Hatchery Impacts on the Genetic Structure of Native Stocks of Chinook Salmon in the Klamath-Trinity Basin

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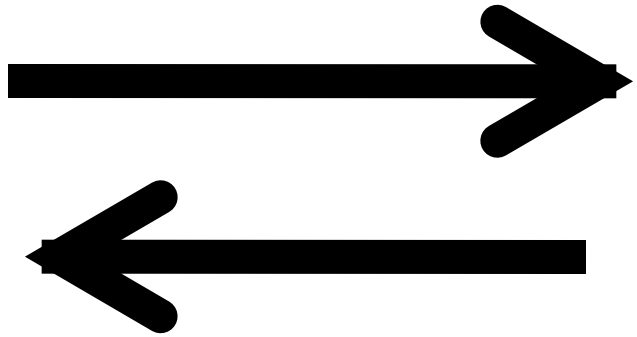
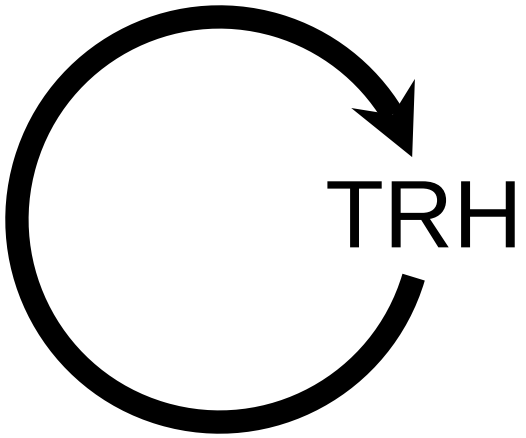
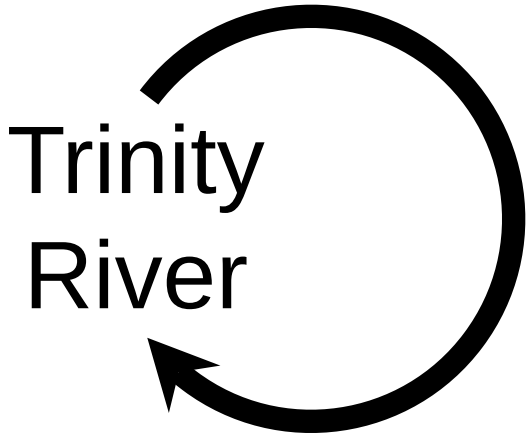
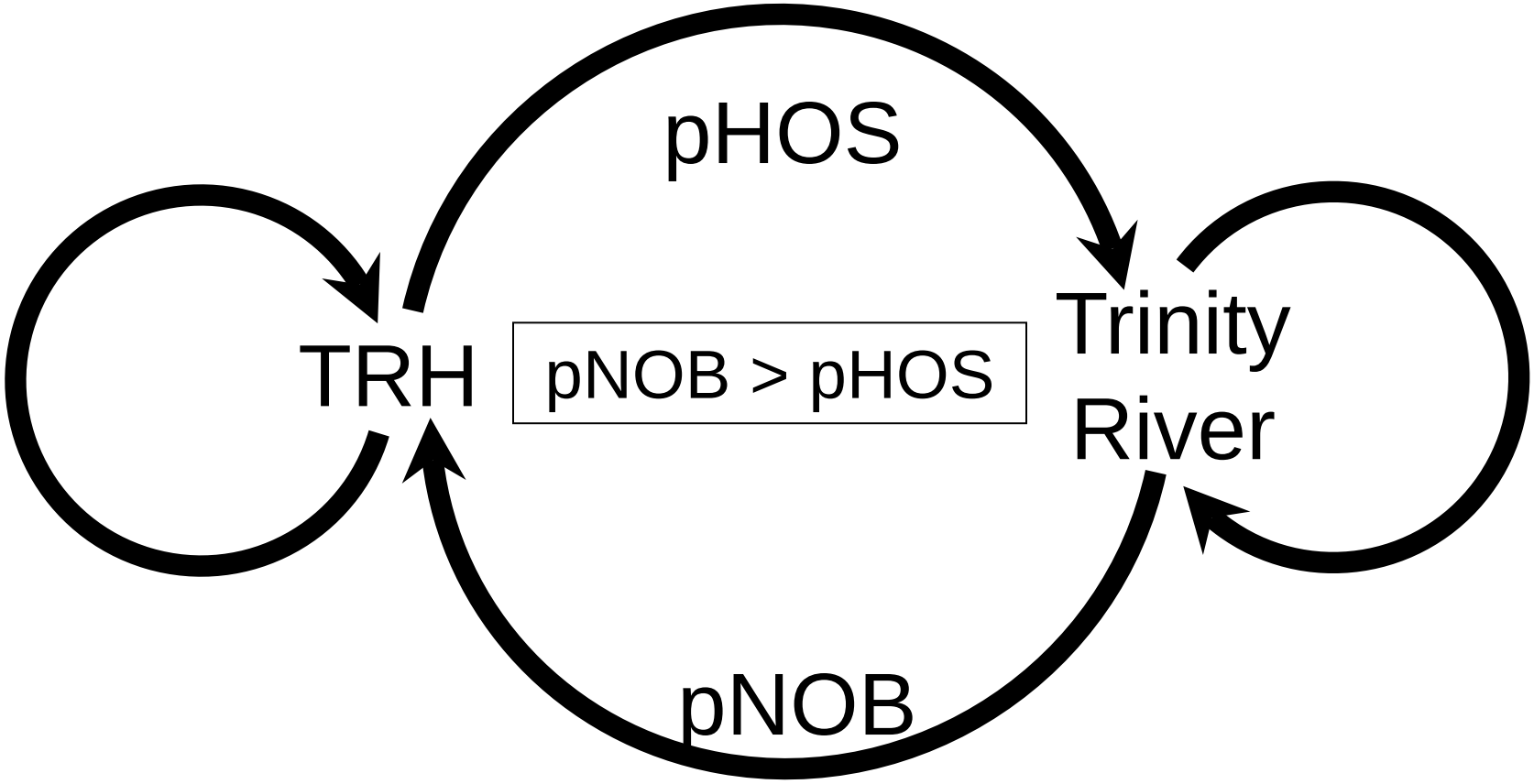
Chinook Salmon Restoration:

TRH  **Trinity River**





Segregated –
two distinct populations



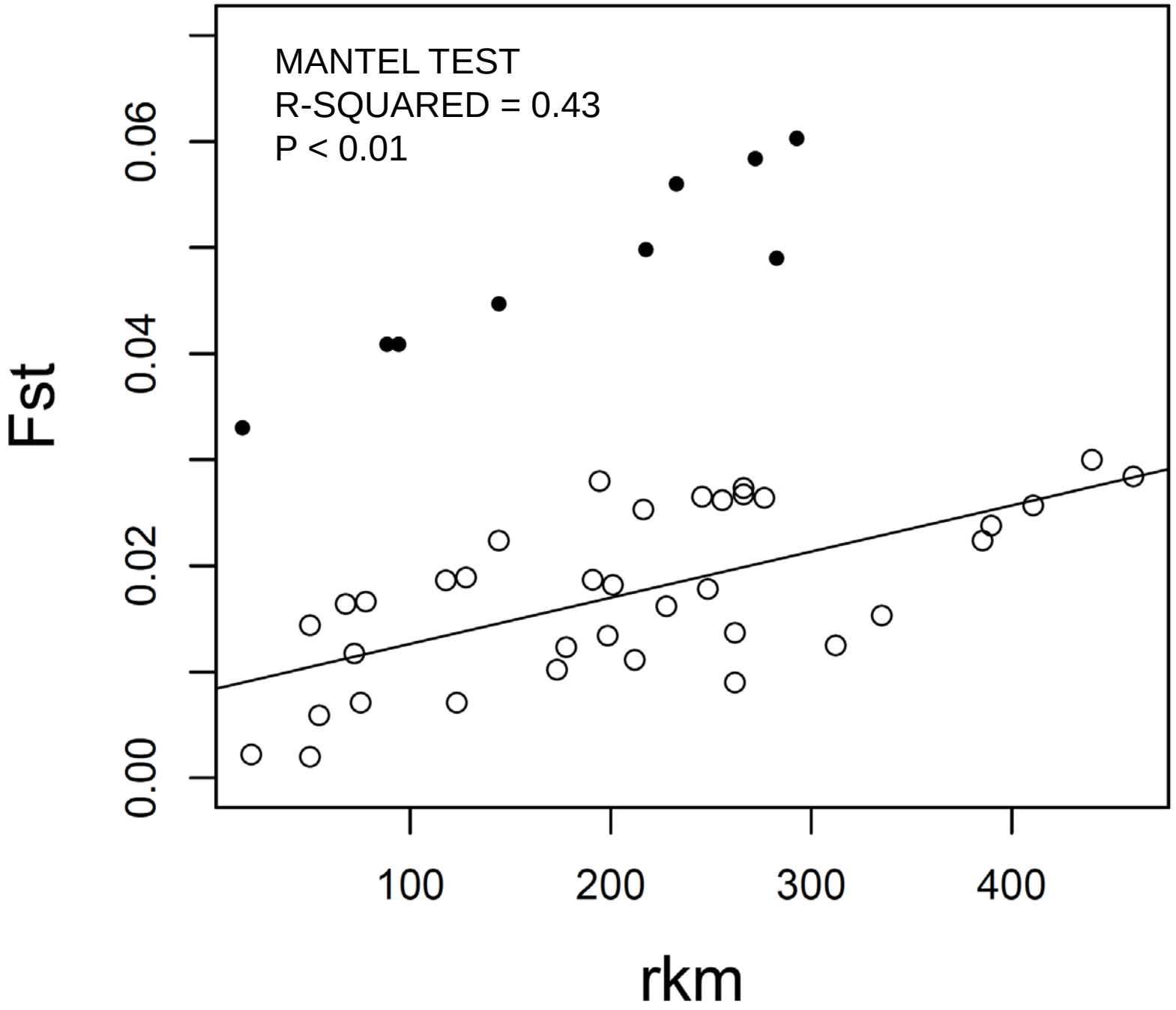
Integrated –
natural selection in wild
drives system

Trinity River and Trinity River Hatchery

- Integrated
- pHOS ≈ 14 to 50%
- pNOB ≈ 10%
- pNOB < pHOS
- Natural selection in hatchery drives system

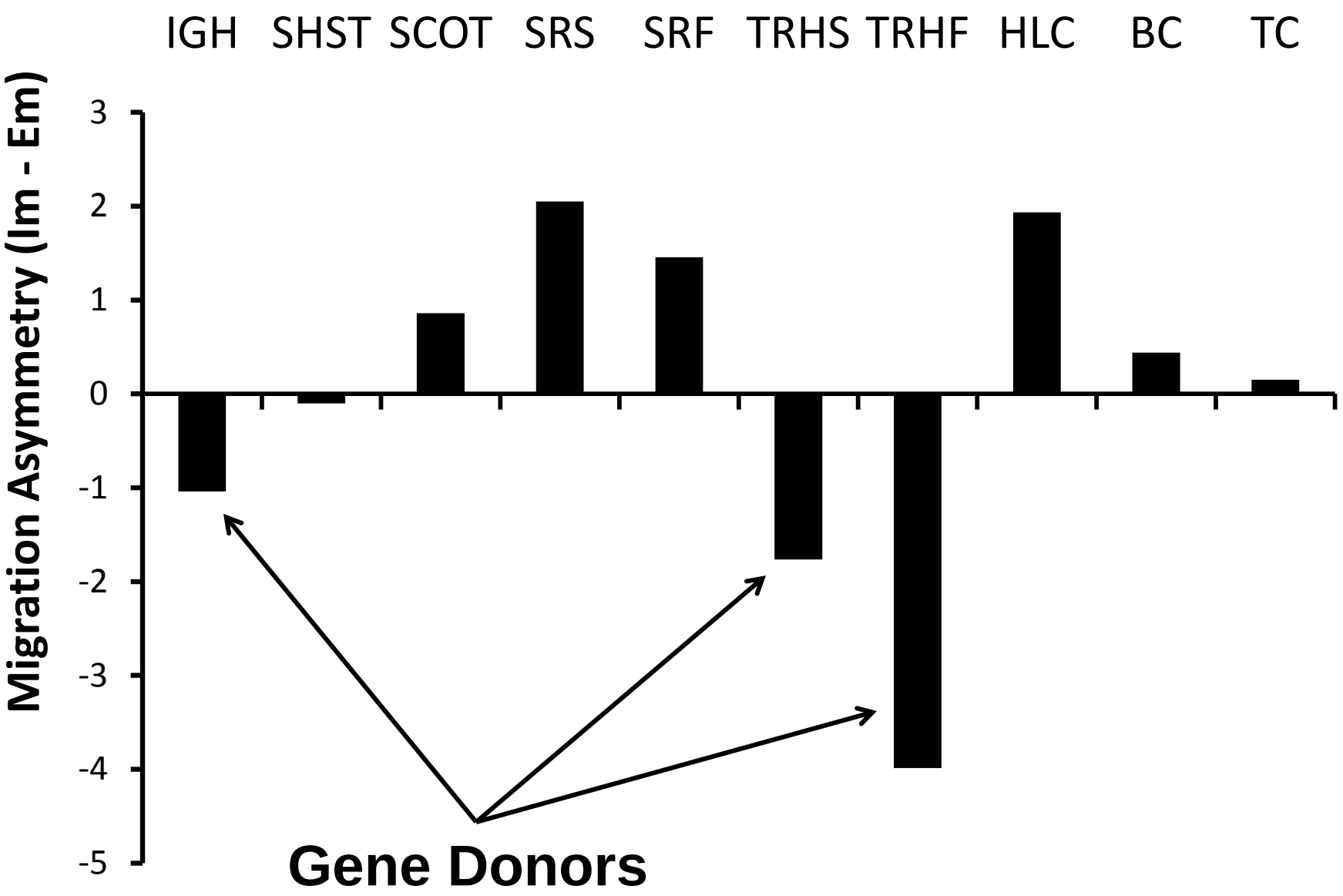
Current Structure:

Influence of TRH genes decreases as distance from TRH increases


MANTEL TEST
R-SQUARED = 0.43
P < 0.01
Fst
0.00
0.02
0.04
0.06
100
200
300
400
rkm

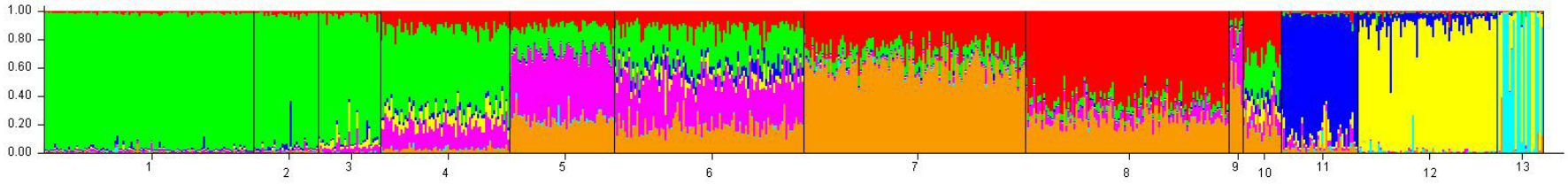
Current Structure:

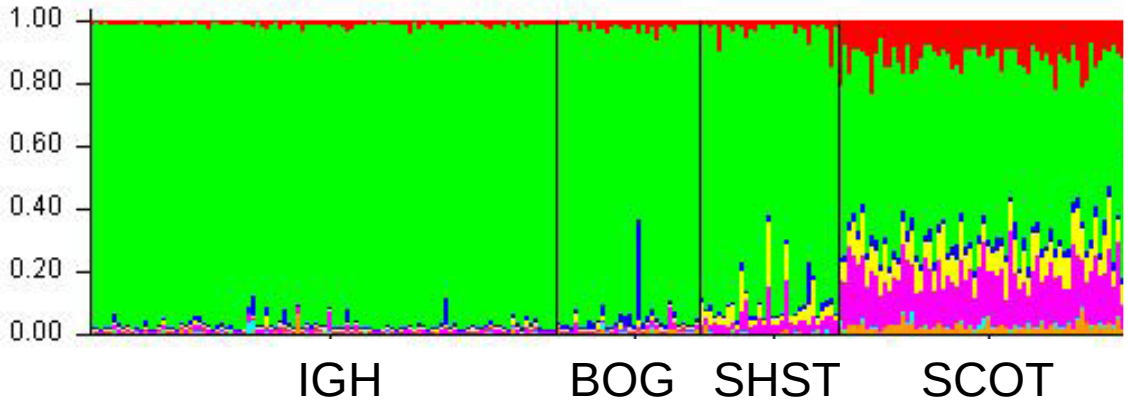
TRH and IGH are source populations whereas most wild stocks are sinks

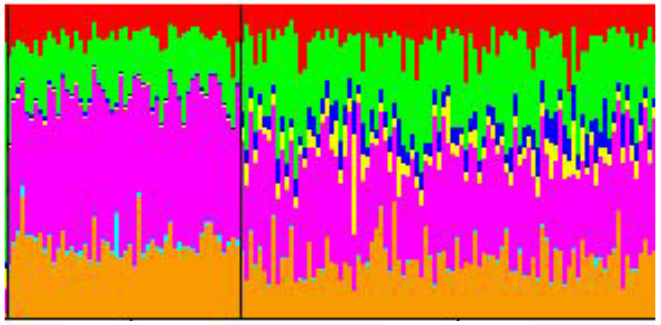

IGH
SHST
SCOT
SRS
SRF
TRHS
TRHF
HLC
BC
TC
Migration Asymmetry (Im - Em)
3
2
1
0
-1
-2
-3
-4
-5
Gene Donors

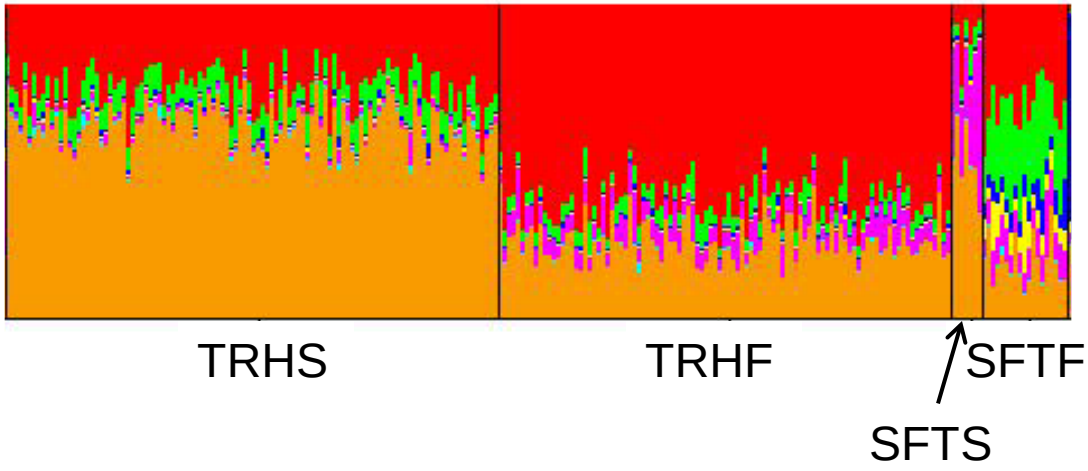
Current Structure:

Upriver populations appear to have been mixed with or replaced by TRH or IGH fish


1.00
0.80
0.60
0.40
0.20
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13


1.00
0.80
0.60
0.40
0.20
0.00
IGH
BOG
SHST
SCOT

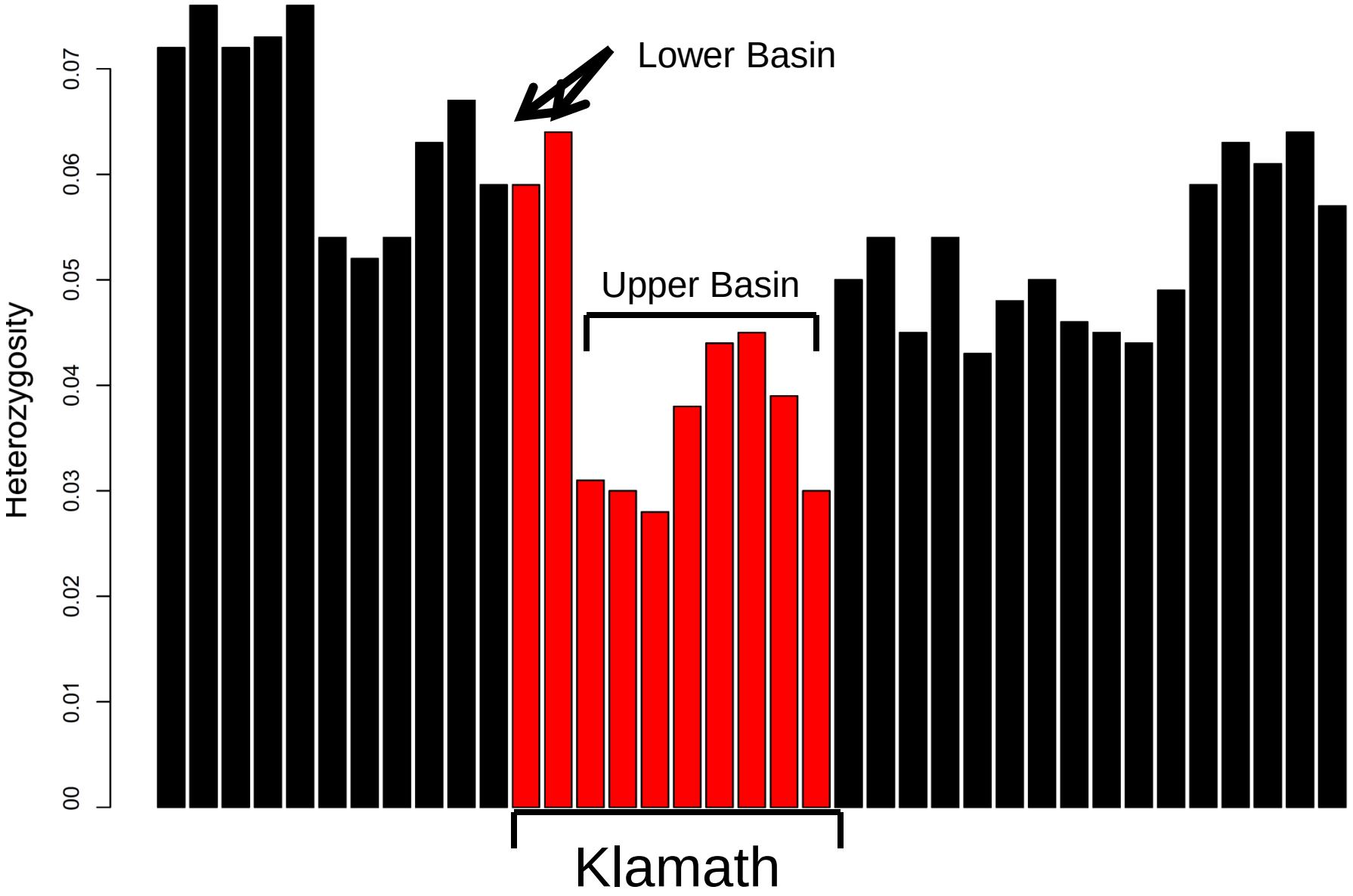

SRS
SRF


TRHS
TRHF
SFTF
SFTS

Current Structure:

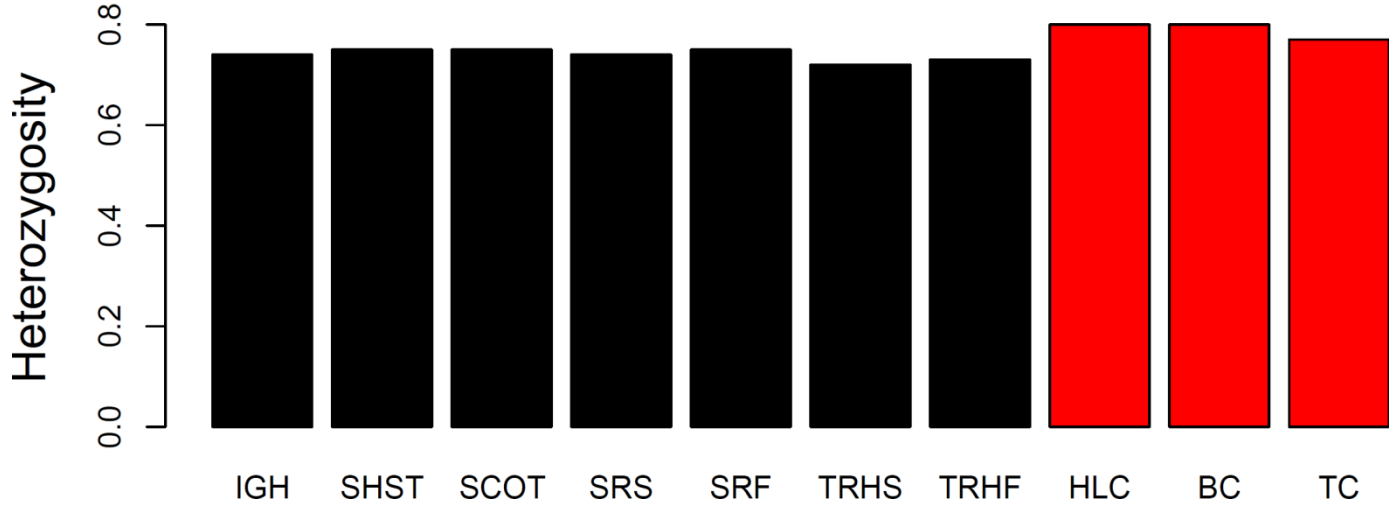
Upper Klamath stocks have reduced genetic diversity

Allozyme Genetic Diveristy in 37 Pops from CA and OR

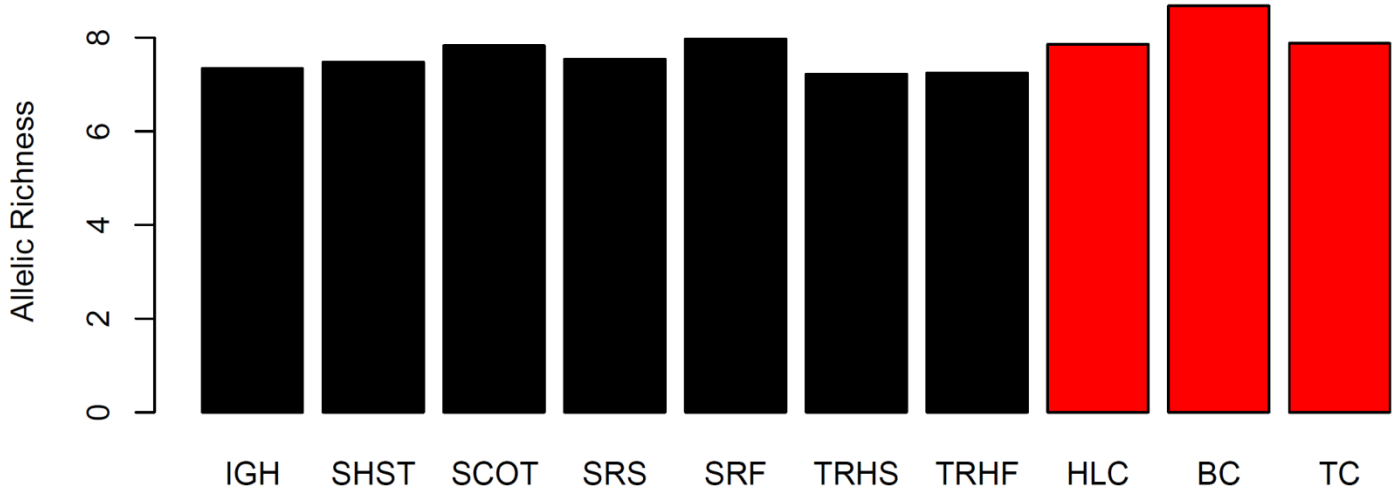


Gall et al. (1991)

Microsatellite Genetic Diveristy Klamath−Trinity Basin



P < 0.05



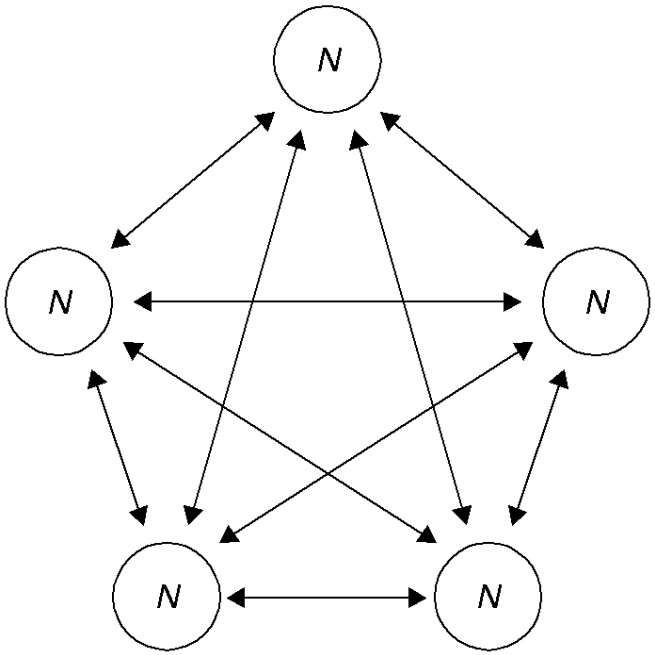
P < 0.05

Summary

- TRH – integrated, natural selection in hatchery drives system (pNOB < pHOS)
- Influence of TRH genes decreases as distance from TRH increases
- TRH and IGH are source populations whereas most wild stocks are sinks
- Upriver populations appear to have been mixed with or replaced by TRH or IGH fish
- Upper Klamath stocks have reduced genetic diversity

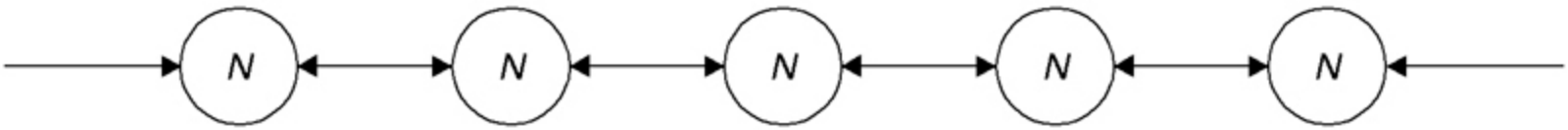
Migration

Models of Migration



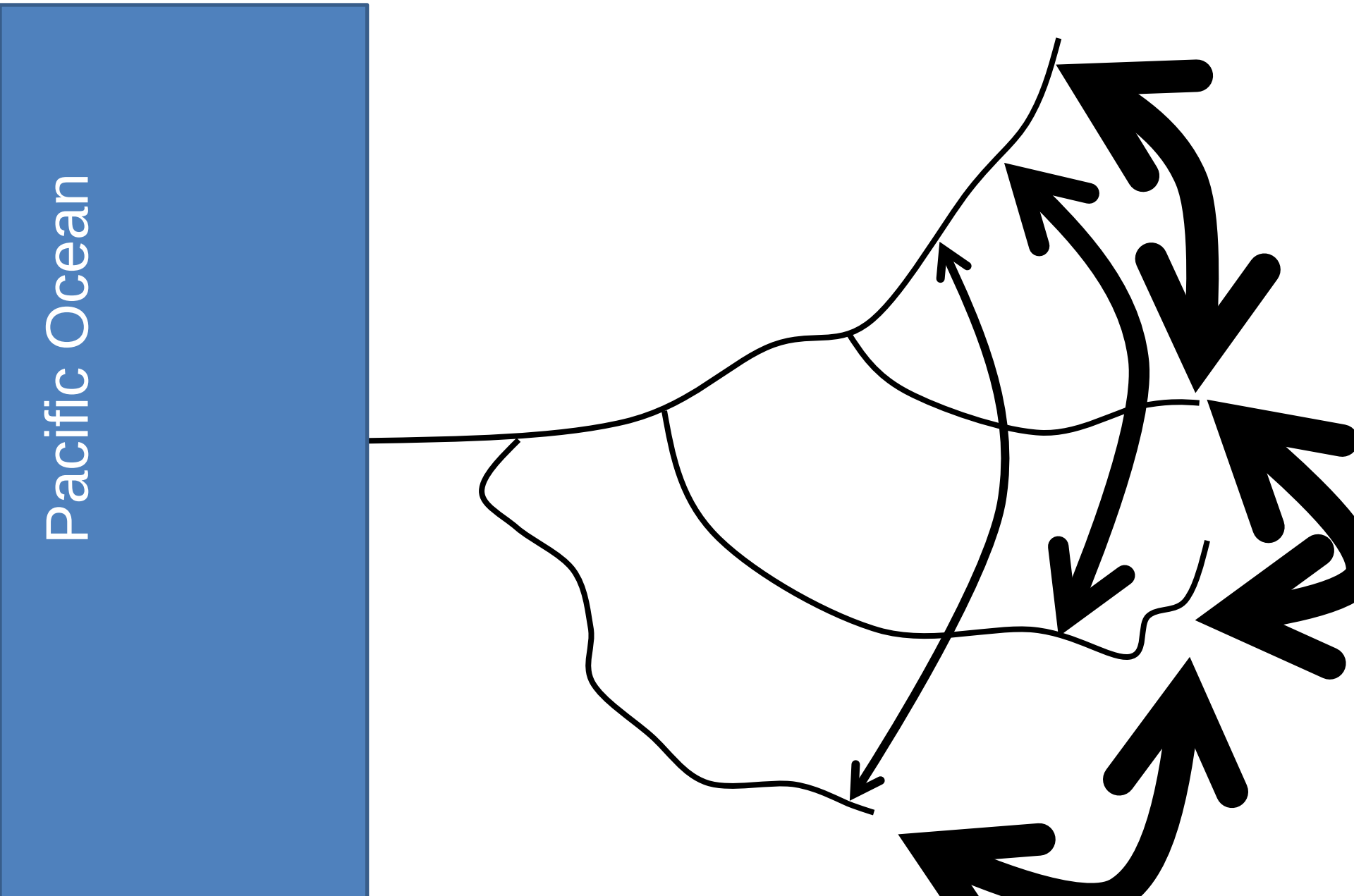
Island Model

Models of Migration



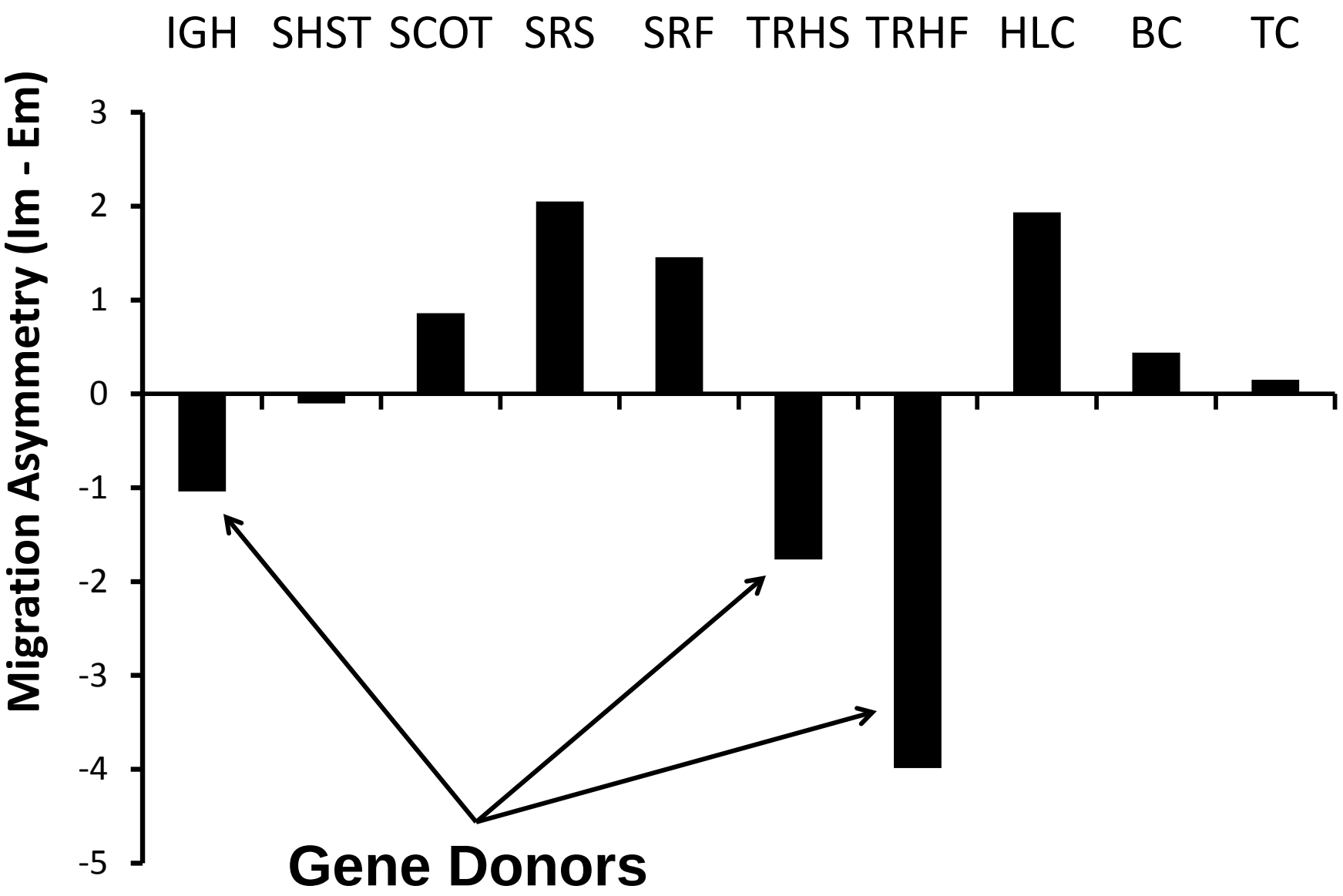
Isolation-By-Distance Model

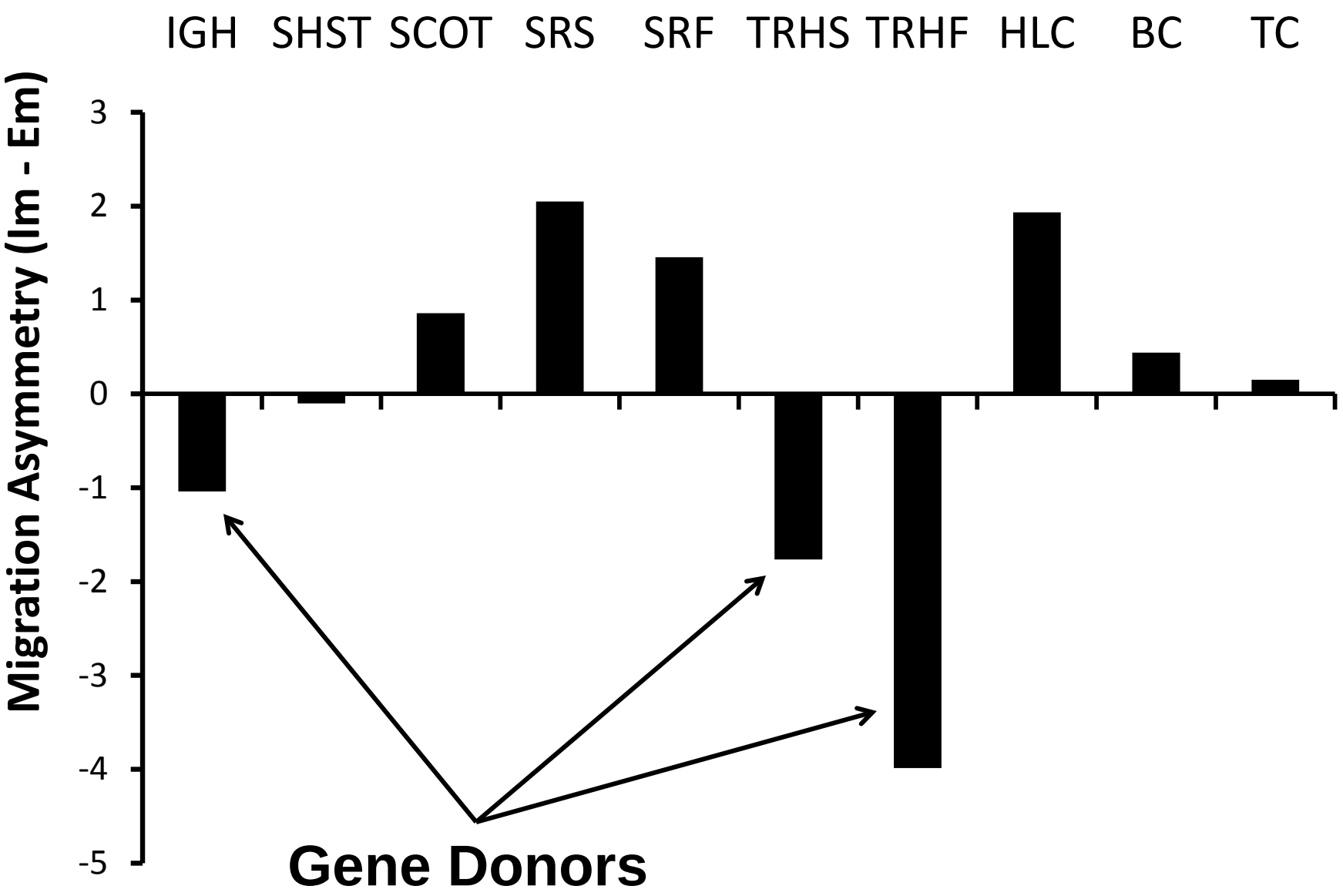
Isolation-By-Distance



Metapopulation Dynamics: Source and Sink Populations

Metapopulation Dynamics: Source and Sink Populations


IGH
SHST
SCOT
SRS
SRF
TRHS
TRHF
HLC
BC
TC
Migration Asymmetry (Im - Em)
3
2
1
0
-1
-2
-3
-4
-5
Gene Donors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SCOT
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TRHF
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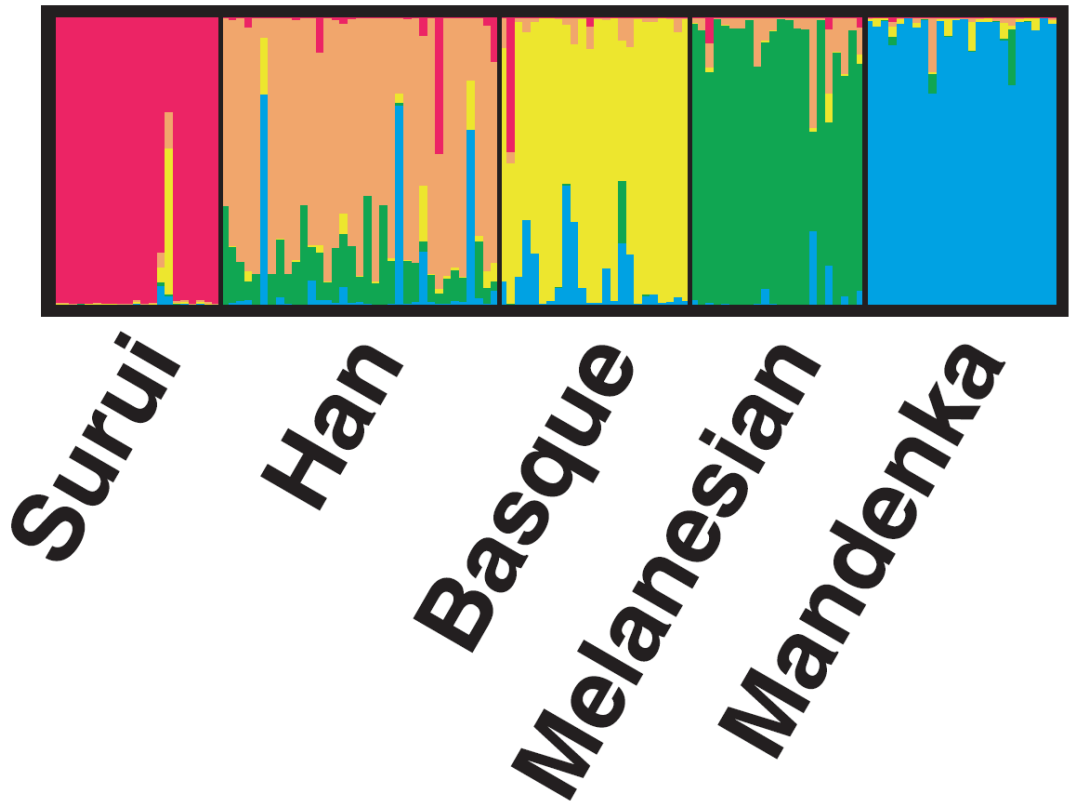
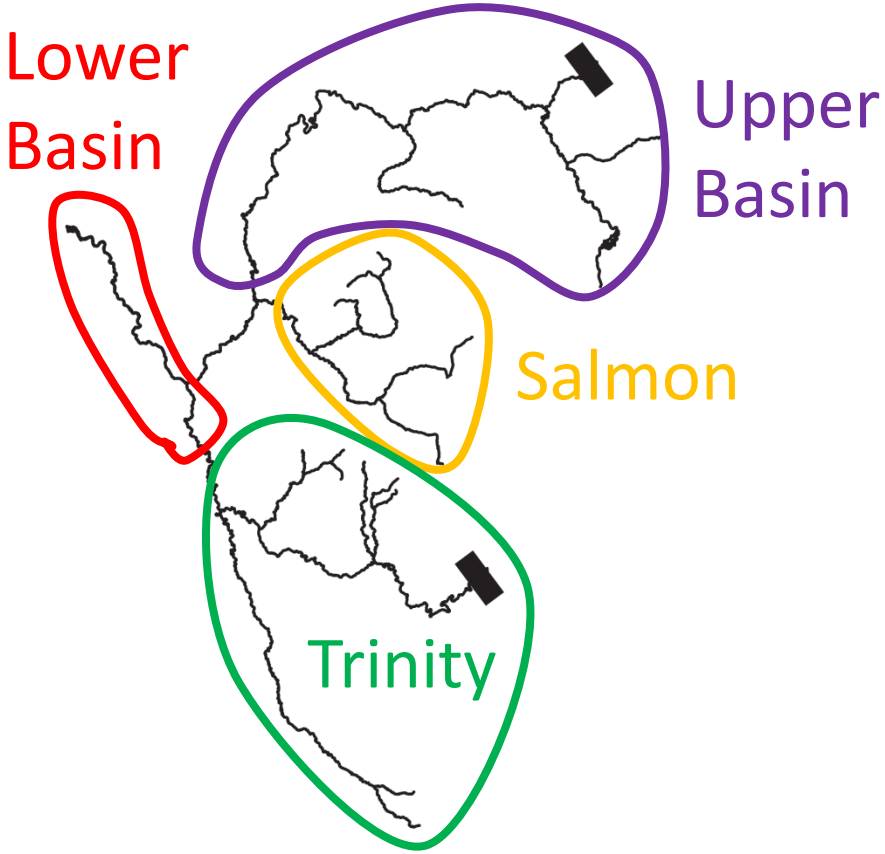
Migration Asymmetry (Im - Em)
3
2
1
0
-1
-2
-3
-4
-5
Gene Donors

Admixture

Individual Admixture Estimates



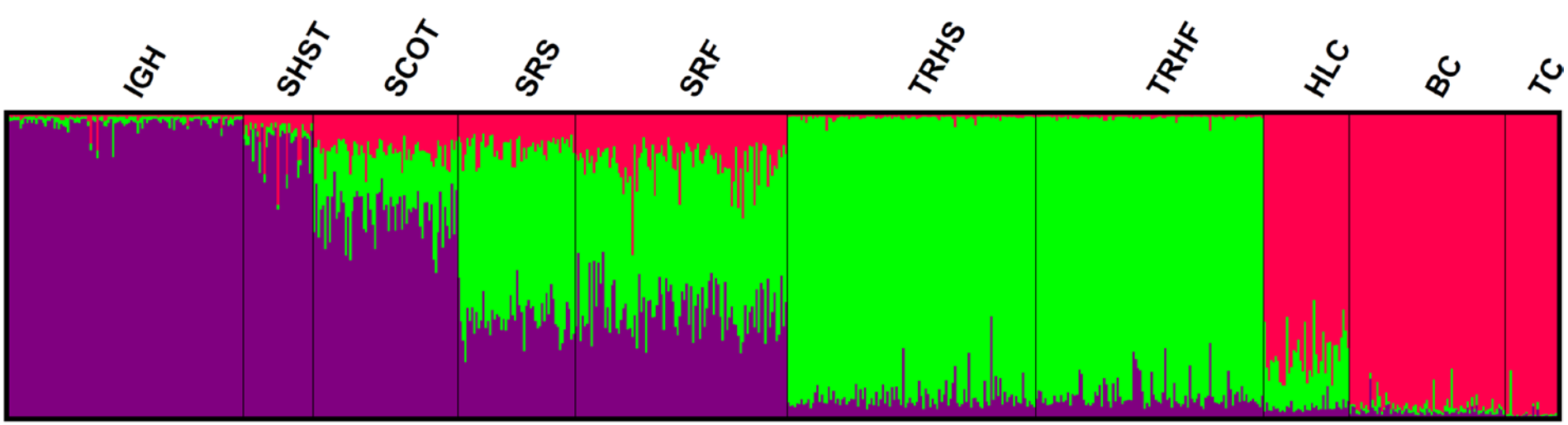
Hubisz et al. (2009) Inferring weak population structure with the assistant of sample group information. Molecular Ecology 9:1322-32



Implications:

(a) Consistent with tree derived mgt. units

(b) Salmon River admixed population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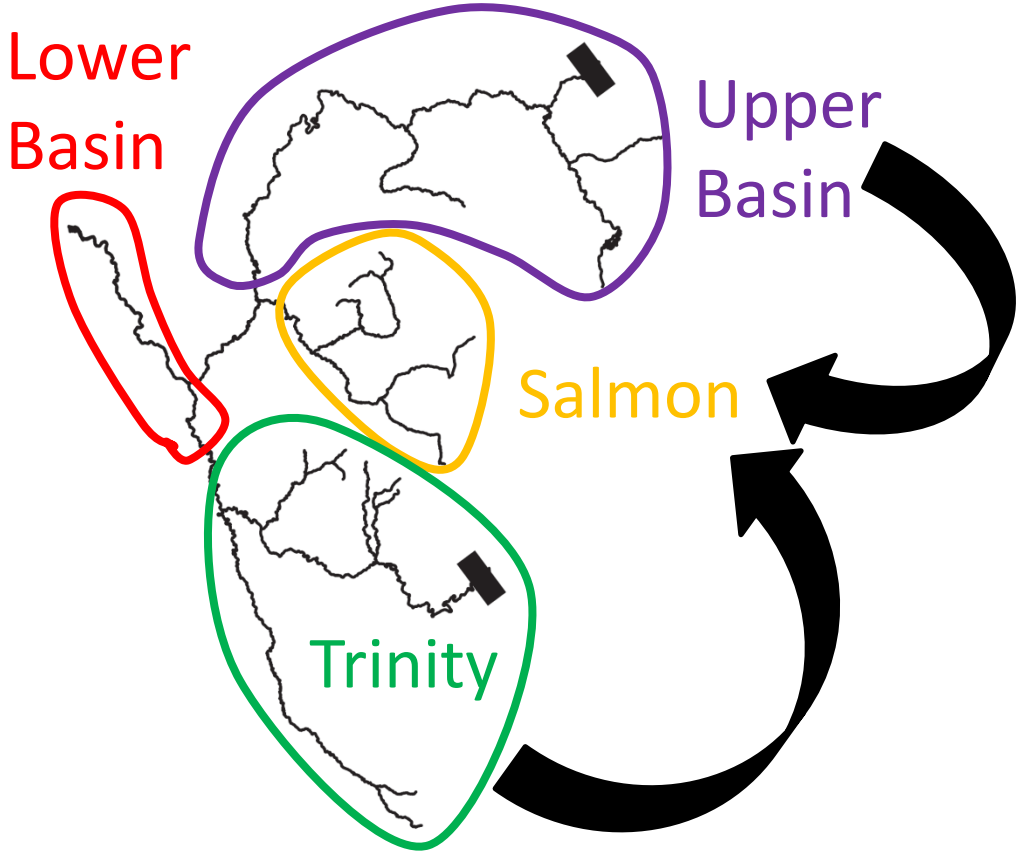
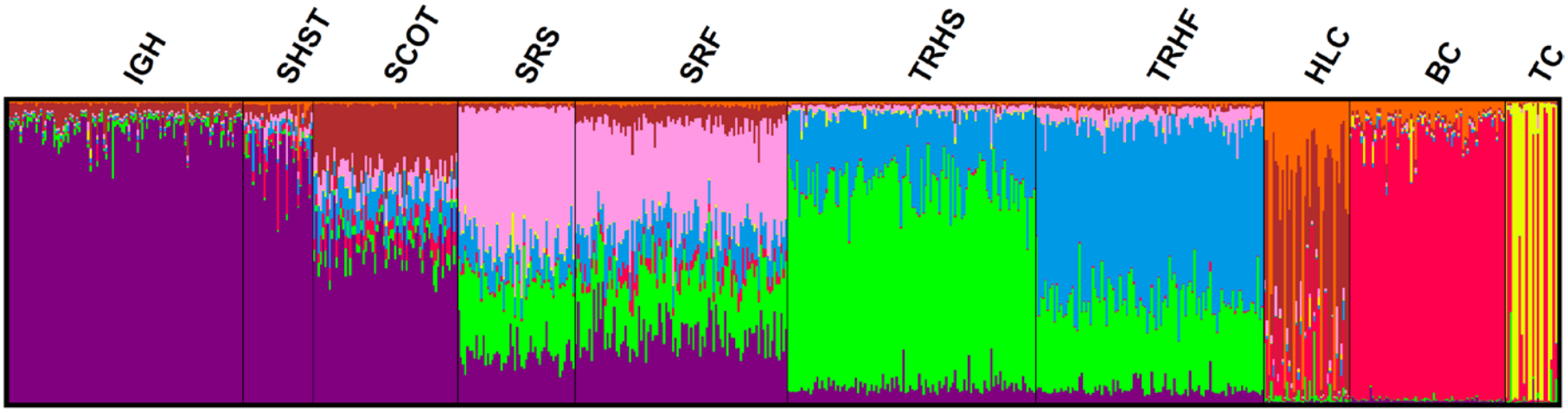
SHST
SCOT
SRS
SRF
TRHS
TRHF
HLC
BC
TC


Lower Basin
Upper Basin
Salmon
Trinity


IGH
SHST
SCOT
SRS
SRF
TRHS
TRHF
HLC
BC
TC

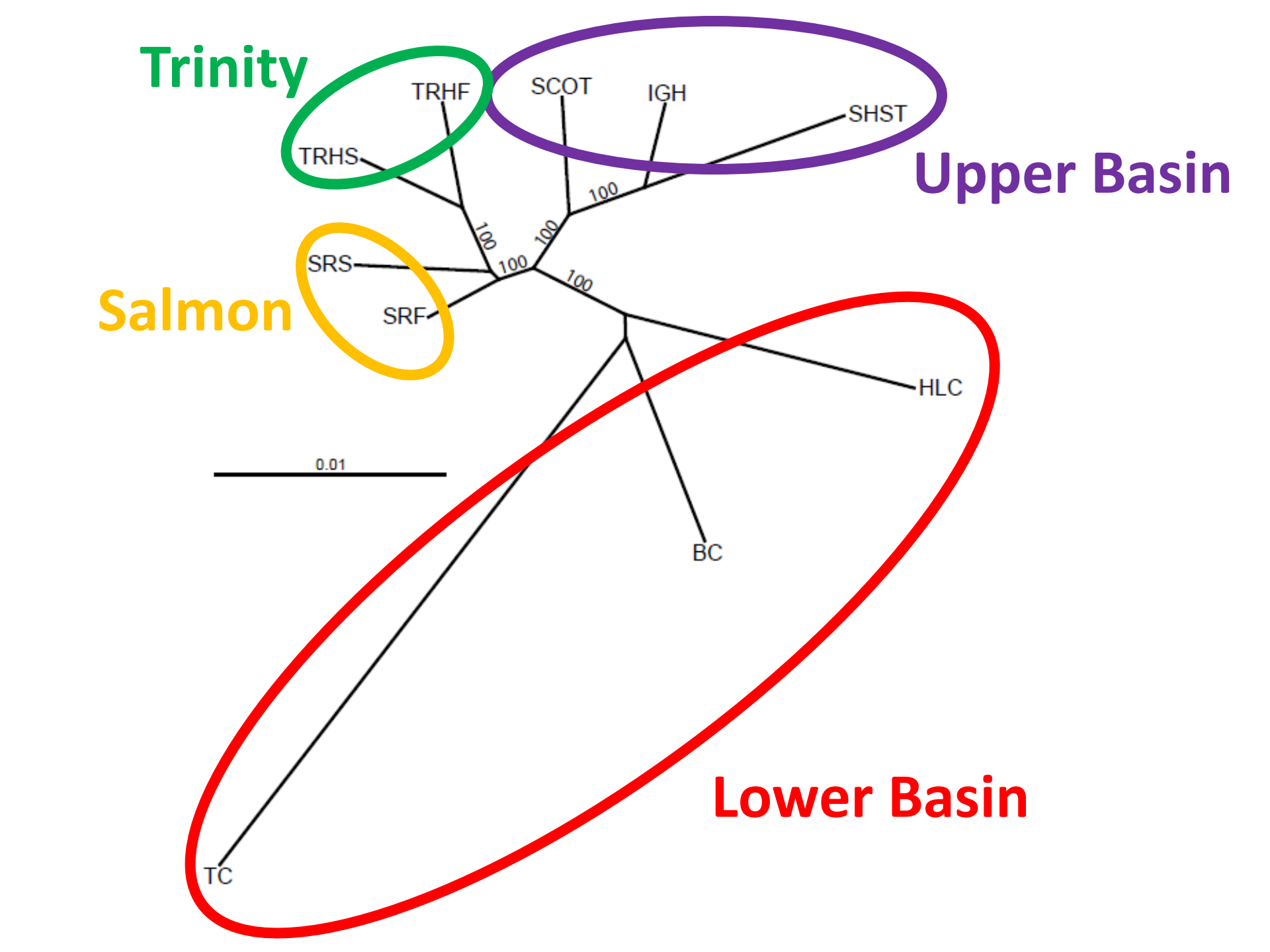
Management Units

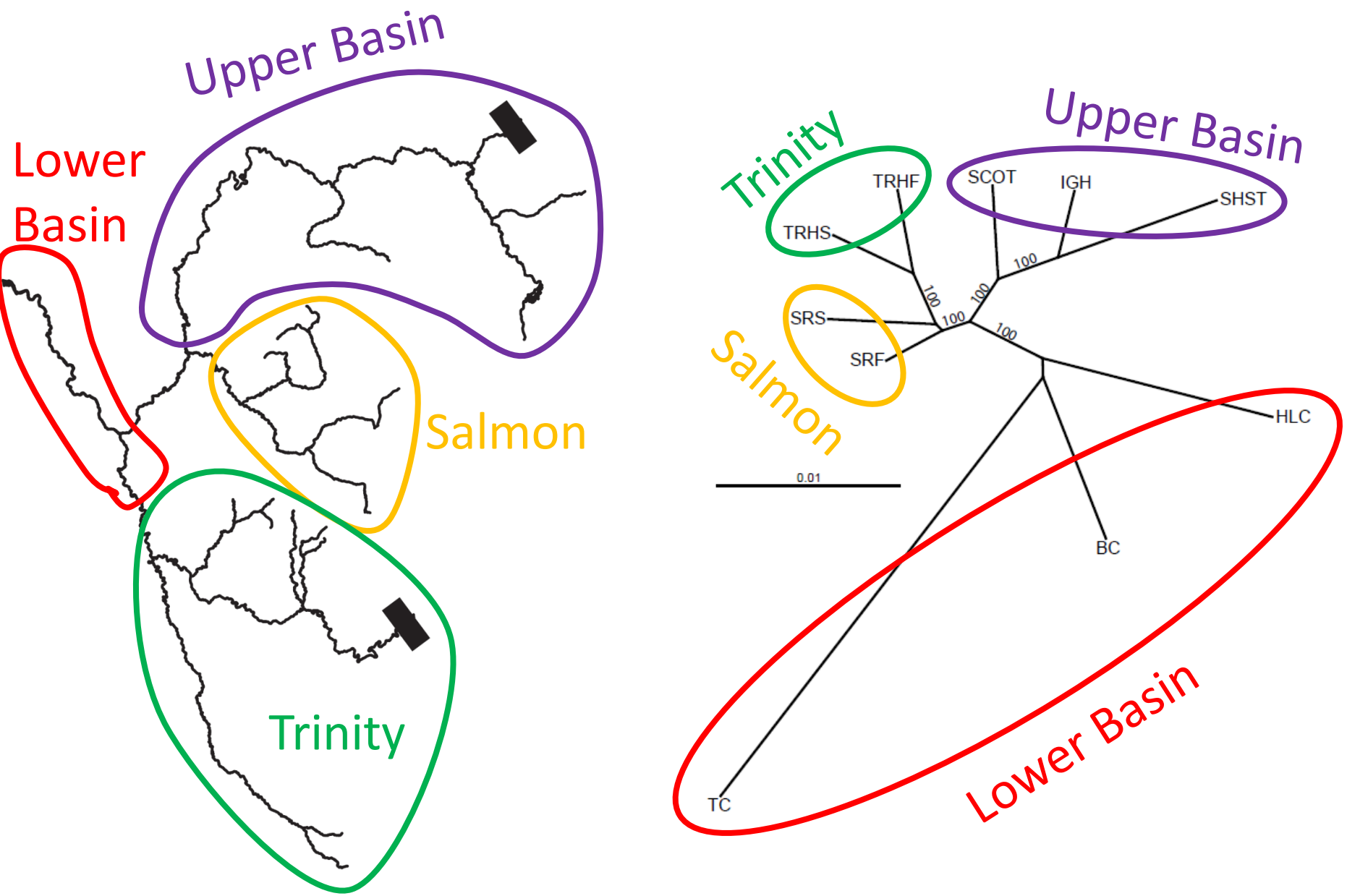
Evolutionary Significant Unit (ESU)

Ryder (1986)
Waples (1991)
Dizon et al. (1992)
Moritz (1994)
USFWS and NOAA (1996b)
Crandall (2000)

Concordant Theme:

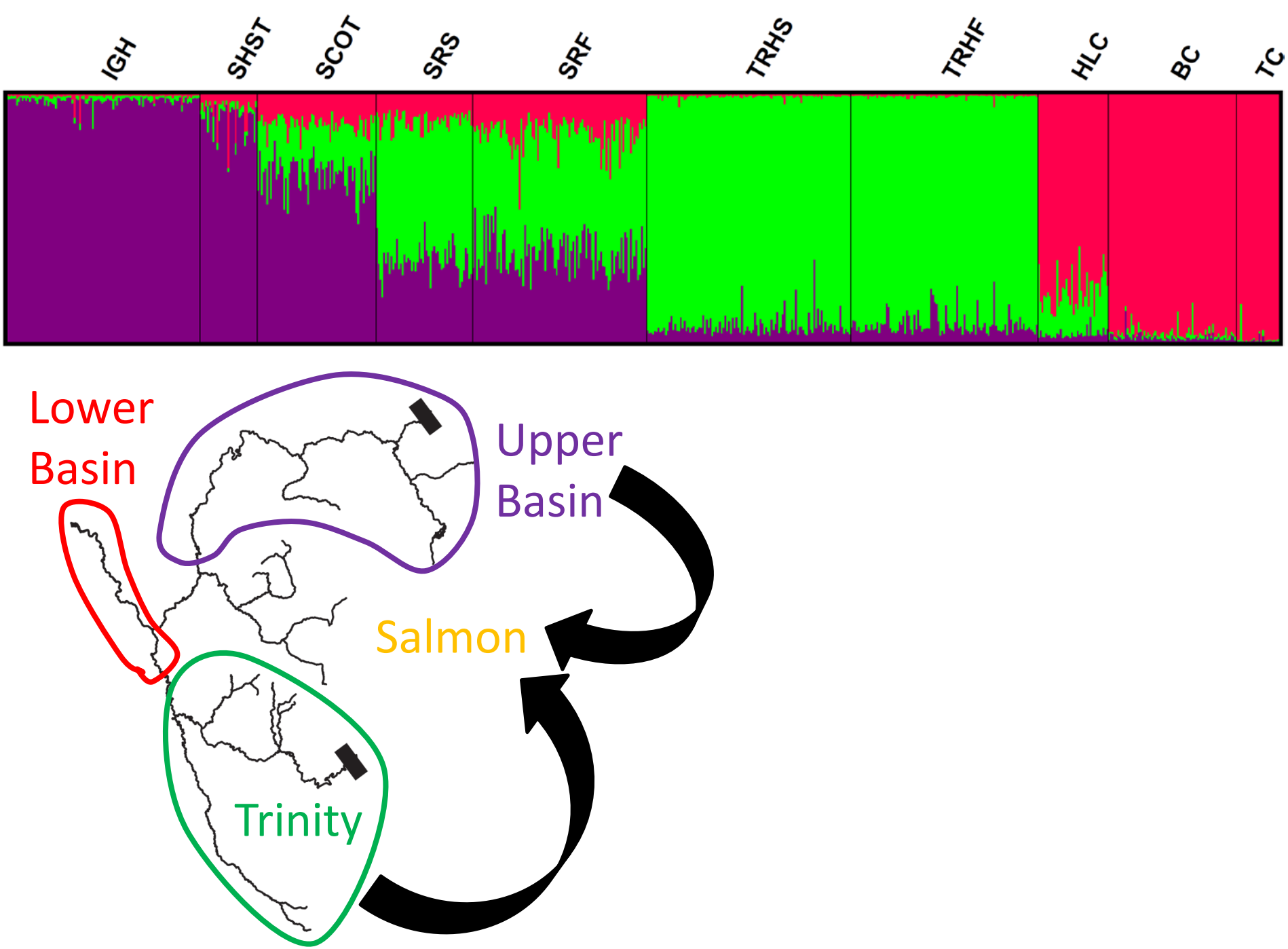
Significant genetic divergence (reduced gene flow)


Trinity
TRHF
SCOT
IGH
SHST
TRHS
Upper Basin
100
100
100
100
SRS
Salmon
SRF
100
HLC
0.01
BC
Lower Basin
TC


Upper Basin
Lower Basin
Salmon
Trinity
Trinity
Upper Basin
TRHF
TRHS
SCOT
IGH
SHST
SRS
SRF
Salmon
100
100
100
100
100
0.01
HLC
BC
TC
Lower Basin

Summary

- Bottleneck (upper basin)
- Migration: Isolation-By-Distance Model
- Management Units
  - Upper Basin
  - Lower Basin
  - Trinity
  - Salmon?
- Admixture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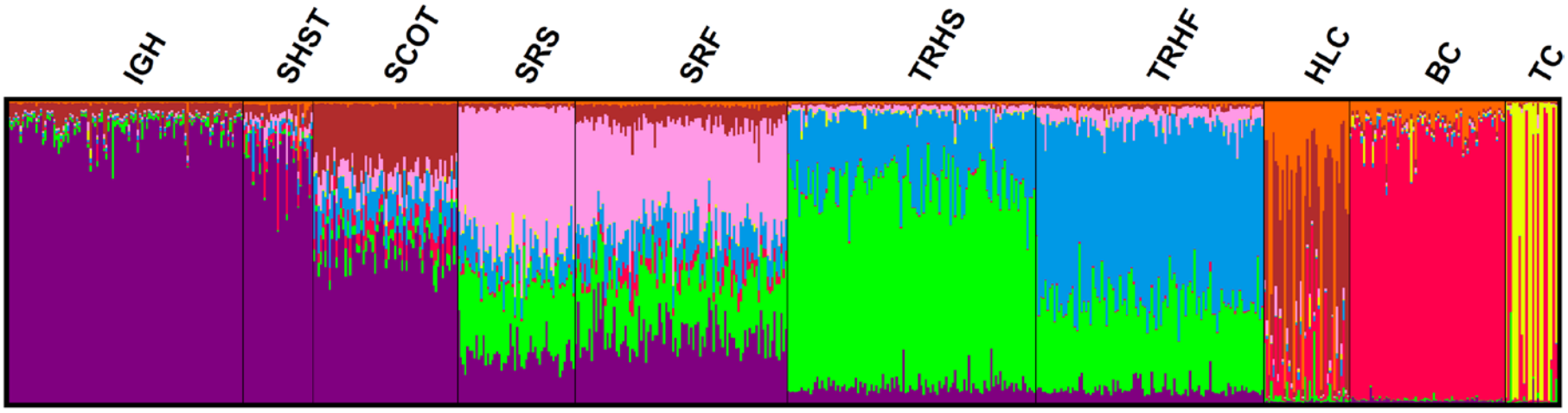
HLC
BC
TC
Lower Basin
Upper Basin
Salmon
Trinity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