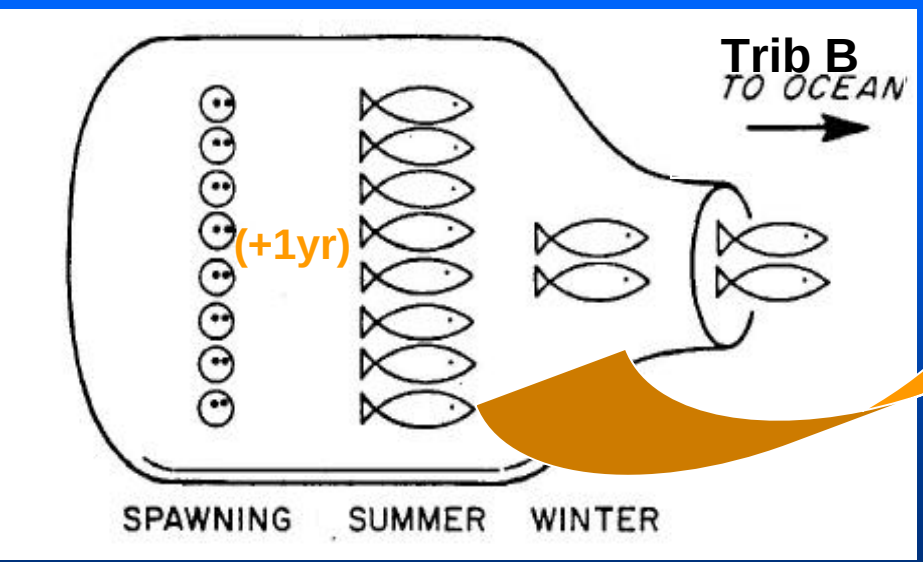
Limiting factor as a bottleneck (by life-stage and season)

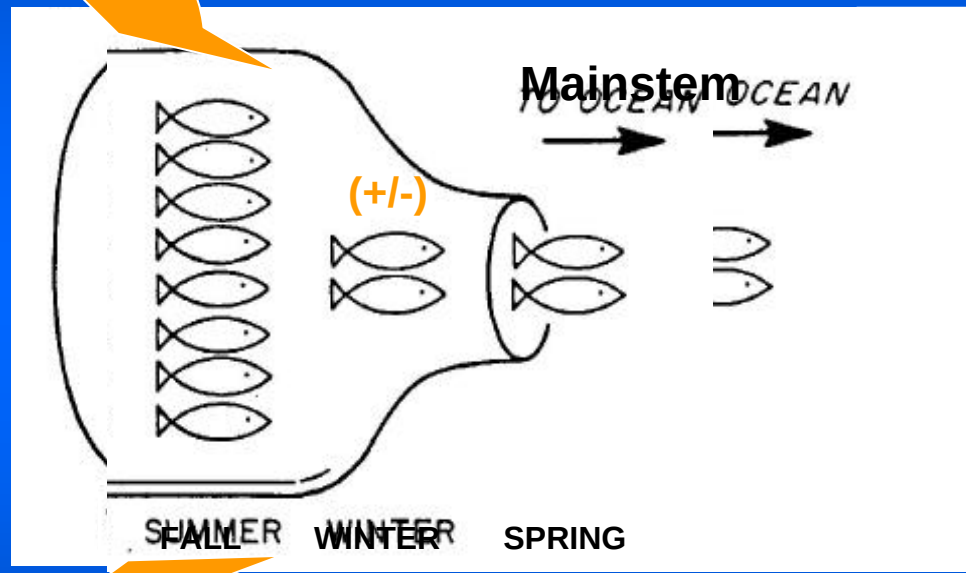
Adapted from:
Hall and Baker (1982)
"...oversimplification of a complex ecological process."

USGS

Incorporating movement, with a winter pinch







Conclusions

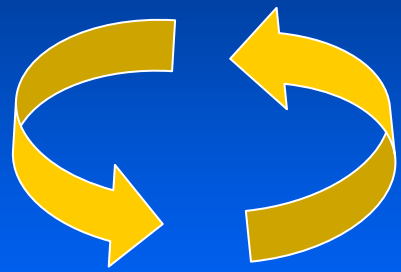
First ask:

"How are fish using the system?

(How did, How will?)

Before asking:

"What is the limiting habitat factor(s)?"



Tracking fate of individual juvenile fish can provide valuable information on existing diversity of life history strategies. ("Who knew?!" moments)

With this kind of information, better able to assess where to focus restoration efforts:

Tributary vs Mainstem?

USGS

Why would juvenile fish move from their natal area?

Response to:

- Food and space
- Interaction (intra-, interspecific)

Displaced by:

- Flow events
- Disturbance (fire, debris flows, etc)

Smolting vs residualization because:

- Genetic (physiological destiny)
- f (food, temperature, growth, maturation)
  - Thorpe (1994), Hendry et al. (2004), Satherwaite et al. (2008)

USGS