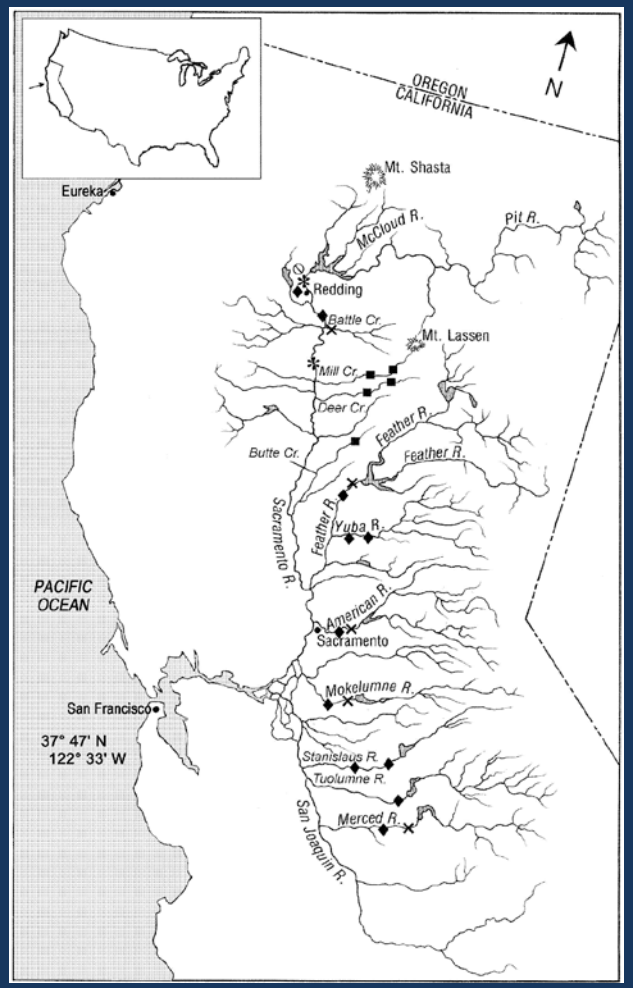
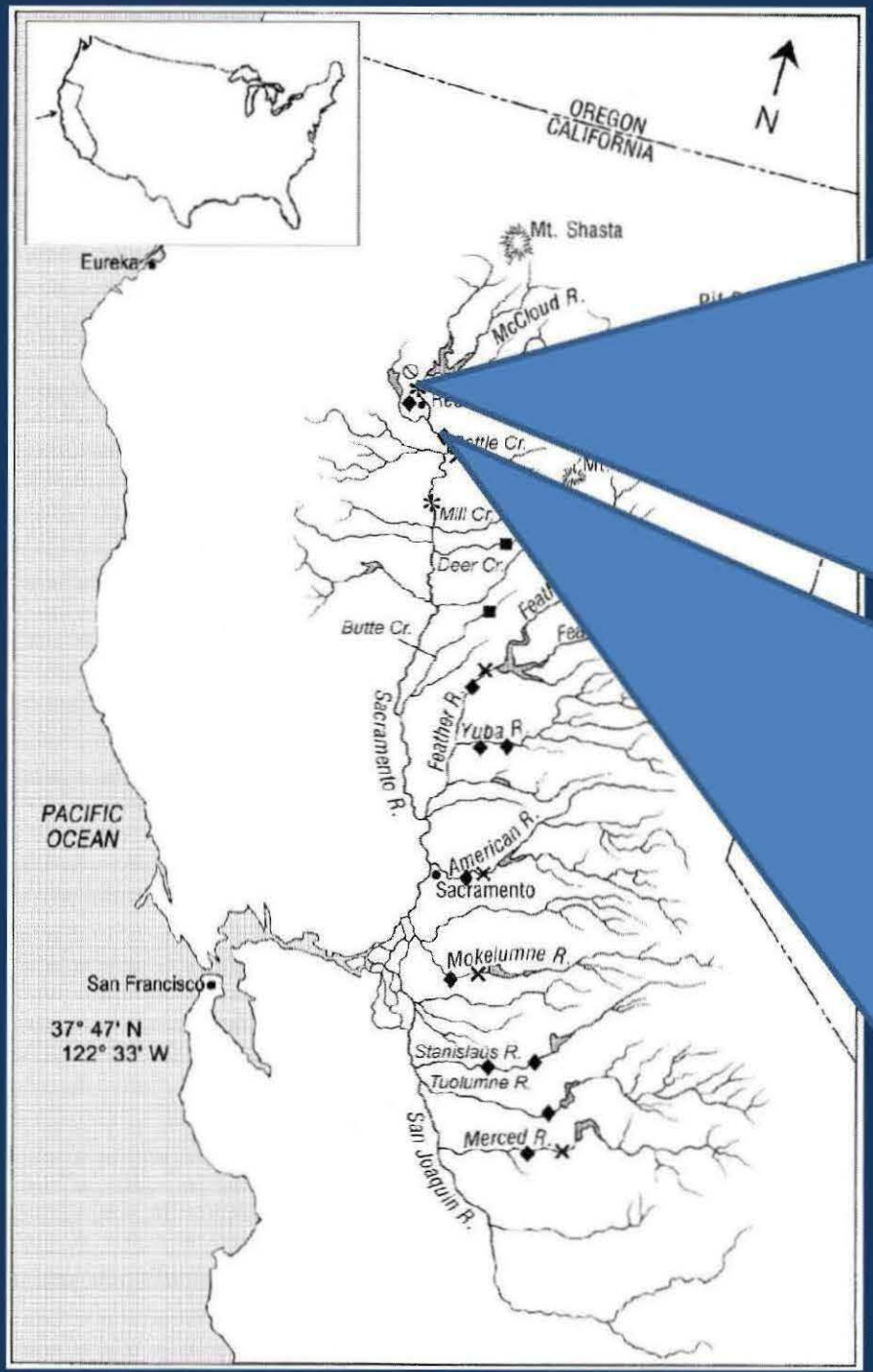
Applied science and the rapid-response genetic assignment of fish trapped at Keswick Dam

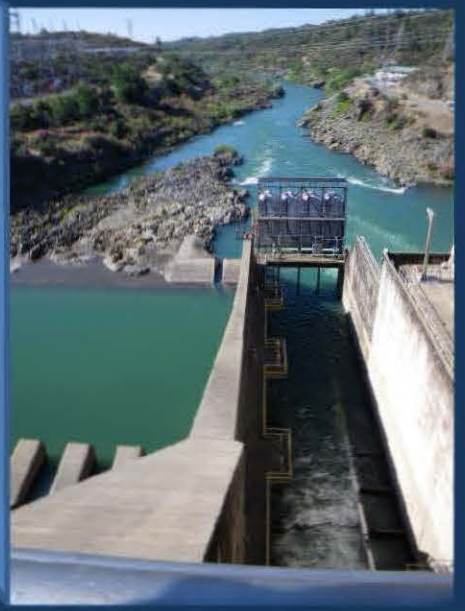
Christian Smith, John Rueth and Jennifer Von Bargen

Sacramento River Winter Run Chinook salmon

- 1989 propagation at existing facility (Coleman NFH)
- Early to mid 1990s collaboration between USFWS, UCDavis and Arizona State University produces hatchery protocols to minimize negative genetic impacts of spawning and identifies need for rapid-response genetic ID
- 1998 propagation at dedicated facility (Livingston Stone NFH)



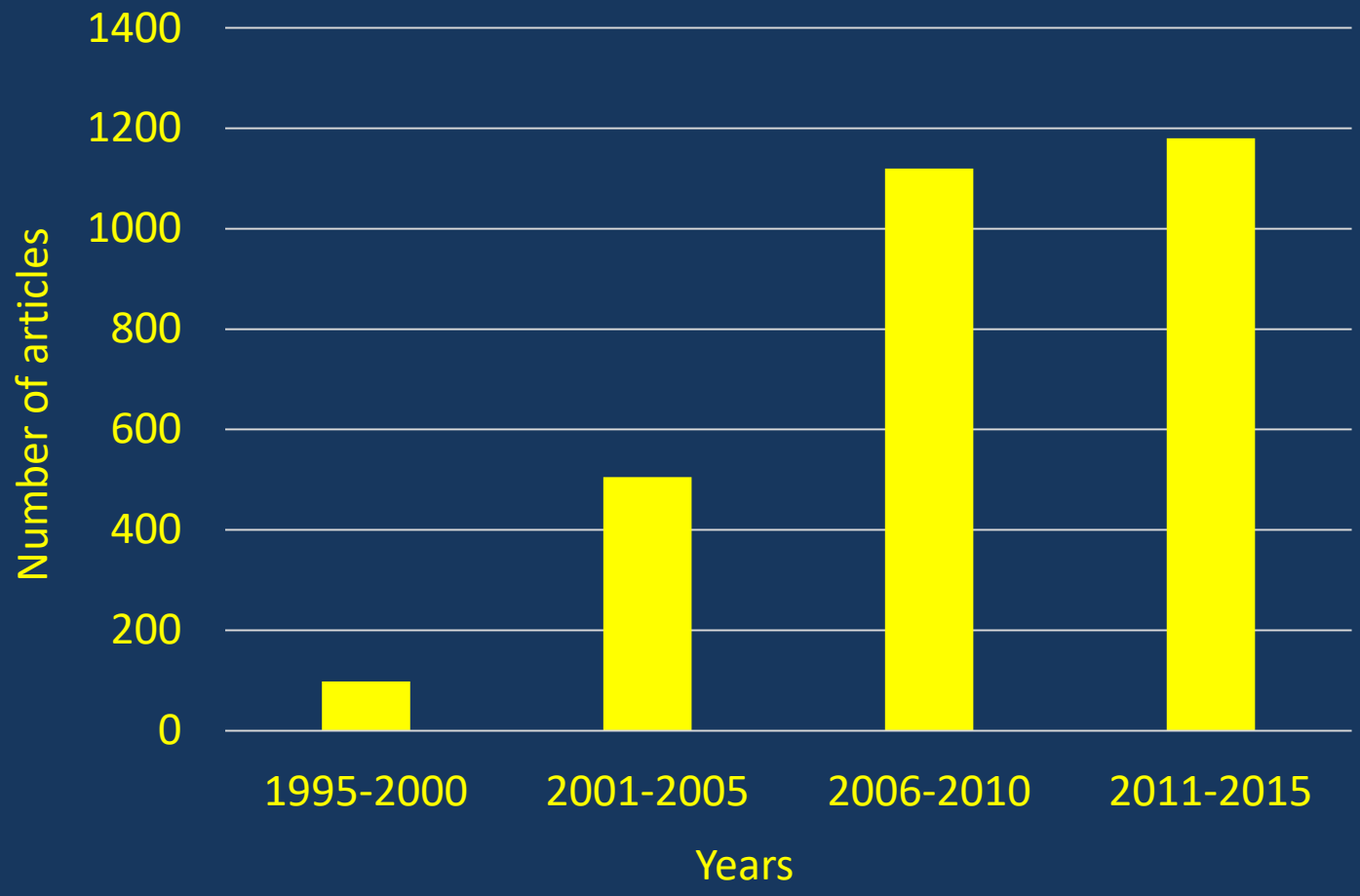

OREGON
CALIFORNIA
N
Mt. Shasta
Eureka
McCloud R.
Mill Cr.
Deer Cr.
Butte Cr.
Feather R.
Yuba R.
Sacramento R.
PACIFIC OCEAN
American R.
Sacramento
Mokelumne R.
San Francisco
37° 47' N
122° 33' W
Stanislaus R.
Tuolumne R.
Merced R.
San Joaquin R.



Information needs

- Protocol for accurate run identification of fish trapped at Keswick
- Assignment of individuals, not mixture proportions
- Must be done rapidly enough that decisions to hold or release fish could be made based on results

Publications featuring genetic assignment tests



Based on number of hits in Google Scholar: genetic “assignment test”

Final Report

January 1998 – September 2001

GENETIC MAINTENANCE OF HATCHERY- AND NATURAL-ORIGIN WINTER-RUN CHINOOK SALMON

COOPERATIVE AGREEMENT

ANADROMOUS FISH RESTORATION PROGRAM

University of California–Davis/U.S. Fish & Wildlife Service

1448-11330-97-J194	1/1/98-12/31/98
1448-11330-97-J045	1/1/99-12/31/99
1448-11330-97-J045	1/1/00-12/31/00
1448-11330-97-J094	1/1/01-09/30/01

Contributers:

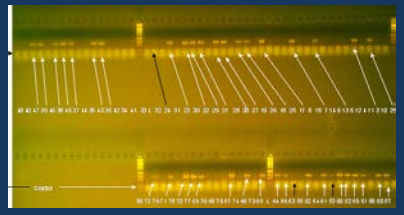
Principal Investigators:	Dennis Hedgecock (1998-2001)
	Michael Banks (1998)
Research Associate:	Vanessa Rashbrook (1998-2001)
Postgraduate Researchers:	Heather Fitzgerald (1998)
	Stephen Sabatino (1999-2001)
	Dimitri Churikov (2001)
Computer Programmer:	Will Eichert (1999-2001)
Subcontract:	Phil Hedrick (Arizona State University) (1998-2001)

Changes in the process

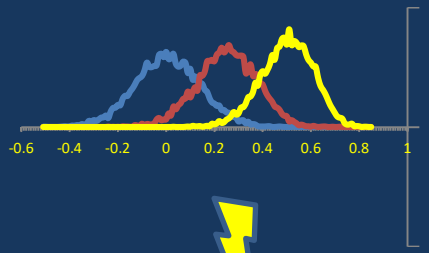
94 SNPs

7 Microsatellites

Genetic sex ID

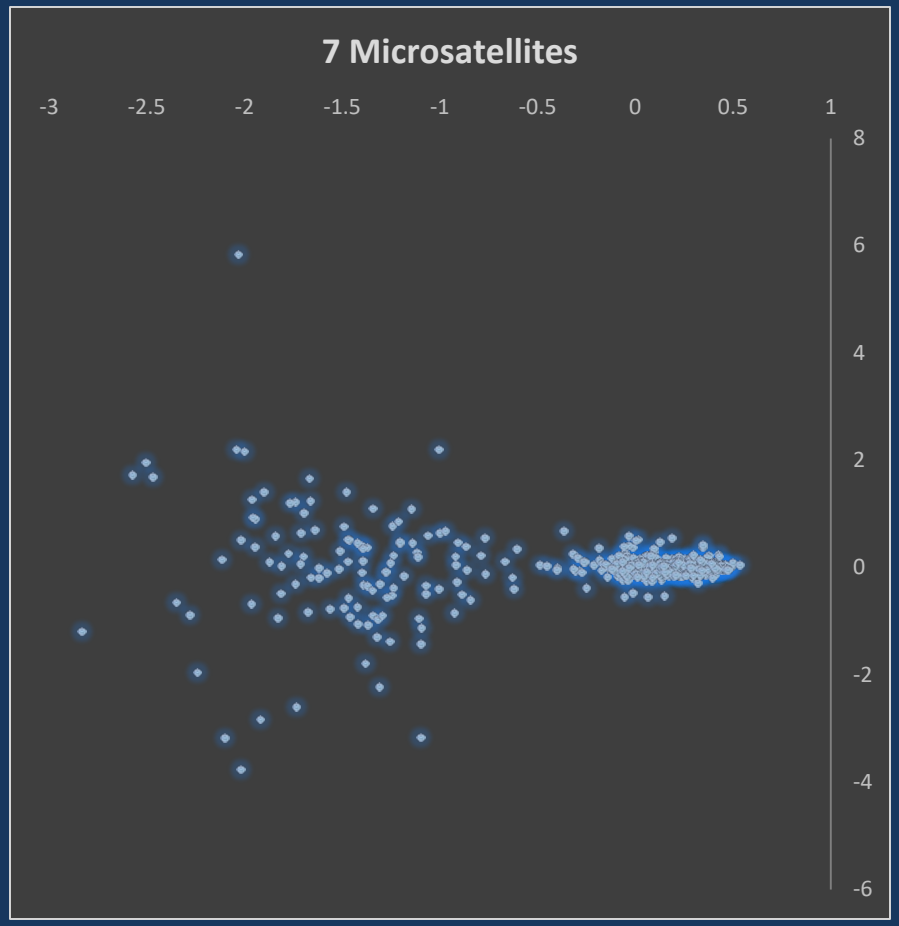


Relatedness

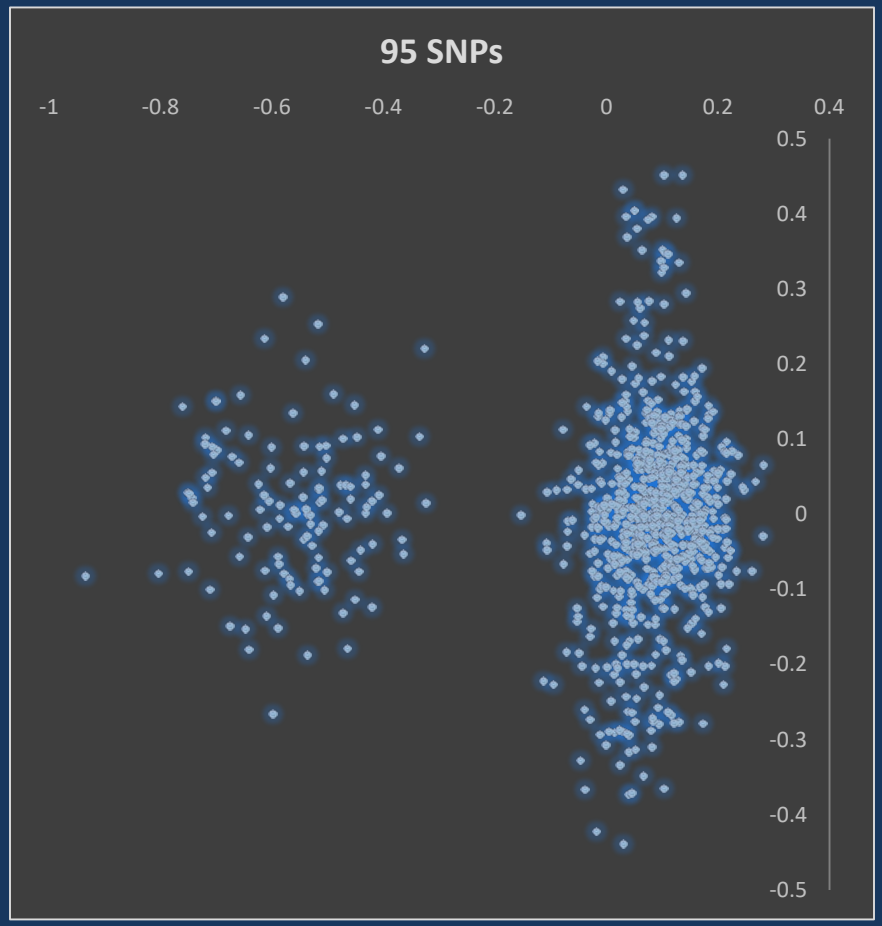


1998 2000 2002 2003 2004 2006 2008 2010 2012 2014 2016

Resolution to ID Winter run



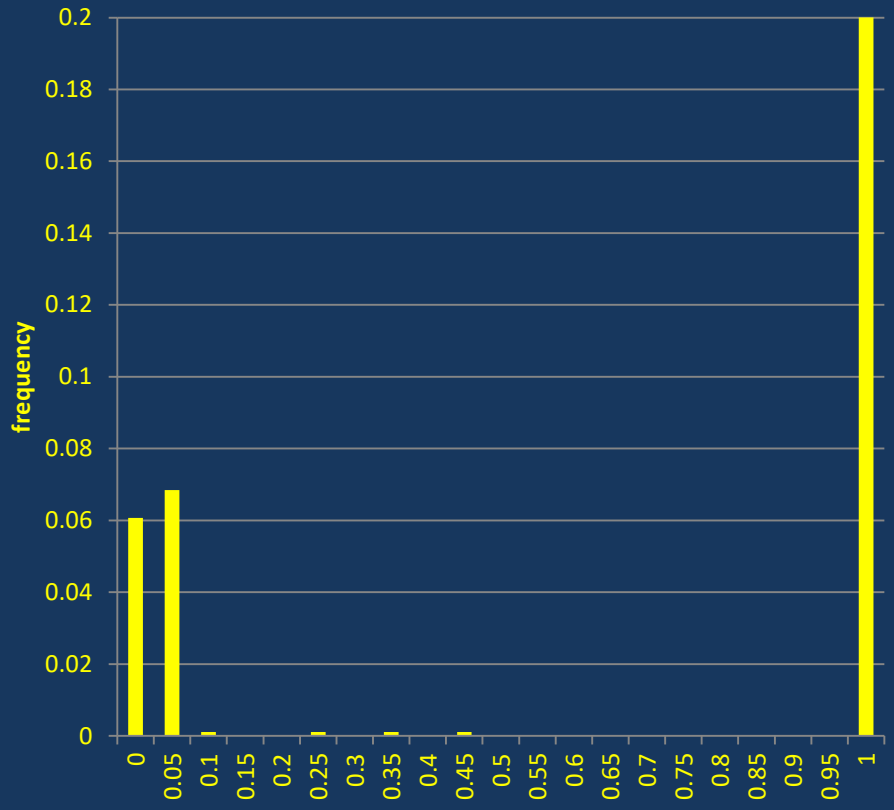
Non-Winter Run Winter Run



Non-Winter Run Winter Run

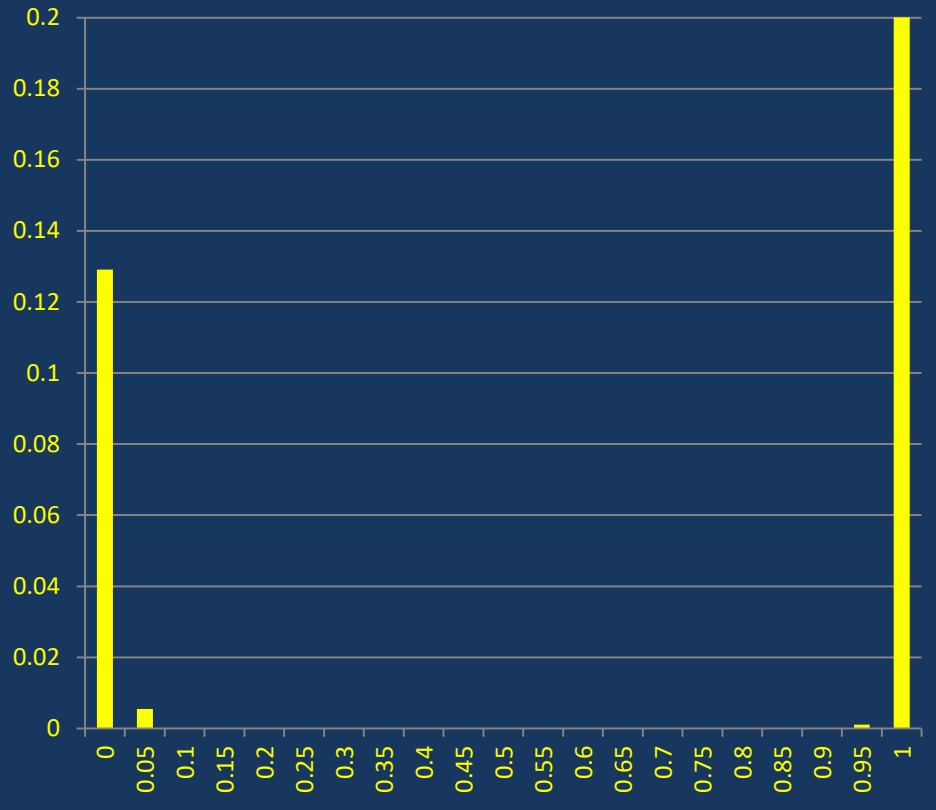
P (winter-run)

7 microsatellites



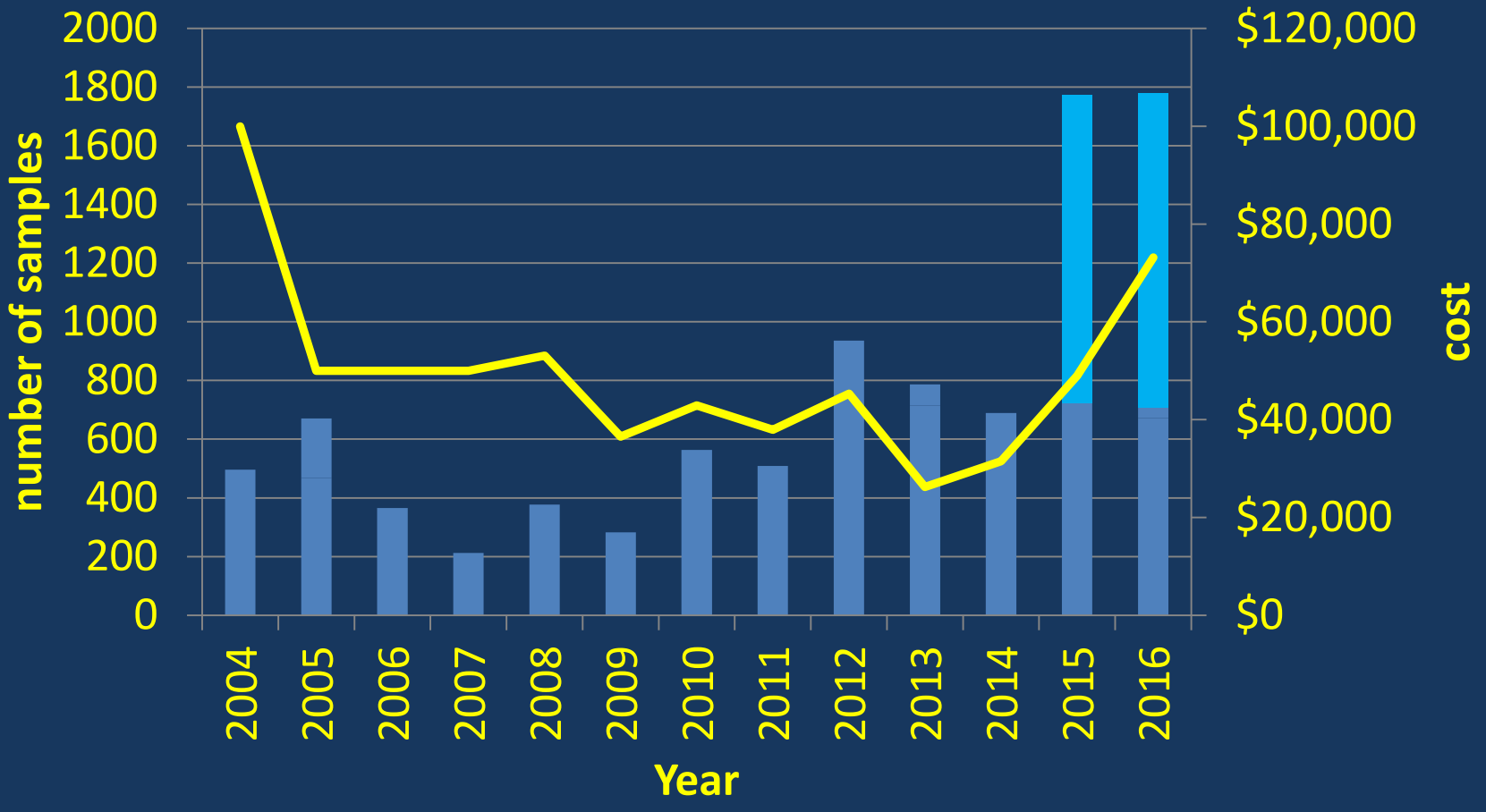
Assignment probability

95 SNPs

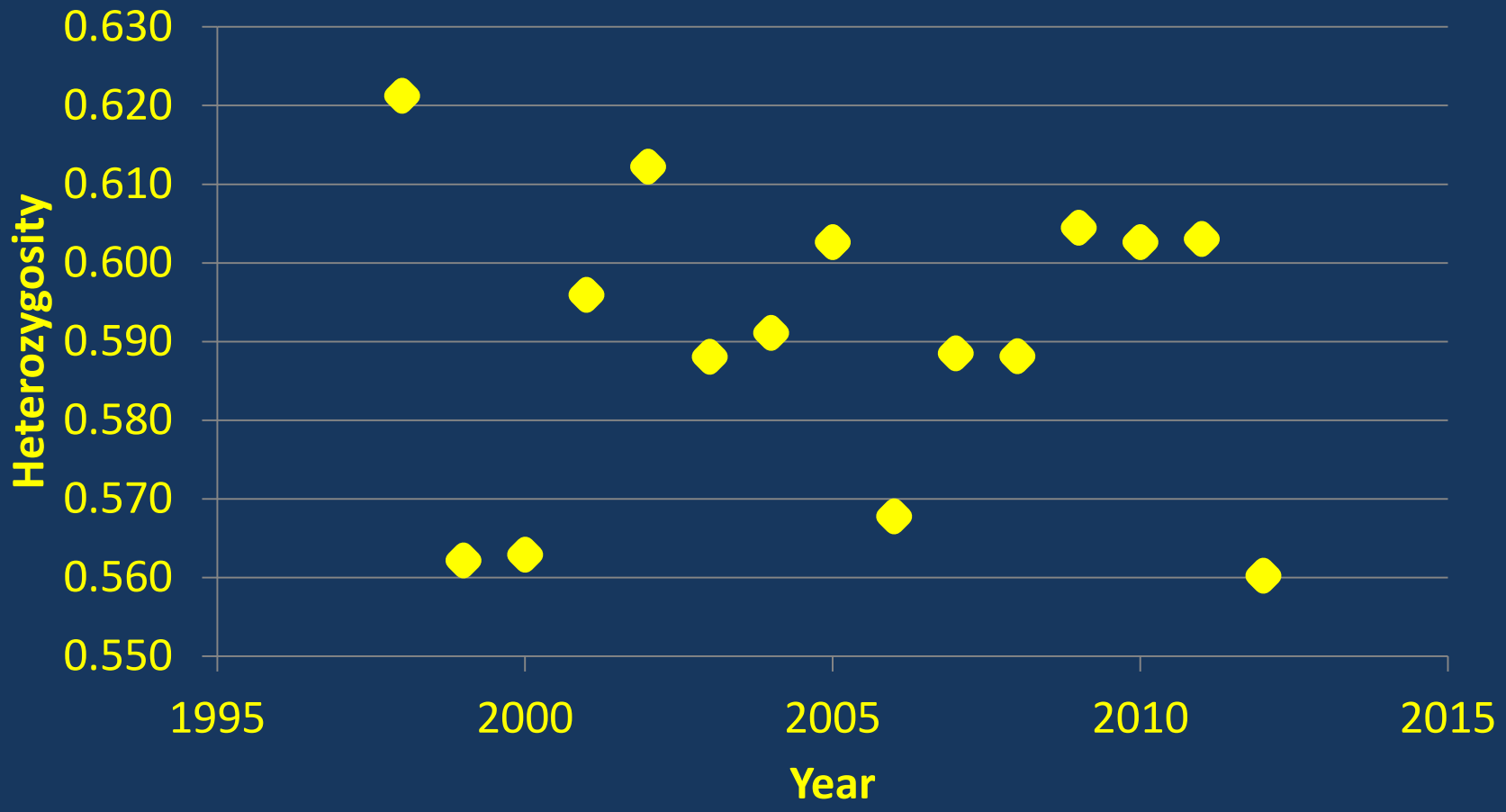


Assignment probability

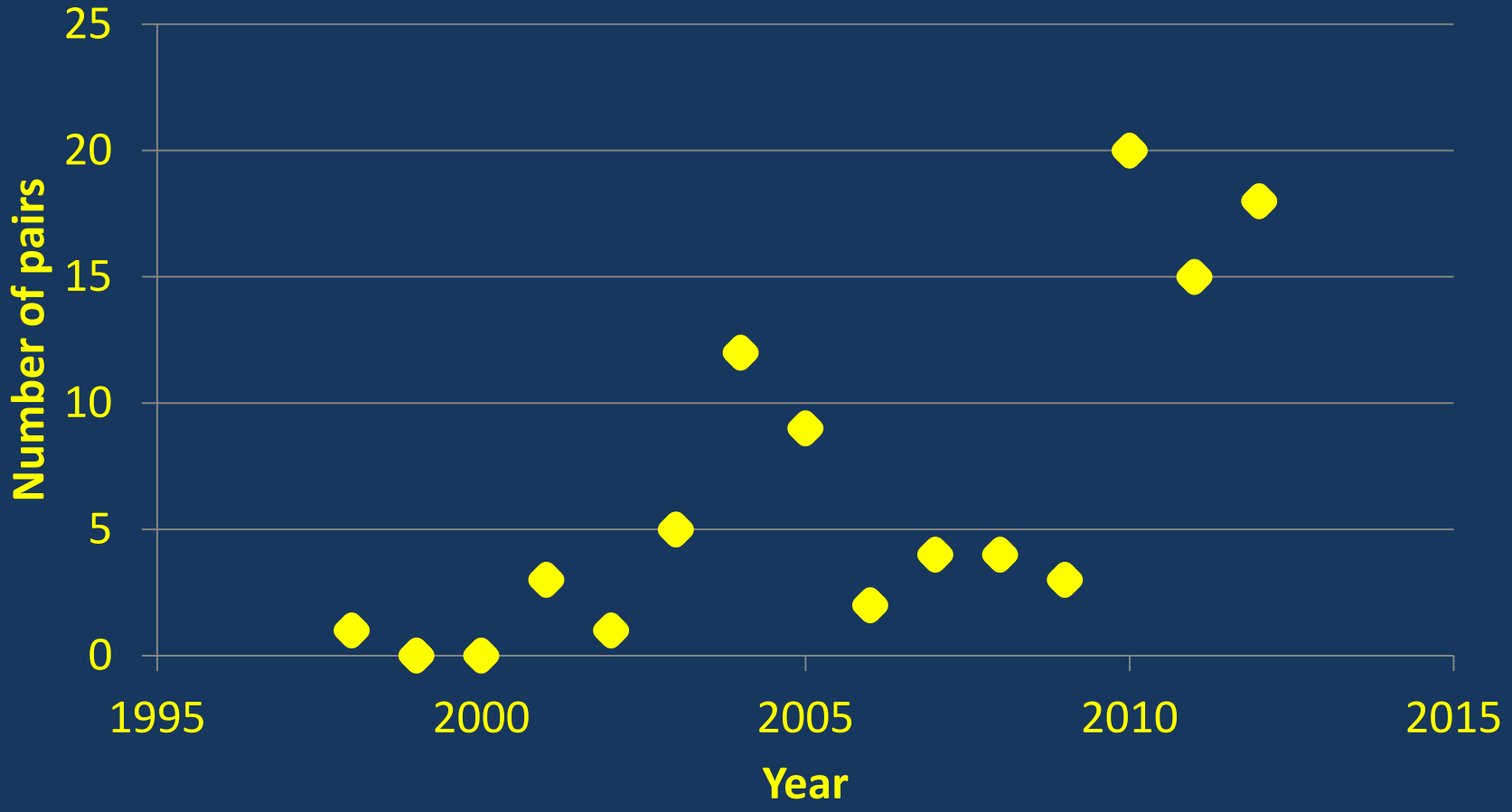
Sample numbers (blue bars) and project costs (yellow line)



Heterozygosity



Linkage disequilibrium



Current challenges

1. Genetic broodstock management changes?
   Captive brood, matrix spawning, …

2. Contribution to naturally-spawning population component

3. Impact to Spring Run Chinook salmon?

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1. Genetic broodstock management changes?

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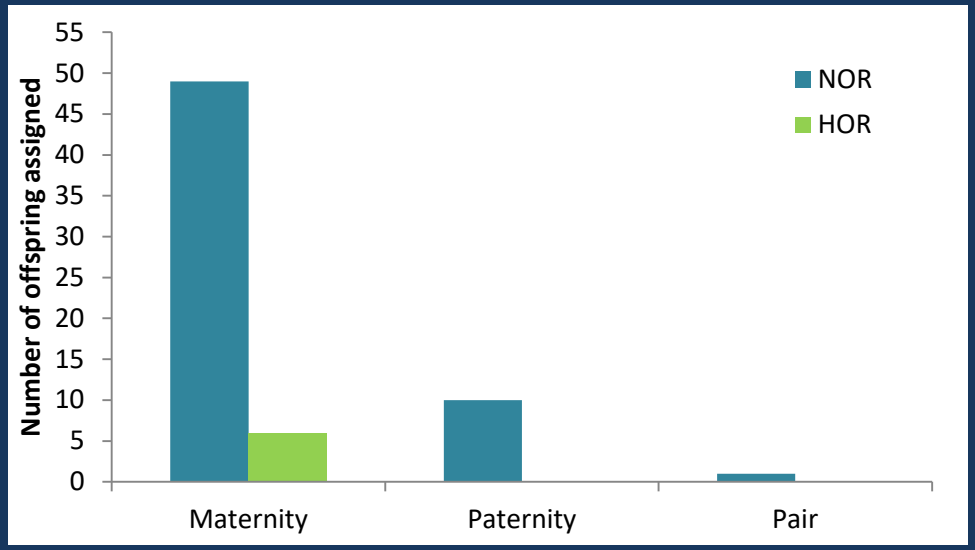
2. Contribution to naturally-spawning population component

Contribution to NOR

- Large and unknown proportion of parents not sampled
- DNA from carcass samples yielded high PCR failure rate



10%

0.1%

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1. Genetic broodstock management changes?
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3. Impact to Spring Run Chinook salmon ?

Impact to spring run?

Adults at Red Bluff Diversion Dam

Phenotypic Assignment	Genetic Assignment		
	Spring	Fall	Winter
Spring	11	14	0
Fall	19	279	1
Winter	13	17	9

Juveniles on the American River*

Phenotypic Assignment	Genetic Assignment		
	Spring	Fall	Winter
Spring	4	141	4
Fall	0	22	0
Winter	1	0	9

*Data provided by Doug Threloff, USFWS

Impact to spring run?

- FRH spring look more like baseline fall than baseline spring using the markers described here

- Ongoing crossing between fall run and spring run in some tributaries

Conclusions

- Rapid response protocol developed at BML provided a solution which met USFWS needs for many years, and a model which has been broadly applied internationally
- Nearly two decades of data suggest no loss of genetic diversity in WRCS, but do indicate risk of over-representation of some families, characteristic of many supplemented populations.

Acknowledgements

Initial project development (1997-2003):

UC Davis, Arizona State University, Coleman NFH

Current (2004-present):

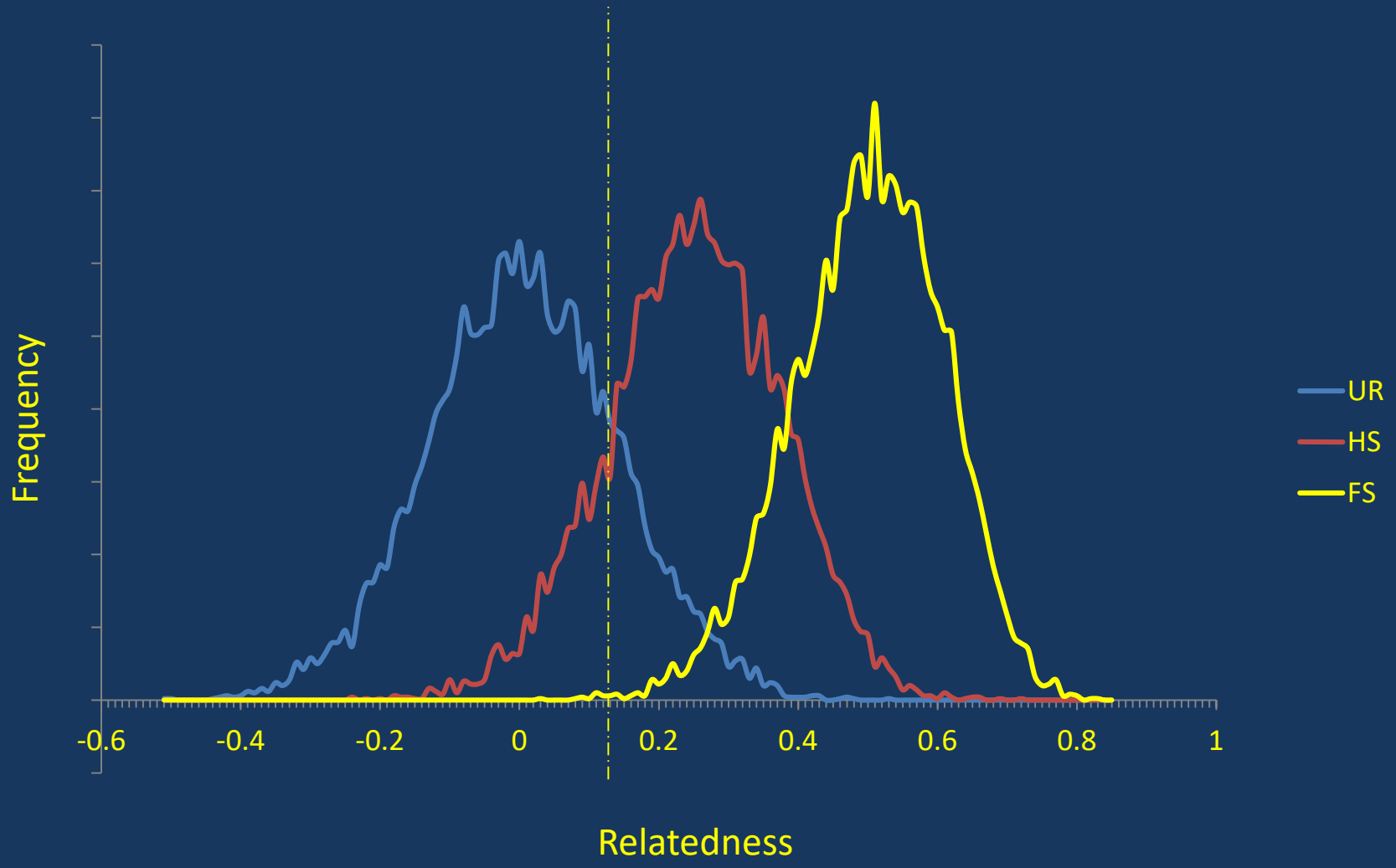
Livingston Stone NFH, Coleman NFH, Red Bluff FWO, Abernathy Fish Technology Center

In collaboration with:

USBR, CDFW, NOAA Fisheries

The findings and conclusions presented here are those of the authors and do not necessarily reflect the views of the United States Fish and Wildlife Service

Reducing relatedness among hatchery spawners



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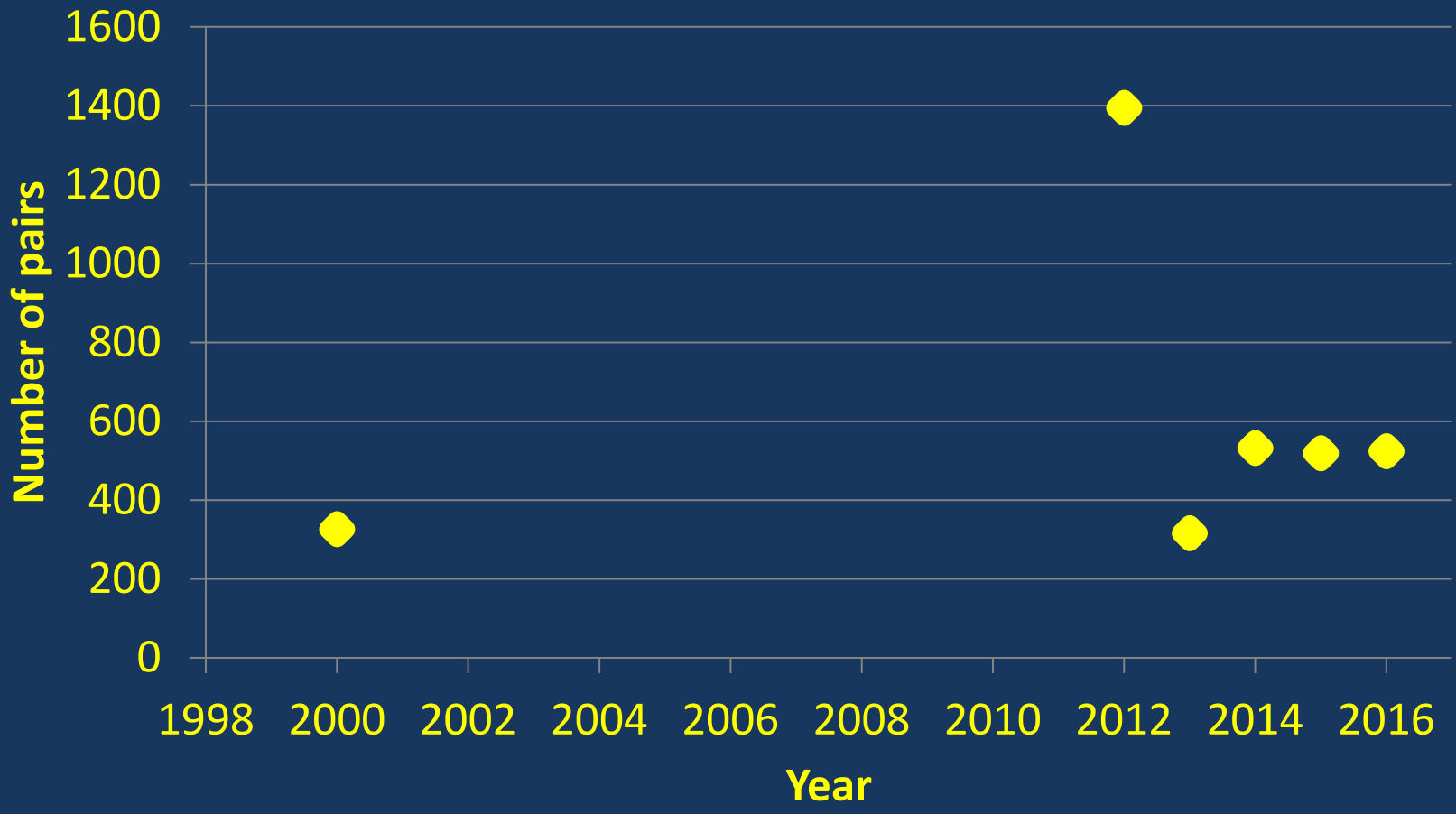
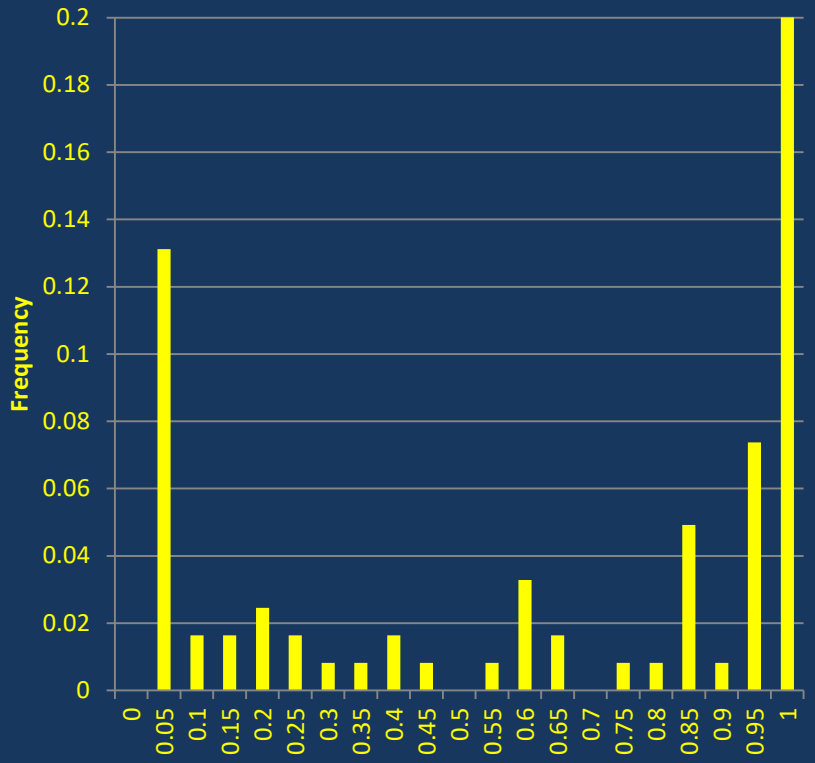


P (spring run)

7 microsatellites



Assignment probability

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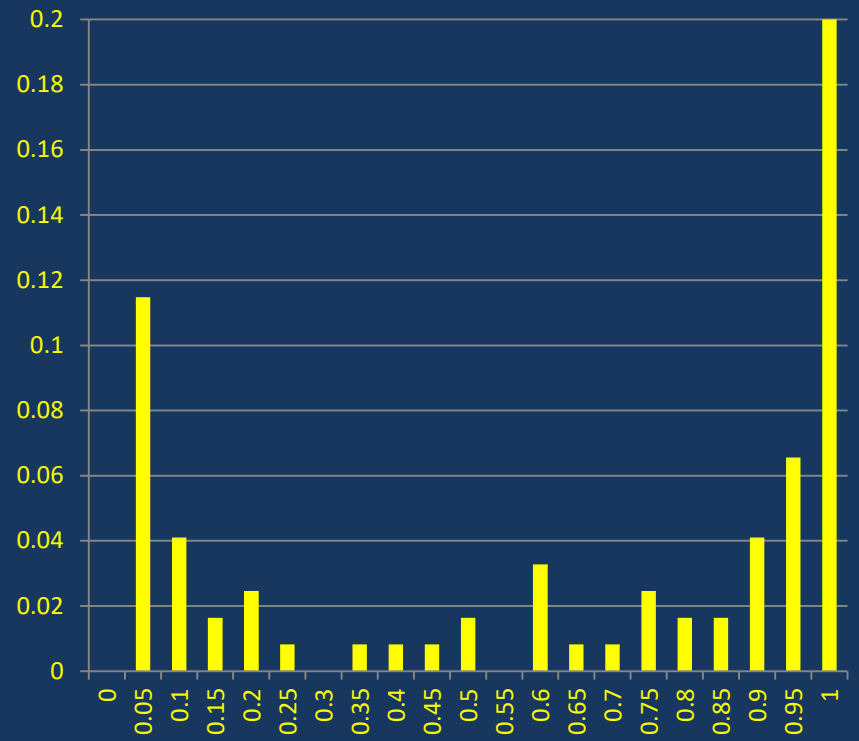

Assignment probability