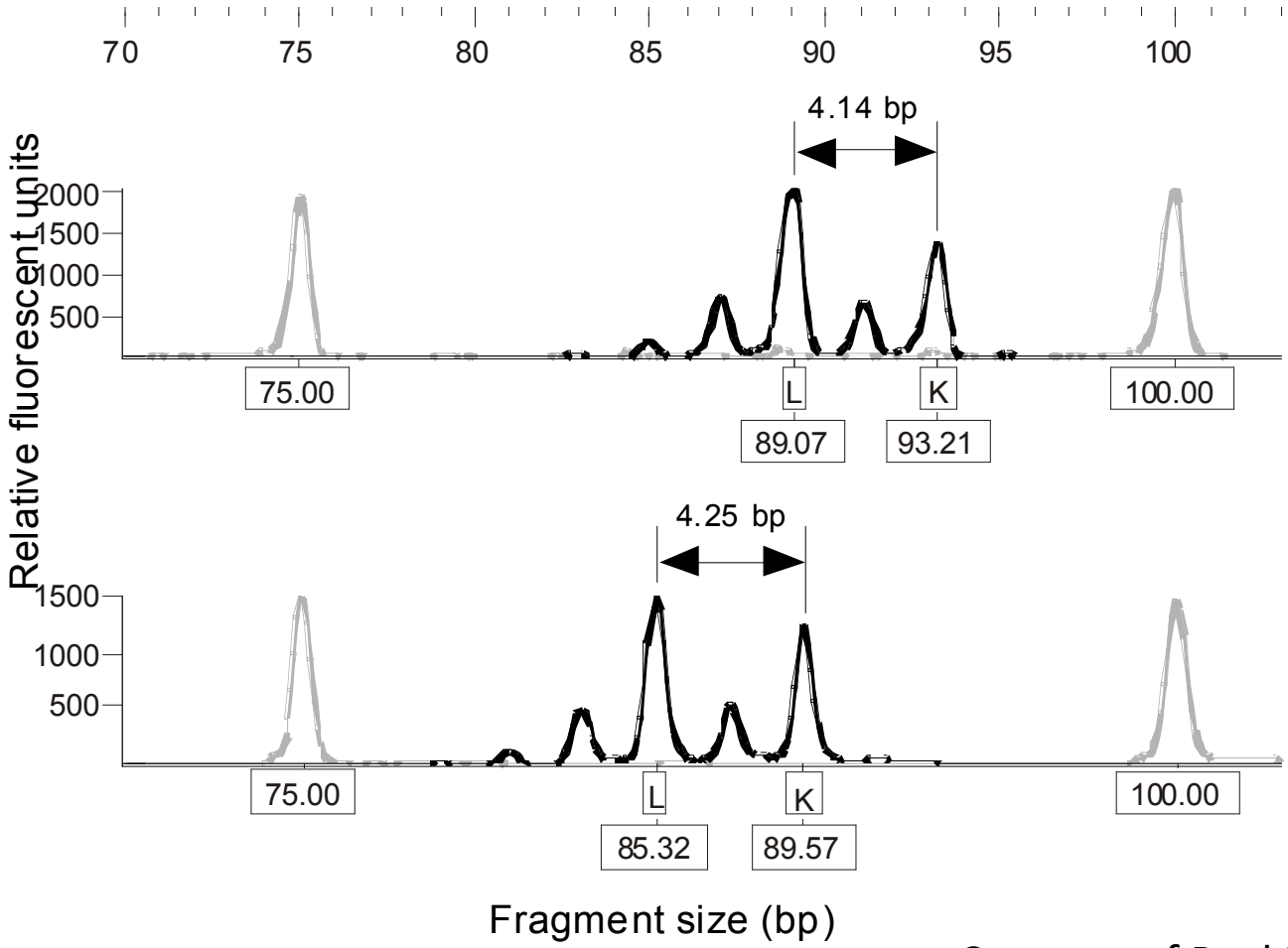
SNP discovery in alosines and their applications in herring biology and management

Molecular Ecology and Genetic Analysis Team (NOAA SWFSC and UC Santa Cruz) effort to discover and validate single nucleotide polymorphisms (SNPs) for alosine fishes (and one herring) for use in genetic stock identification (GSI) and other ecological and evolutionary investigation

- Alewife (*Alosa pseudoharengus*)
- Blueback herring (*Alosa aestivalis*)
- American shad (*Alosa sapidissima*)
- Pacific herring (*Clupea pallasii*)

The standardization issue with microsatellites

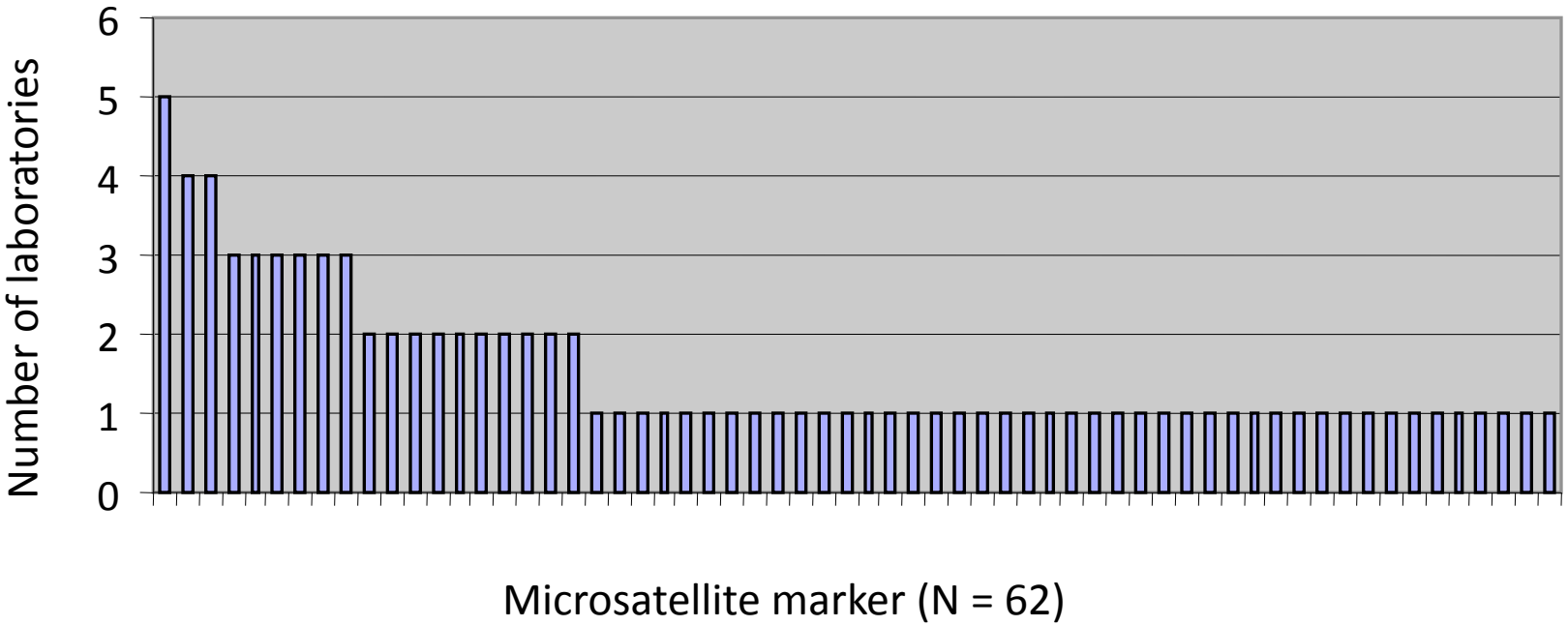
Lack of reproducible size determination on different instruments



Courtesy of Paul Moran

The “other” standardization issue

Use of different markers, SNPs or microsatellites,
means data can not be combined



Courtesy of Paul Moran

Advantages of SNPs for genetic stock identification and other collaborative investigations (e.g. large scale parentage-inference)

- Allele calls (nomenclature) are easily standardized between labs
- Low genotyping error rate
- Minimal human interaction with the raw genotyping data
- Amenable to high-throughput / low-cost genotyping- new technology: material costs for 100 SNPs similar to 12-18 microsatellites, and labor costs are MUCH lower.

West Coast Salmon GSI Project - California

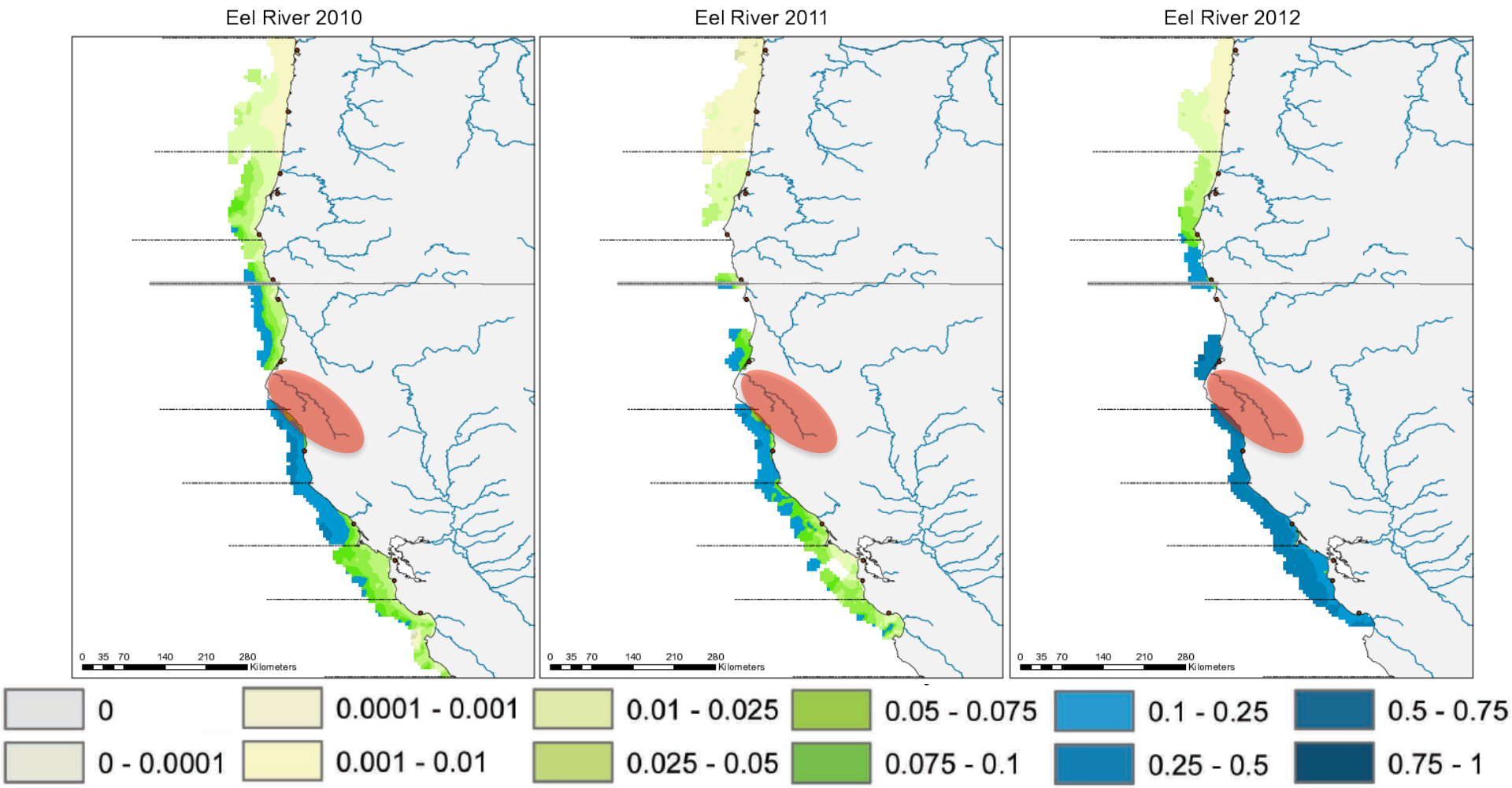
- GSI with Baseline database of 96 SNPs for 8,000 fish covering all salmon stocks found at more than 0.1% in California fishery.
- Five consecutive years of genetic tissue and GPS effort data sampling by commercial fishing fleet (2010-2014)
- Combination of in-season (retention) and closed area (non-retention) collection
- Coordinated with efforts in OR and WA

- Samples collected and analyzed with IDs
  - 2010 = 4,972
  - 2011 = 7,948
  - 2012 = 9,123
  - 2013 = 2,885
  - 2014 = 4,143

  Total = 29,071

West Coast Salmon GSI Project - California

Stock-specific catch probability maps



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Alewife (*Alosa pseudoharengus*) Ascertainment Panel

- Sequencing Run 1: 25M reads
- Sequencing Run 2: 29M reads

Stock	Population
Gulf of St. Lawrence	Miramichi River
Atlantic coast of Nova Scotia #1	Medway River
Atlantic coast of Nova Scotia #2	Argyle Brook
Bay of Fundy	Shubenacadie River
Saint John River	Saint John River
Gulf of Maine	Damariscotta River
Kennebec River	Sewell Pond
Northern New England Stock	St. George River
Southern New England Stock	Hudson River
Mid-Atlantic Stock	Rappahannock River
Great Lakes	Lake Ontario
Finger Lakes	Ostico Lake
Landlocked	Quonnipaug Lake
Landlocked	Rogers Lake
Landlocked	Pattagansett Lake
Long Island Sound	Bride Brook
Long Island Sound	Dodge Pond

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American shad (*Alosa sapidissima*)
Ascertainment Panel

- Sequencing Run 1: 27M reads

Population
Hudson River
Susquehanna River
Columbia River
Sacramento River (American River)
San Joaquin River (Millerton Lake)

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Blueback herring (*Alosa aestivalis*) Ascertainment Panel

- Sequencing Run 1: 22M reads

Stock	Population
Northern New England	East Machias River
Southern New England	Gilbert-Stuart River
Mid-Atlantic	Connecticut River
Southern Atlantic	Savannah River

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Allele frequencies for Blueback Herring

Locus		Populations		
		Mystic, MA	Monu, MA	St Johns, FL
GTA0101445	3	77.27	73.40	21.28
	4	22.73	26.60	78.72
GTA0100088	2	96.74	98.94	100.00
	4	3.26	1.06	
GTA0100103	2	33.33	30.85	21.28
	3	66.67	69.15	78.72
GTA0100145	2	98.86	94.57	100.00
	4	1.14	5.43	
GTA0102361	1	31.11	43.62	
	3	68.89	56.38	100.00
GTA0100130	3	45.65	43.62	36.96
	4	54.35	56.38	63.04
GTA0100169	1	59.30	54.26	70.21
	2	40.70	45.74	29.79

Locus		Populations		
		Mystic, MA	Monu, MA	St Johns, FL
GTA0100131	3	97.83	90.43	58.70
	4	2.17	9.57	41.30
GTA0100104	2	31.82	9.57	12.77
	4	68.18	90.43	87.23
GTA0100121	1	96.74	97.87	95.74
	4	3.26	2.13	4.26
GTA0100100	2	51.09	45.74	28.72
	4	48.91	54.26	71.28
GTA0101446	1	90.00	97.87	94.68
	4	10.00	2.13	5.32
GTA0102355	1	34.78	6.38	75.53
	3	65.22	93.62	24.47
GTA0100108	1			6.38
	2	100.00	100.00	93.62