COLONIZATION OF WILD AND HATCHERY STEELHEAD IN A SMALL TRIBUTARY AFTER BARRIER REMOVAL

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Home
Safe natal habitat
Local adaptations

Migrate
Reduce competition
Genetic diversity
Demographic support
Spread risk repro effort

Successful migration is essential for colonization of unoccupied habitats

Triggers for migration and attributes for success are relatively unknown

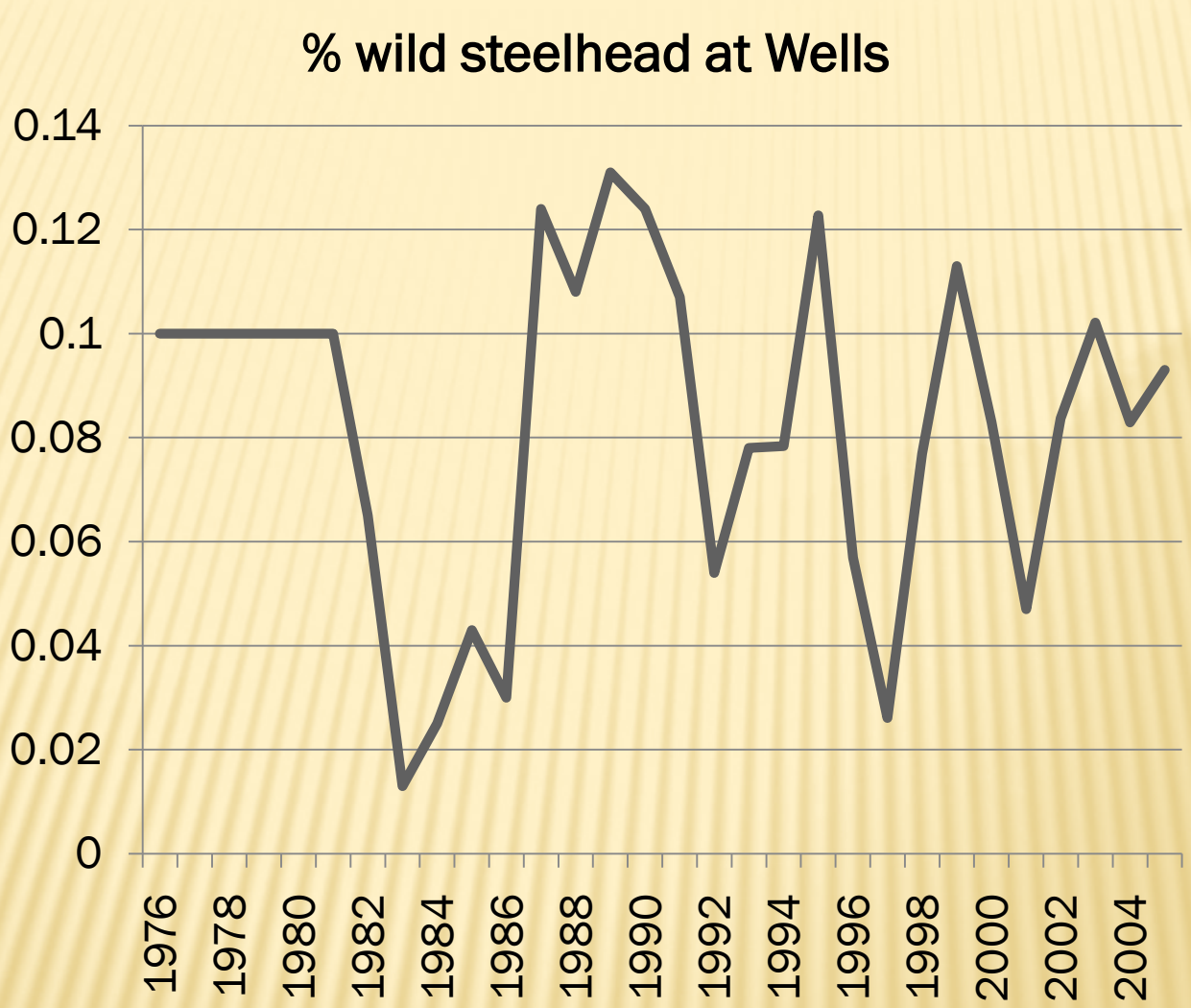
HATCHERY STEELHEAD REDUCED REPRODUCTIVE SUCCESS

McLean et al. 2004
Hatchery females 1.0-1.3 smolts per indiv
Wild females 18.8-24.5 smolts per indiv

Miller and Kapucinski (2004)

	To hatch	Fry to age 1	Cumm survival
NxN	1.0	1.0	1.0
NxH	0.99	0.59	0.58
HxN	0.80	0.37	0.30
HxH	0.67	0.21	0.14

Study Area – tributary Methow River, upper Columbia Basin


% wild steelhead at Wells
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

STUDY ATTRIBUTES

- 7 irrigation barriers removed 2002-2004
- Natural colonization process (no stocking)
- High numbers of hatchery adult returns
- Monitor adult steelhead/rainbow trout into re-opened habitat 2005-2009

Before treatment

After treatment

Lowest dam removed on Beaver Creek Nov 2004
6 foot high, 29 ft crest length

STUDY OBJECTIVES

- Enumerate SH/RBT in Beaver Creek after barrier removal (HA, WA, R, F)
- Identify source population of colonizers
- Identify attributes of successful colonizer (produces offspring outmigrate as parr)

METHODS

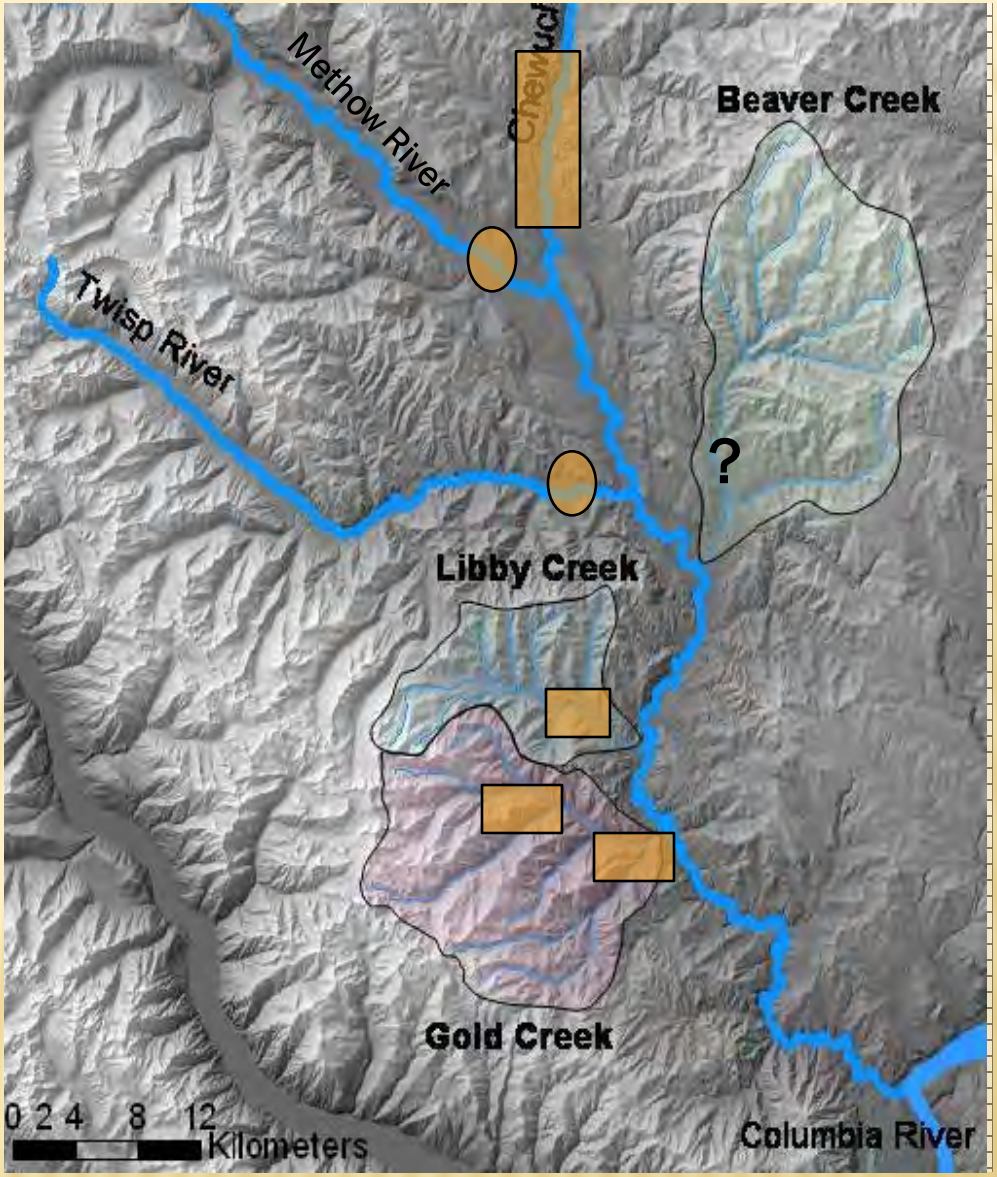
- Collect parent and parr from a picket weir 2005-2008
- Use length frequency data to identify brood years and query tissue for analysis
- Use PIT tag data to identify individual migratory behavior
- Collect tissue from a small caudal fin clip preserved in 95% EtOH

TISSUE COLLECTION AND GENOTYPING

- DNA extracted
- PCR amplification optimized for each locus
- 16 usat loci multiplex standardized across Columbia labs
  - Oke4
  - Oki23
  - One14
  - Ssa289
  - Ssa408
  - Ogo4
  - Omm1046
  - Omy7
  - One102
  - Ots4
  - Ssa407
  - Omm1036
  - Omy1001
  - Omy1011
  - Ots100
  - Ots3m

Local source populations

Chewuch
Methow smolt trap
Twisp smolt trap
Libby
Gold

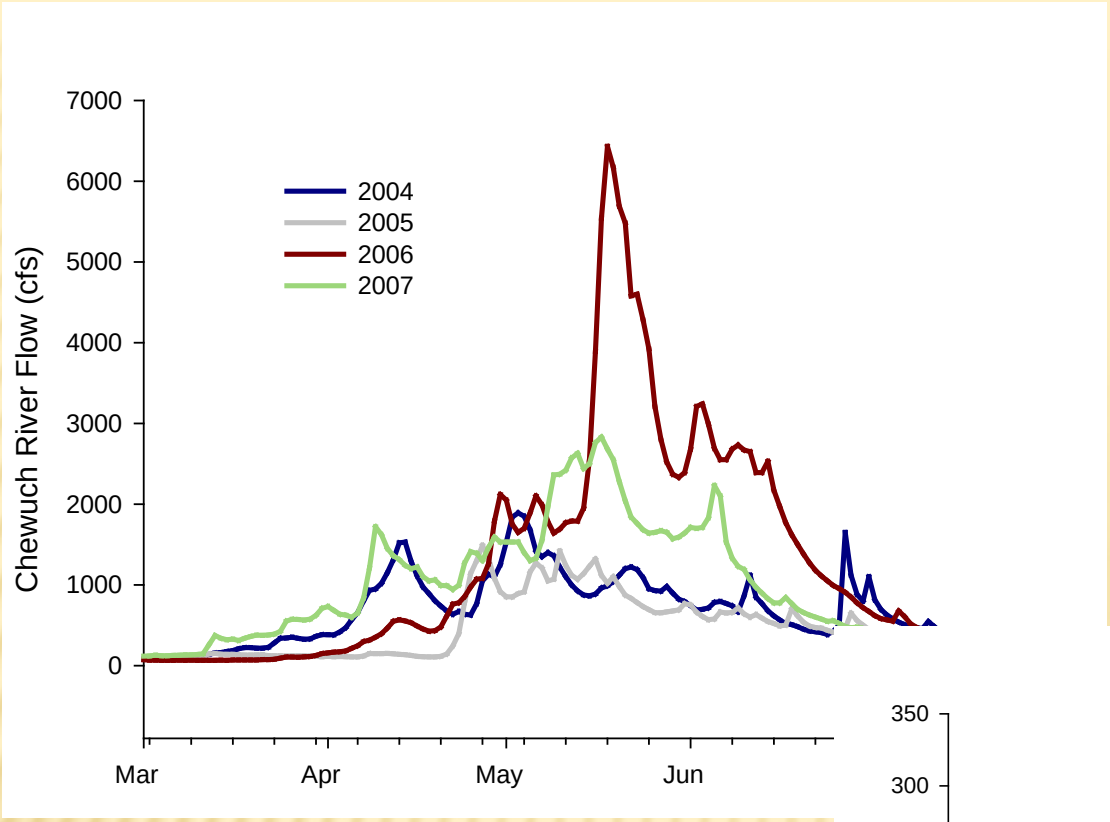


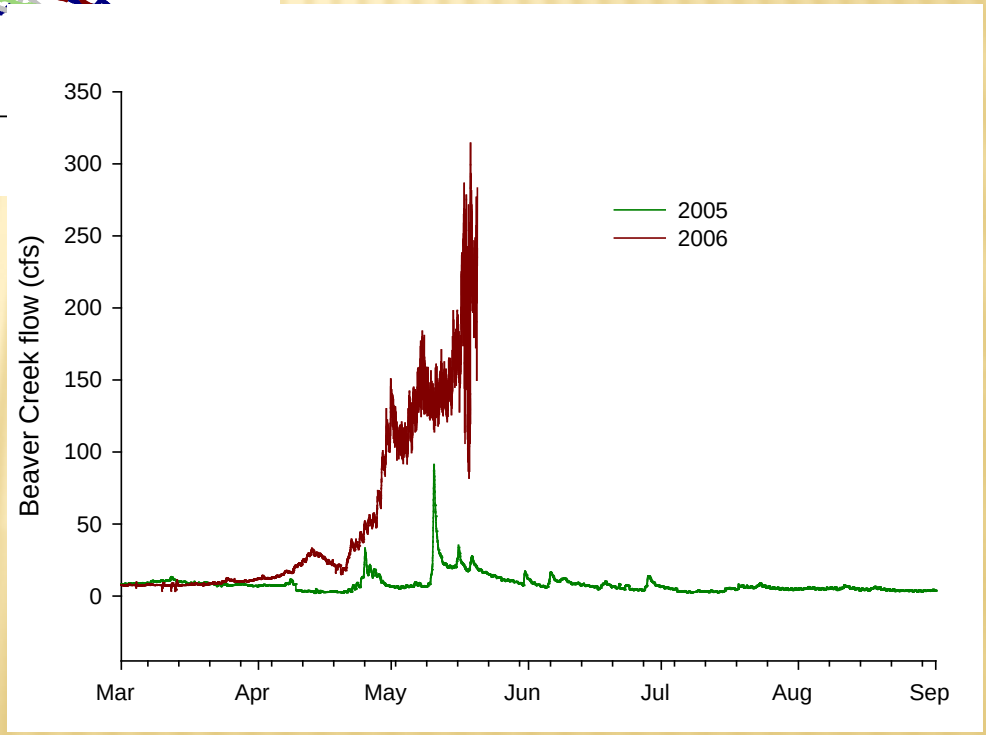
DATA ANALYSIS

- Parentage – exclusion using CERVUS allow 1 mismatch
- Spawner attributes –
  - Wilcoxon rank test in R between successful and unsuccessful
  - Poisson GLM in R predicting number of offspring

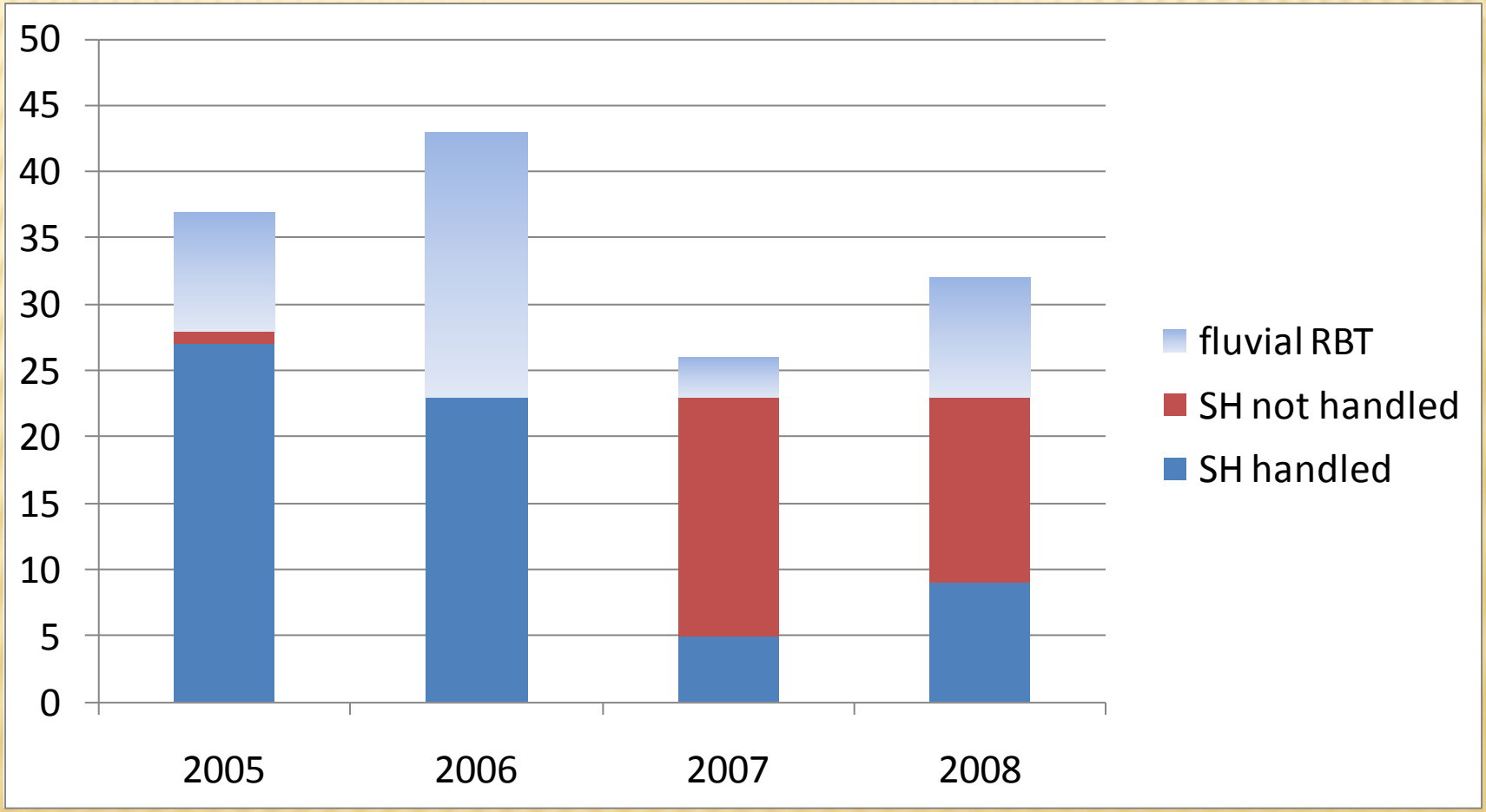
Results

Number and source of colonizers
Conditions and tag returns


Chewuch River Flow (cfs)
7000
6000
5000
4000
3000
2000
1000
0
2004
2005
2006
2007
Mar
Apr
May
Jun


Beaver Creek flow (cfs)
350
300
250
200
150
100
50
0
2005
2006
Mar
Apr
May
Jun
Jul
Aug
Sep

Adults into Beaver Creek during spawning season



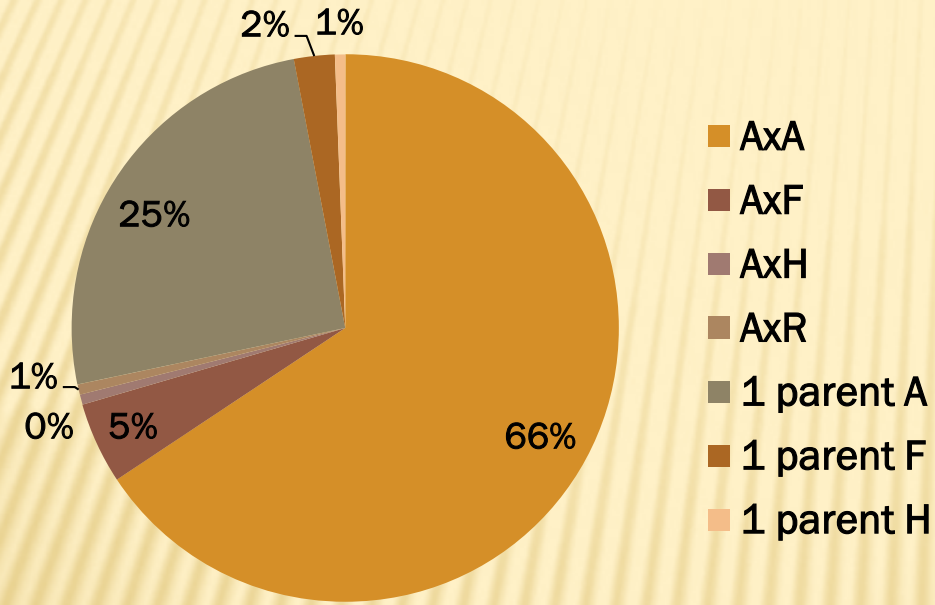
SOURCE OF RETURNS PIT TAG DATA

Year	Wells H	Methow	Beaver	Out basin H	Snake
2005	1				
2006	2				
2007	17		1	1	
2008	2	1	2		1
2009	4			1	
2010	1		2		

RESULTS - PARENTAGE

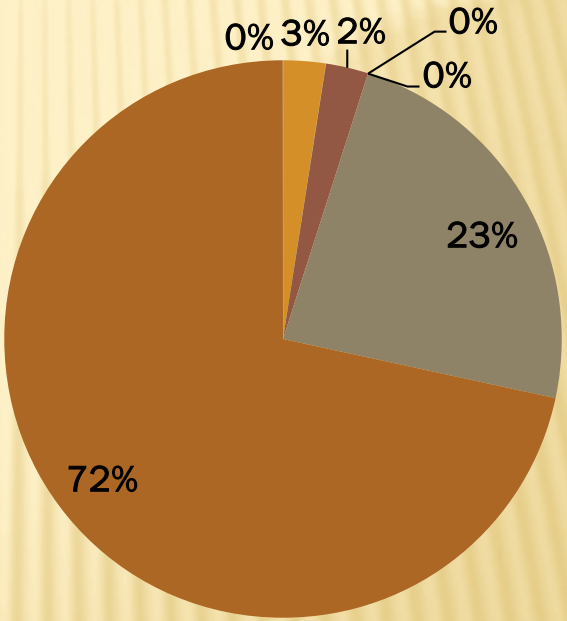
- Crossing between life history types
- Male and female SH had progeny with up to 3 different partners
- Successful multiple partner matches
  - 17% 2005
  - 3% 2006

BY 2005



2 parent wild anad

BY 2006



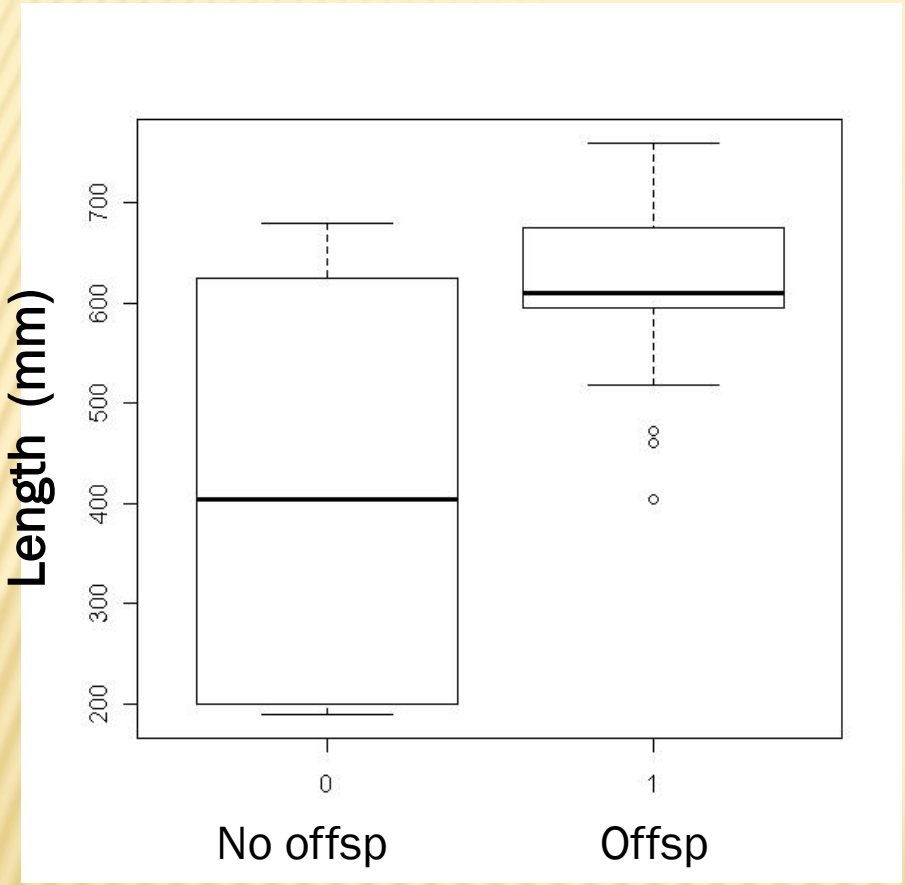
1 parent wild fluvial

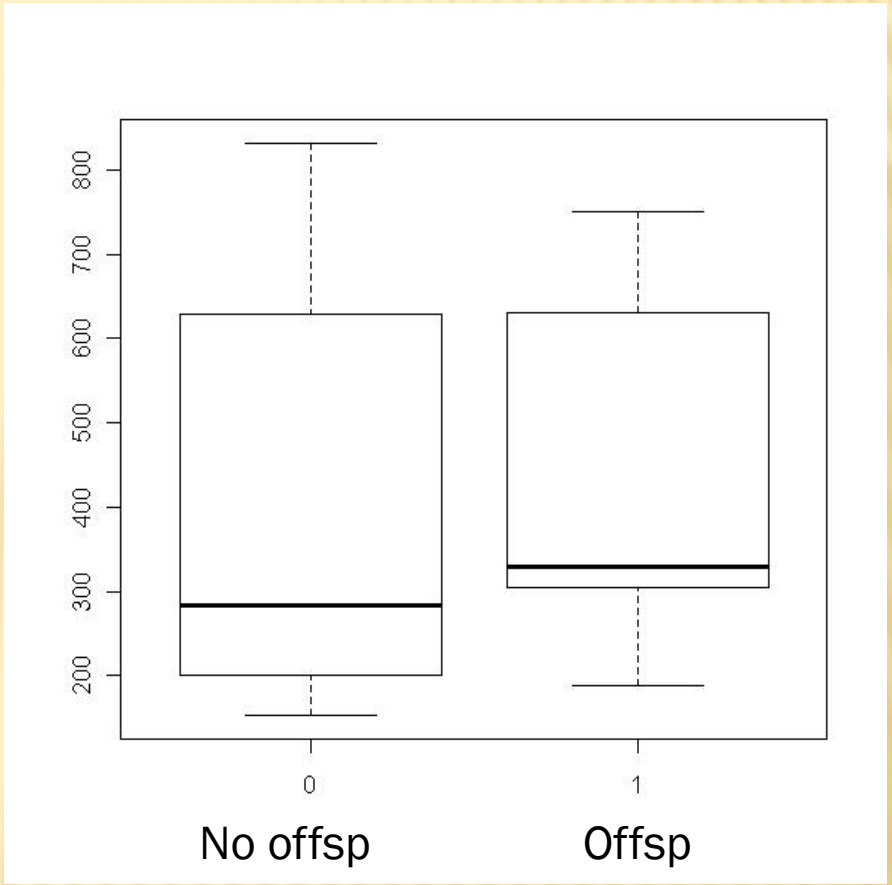
Results

Attributes of successful colonizers

2005

2006





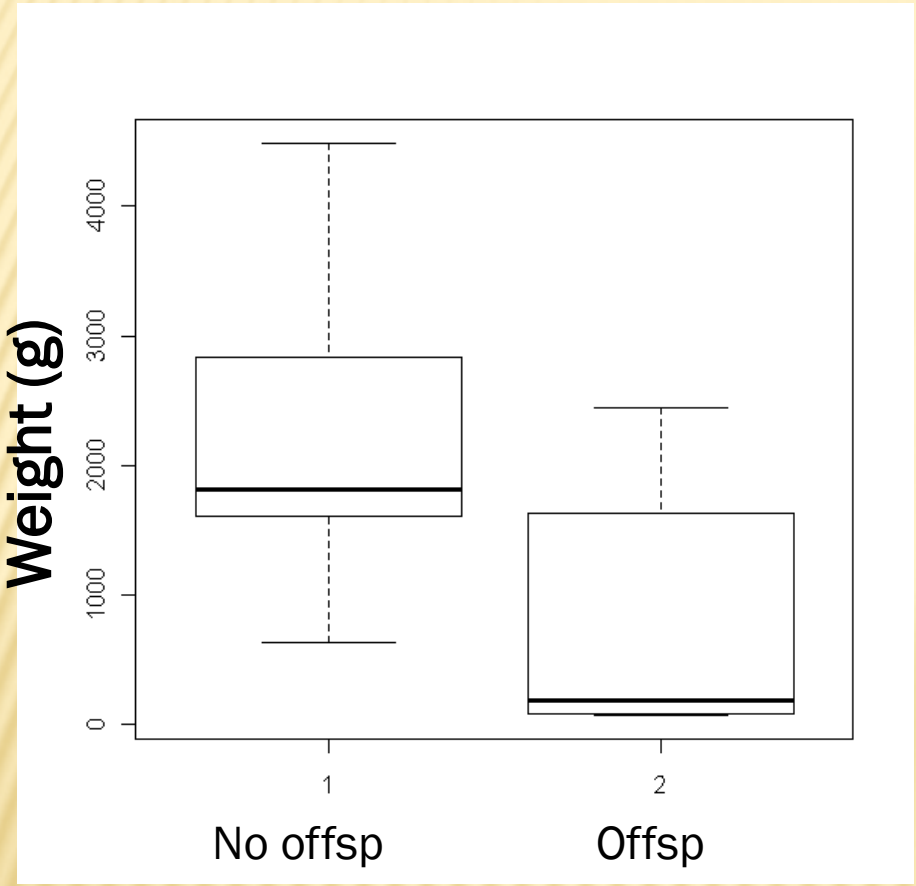
n=12 n=24

n=37 n=19

p=0.017

p=0.27

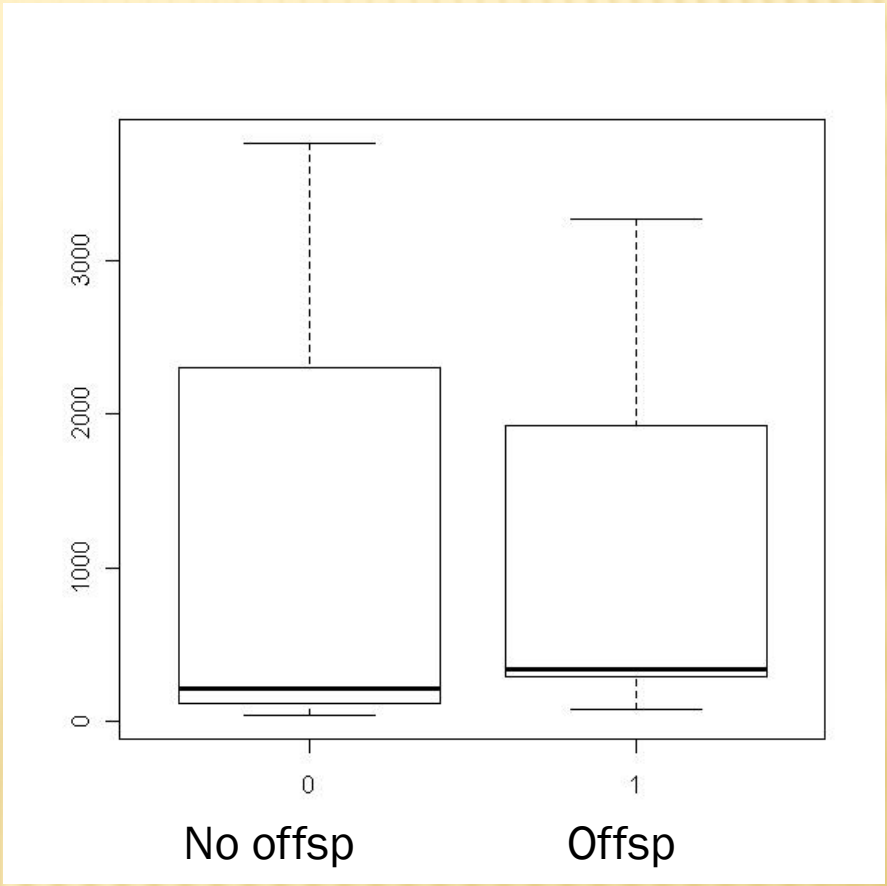
2005



n=11 n=23

p=0.001

2006

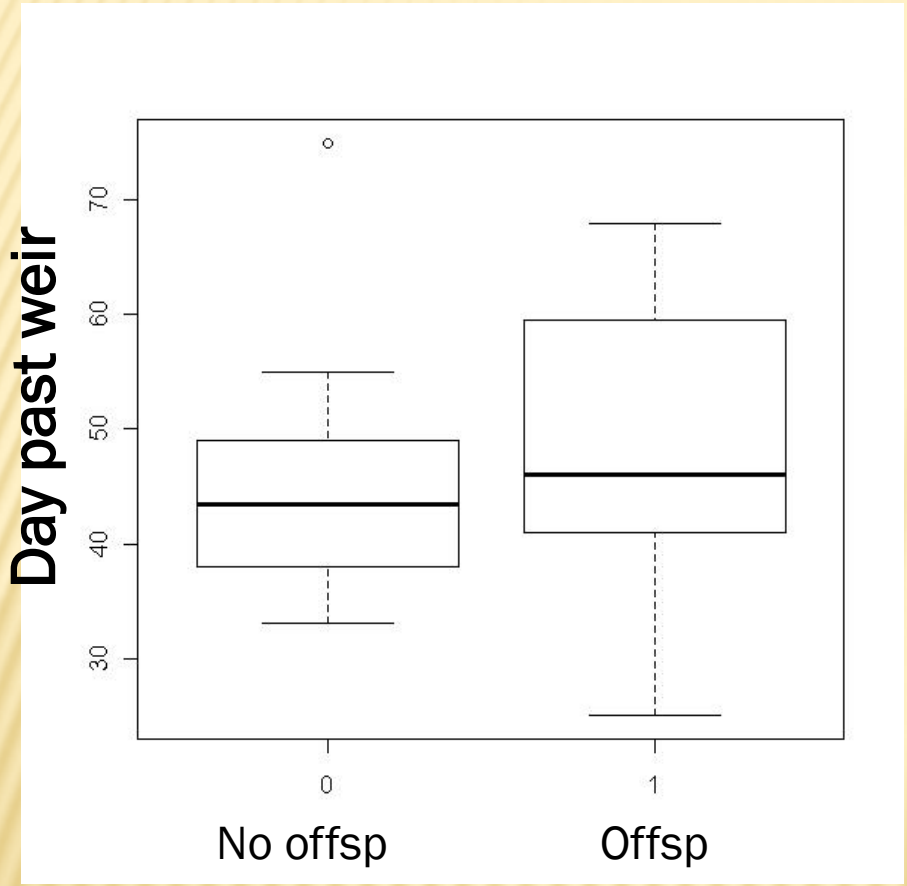


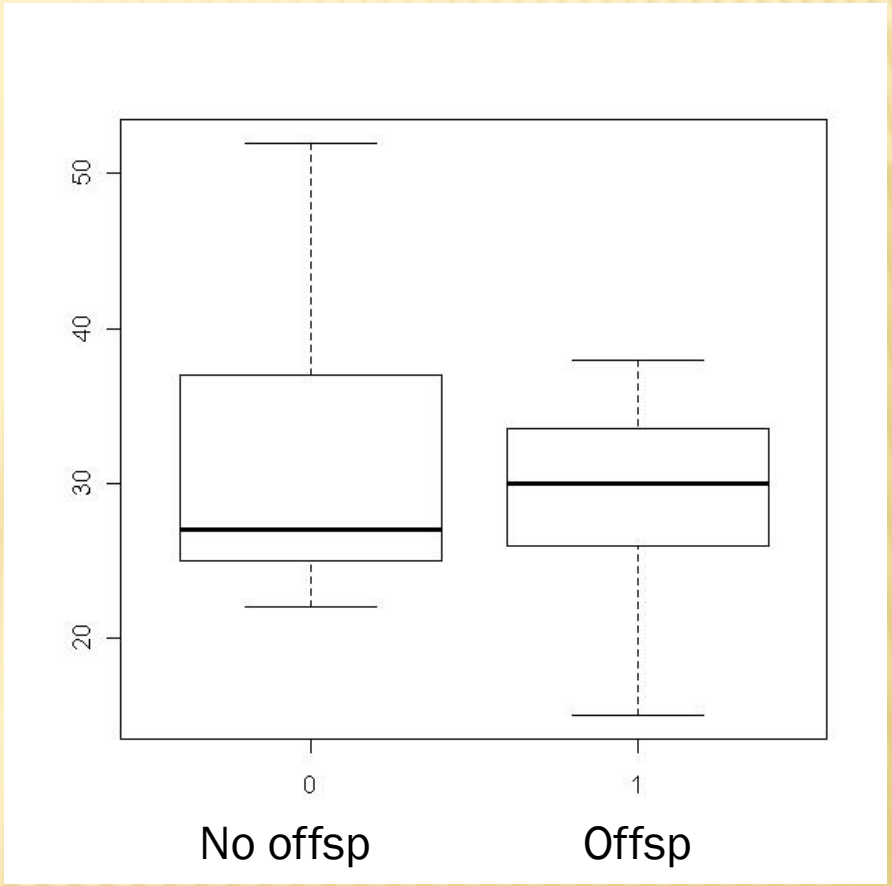
n=37 n=19

p=0.42

2005

2006



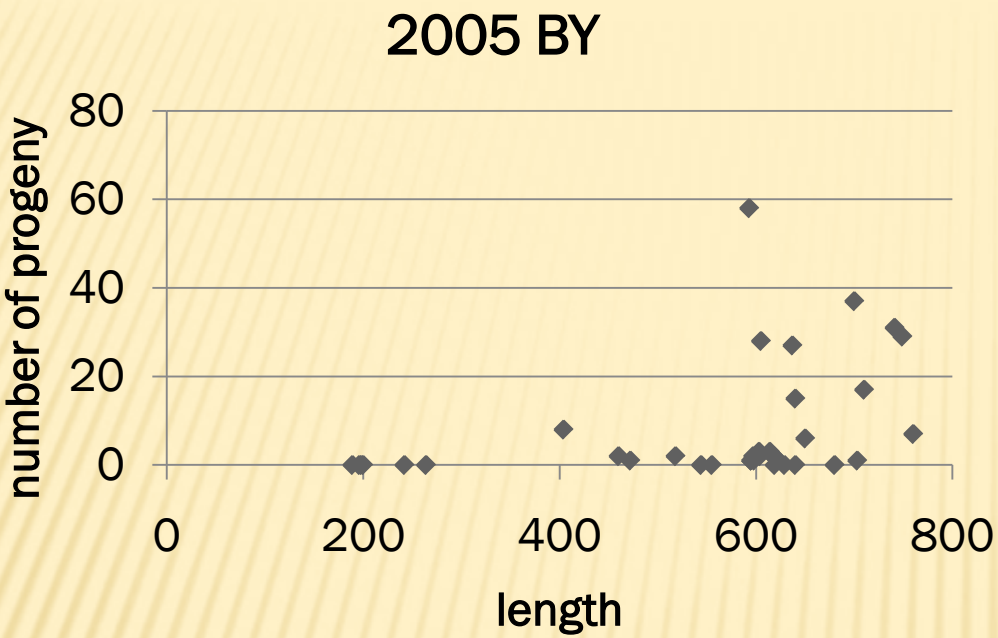


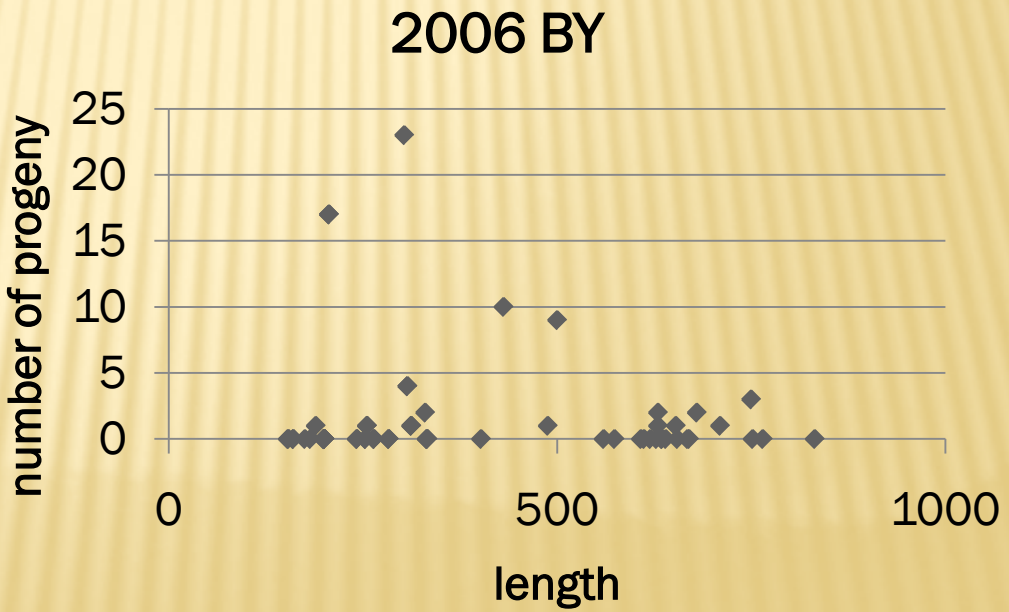
n=12 n=24

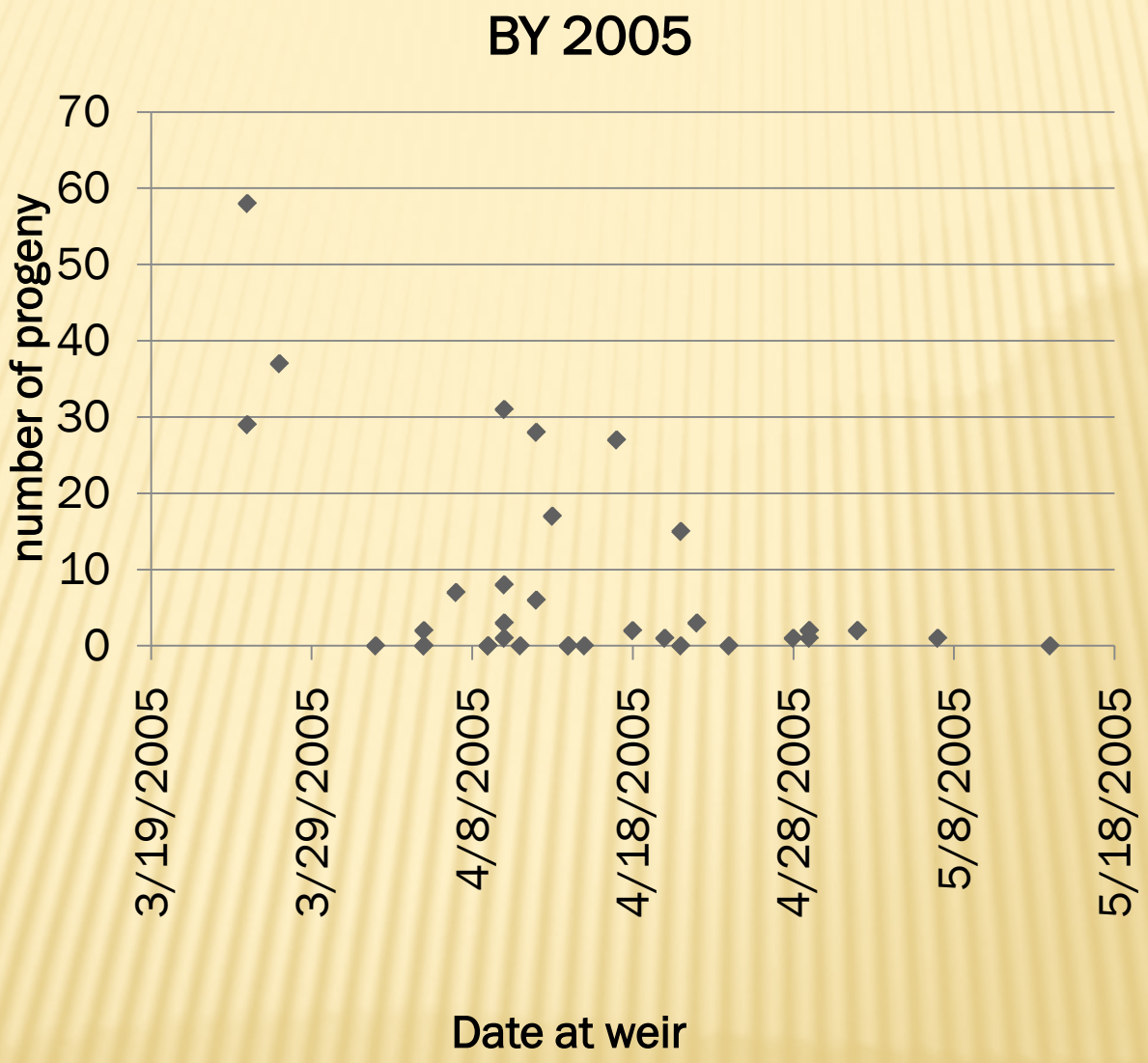
n=37 n=19

p=0.46

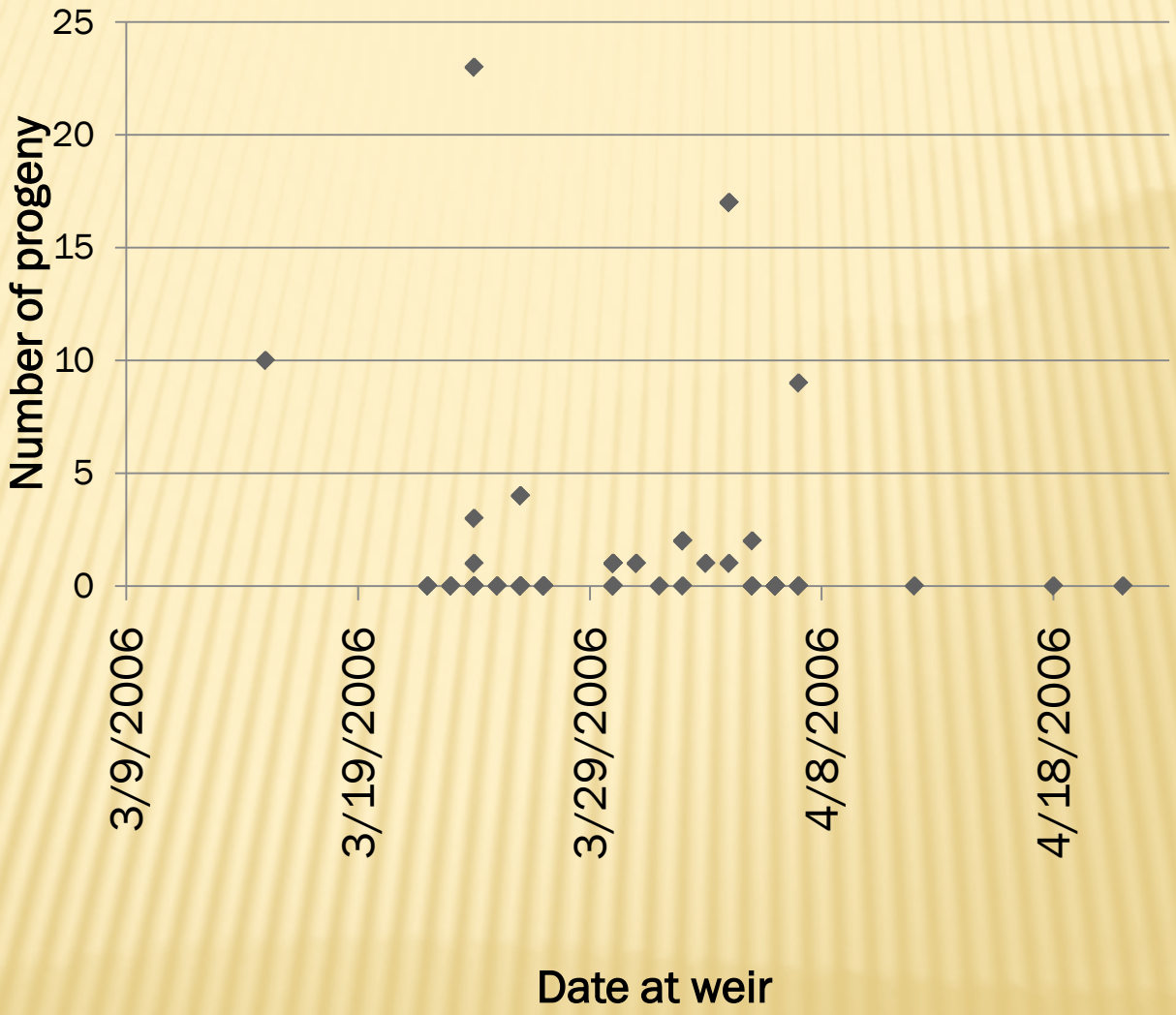
p=0.92


2005 BY
number of progeny
80
60
40
20
0
0
200
400
600
800
length


2006 BY
number of progeny
25
20
15
10
5
0
0
500
1000
length


BY 2005
number of progeny
70
60
50
40
30
20
10
0
3/19/2005
3/29/2005
4/8/2005
4/18/2005
4/28/2005
5/8/2005
5/18/2005
Date at weir

BY 2006


25
20
15
10
5
0
Number of progeny
3/9/2006
3/19/2006
3/29/2006
4/8/2006
4/18/2006
Date at weir

POISSON GLM 2005

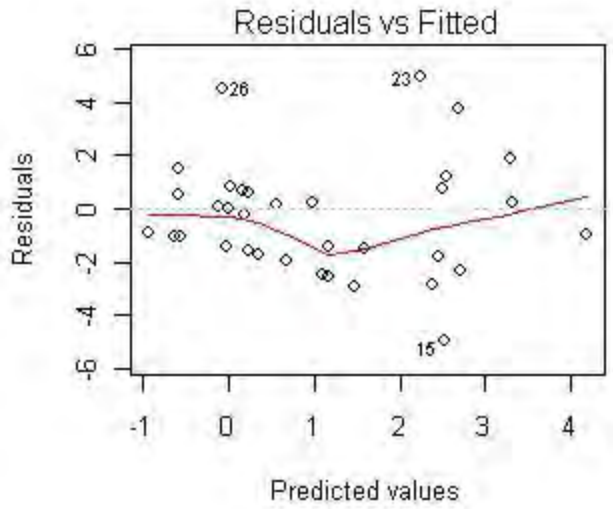
Variables in model	AIC
LH, day, wt, day:wt, **LH:wt**, LH:day	243
Length, LH, day, wt	276
LH, day, weight	277
LH, day	338
Length, day	377
Day, **wt**	423
LH, day, **length**	339
LH, day, wt, day:wt	247
LH, day, wt, day:wt, LH:wt	244
LH, day, wt, day:wt, LH:day	**242**

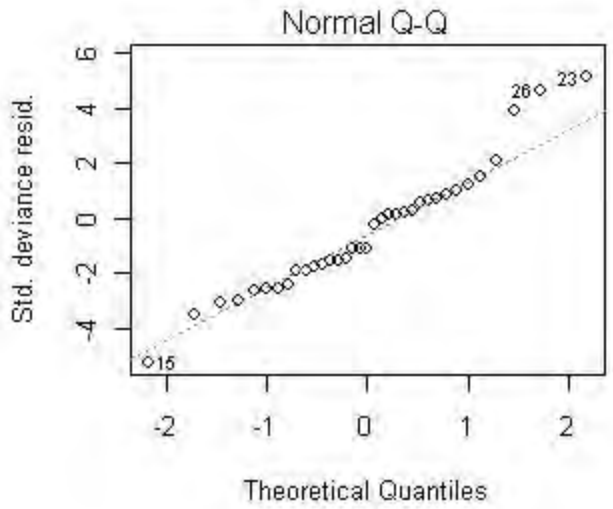
Variables in bold = ns

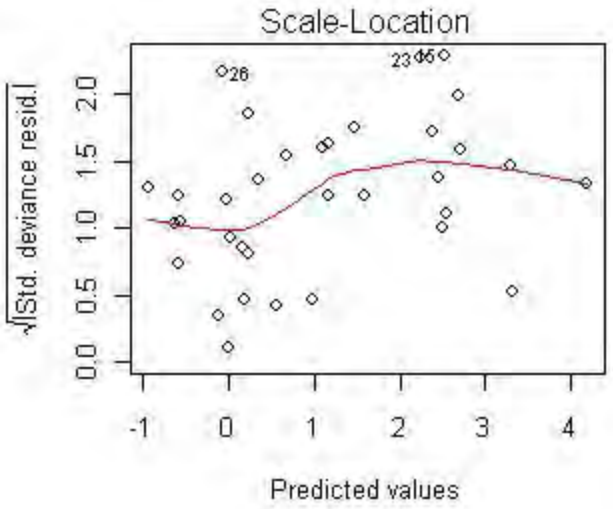
Slopes: - LH, - day, - wt, + int

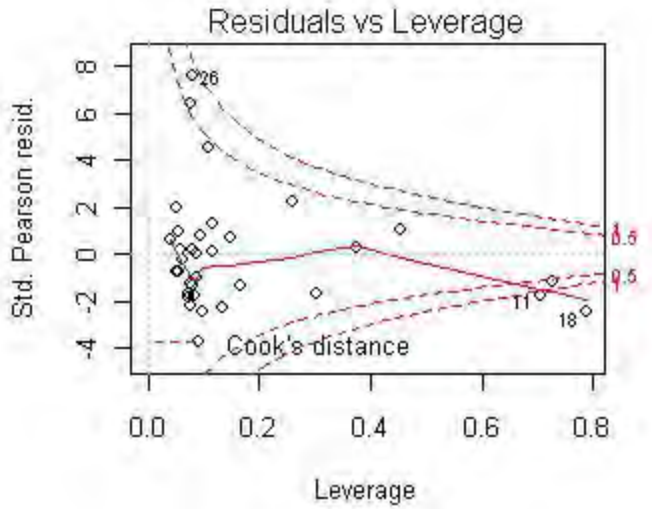
glm(total.offspring ~ Life.History + no..day + weight + no..day:weight + Li...

Life.history:no.day









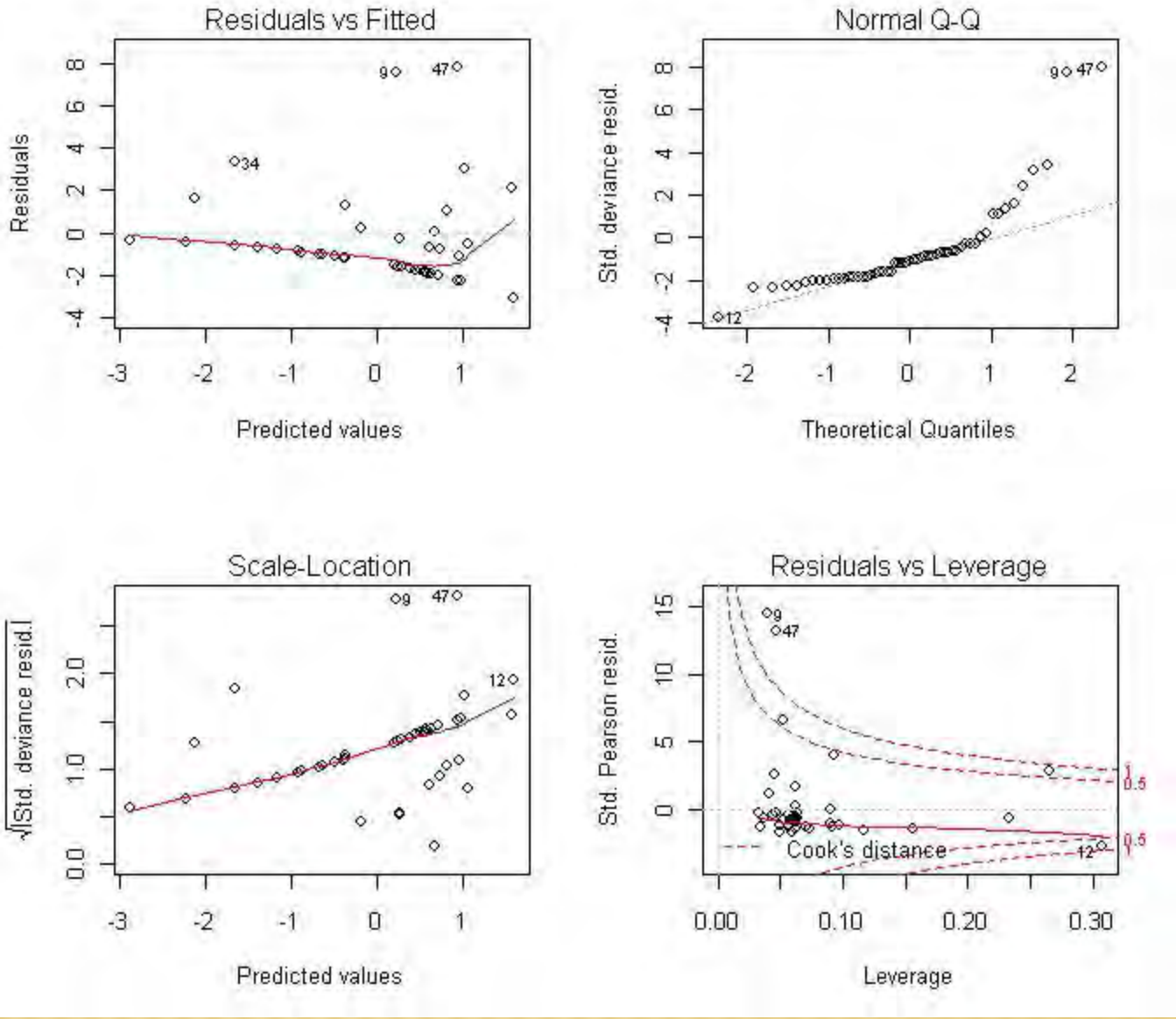
POISSON GLM 2006

Variables in model	AIC
Length, **LH**, wt, **length:LH**, length:day	315
Length, LH, **day**, wt	314
Length, LH, wt	315
Length, **LH**	344
Wt, LH	325
Length, **LH**, wt, length:day	313
Length, wt, length:day	314
Length, **wt,** weight:day	316
Wt, LH:day	320
Length, wt:day	316
Length, wt, LH:day	**313**

Variables in bold = ns

Slopes: + Length, - wt, - int

glm(total.offspring ~ Length + weight + Life.History:no..day)



TAG RETURNS FROM BEAVER CR JUVENILES

Upstream most detection	Number
Downstream Wells	11
Wells	5
Lower Methow (Pateros)	4
Beaver	8
Methow (Winthrop)	1
Twisp	3

Rough est of 66% homing back to Beaver Cr

FINDINGS

- Returning steelhead numbers consistent 20-25 fish during first 4 years
- SH colonized naturally immediately after barrier removal
- Few adult hatchery SH entered the tributary during the first 4 years (12%) and only 1 parr offspring matched to a hatchery SH 2005-2006
- Fluvial RBT were an important component of colonization particularly during the high flows in 2006

FINDINGS

- Length and weight sig. greater in SH that produced offspring in 2005, but length was slightly neg. related to number offspring produced per indiv.
- Day past weir was not sig. different between SH that produced offspring, but was related to number of offspring produced per indiv.

ACKNOWLEDGMENTS

- Funding from the Bureau of Reclamation FCRPS, RME program
- US Geological Survey, BRD for field data collection and migration information
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