



Washington
Department of
FISH AND
WILDLIFE

Managing Integrated Hatchery Programs with the PNI Statistic

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HSRG Hatchery Program Types

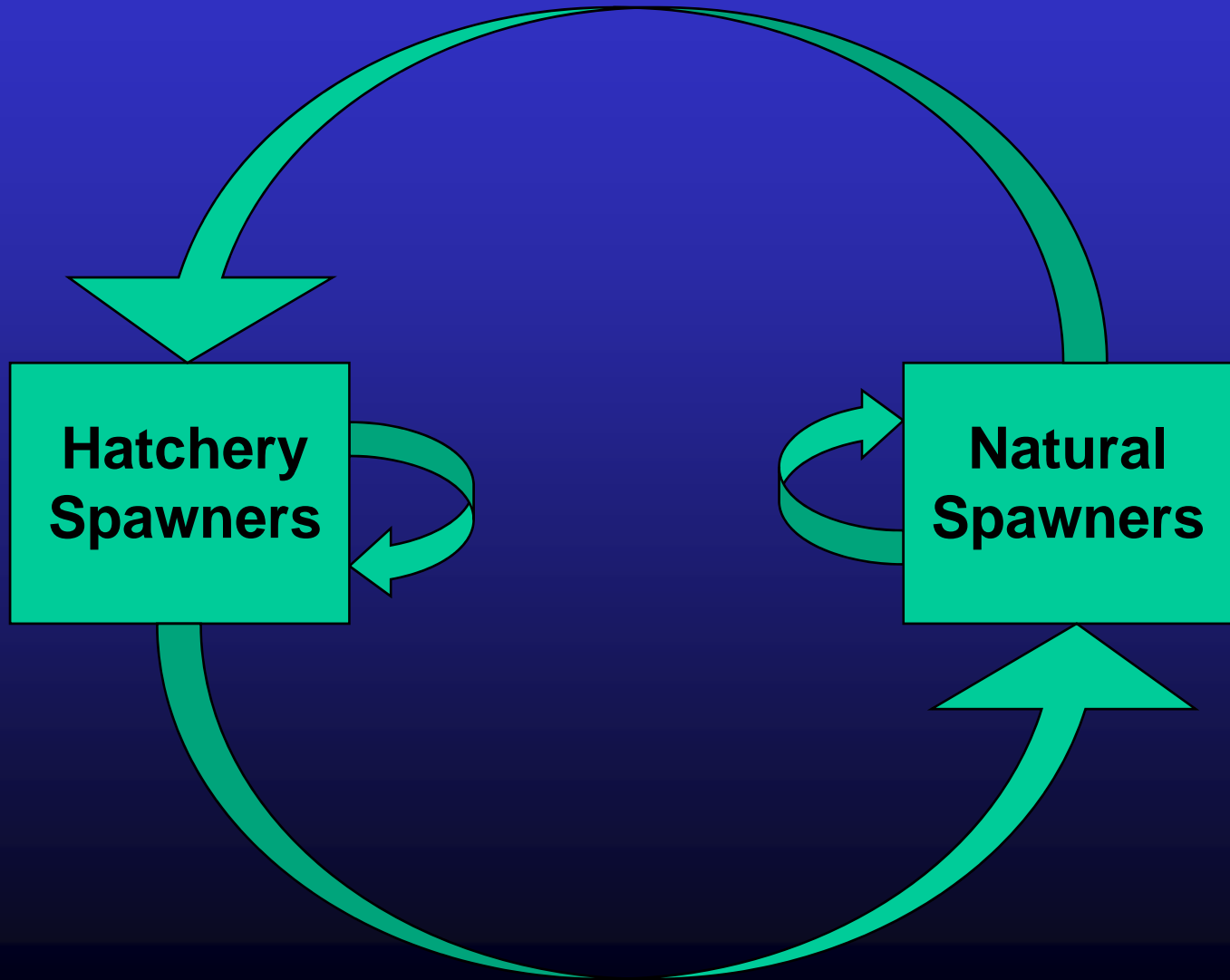
(HSRG/WDFW/NWIFC 2004)

1) *Segregated programs.* “A hatchery program is a *Segregated Type* if the intent is for the hatchery population to represent a distinct population that is reproductively isolated from naturally spawning populations.” (HSRG/WDFW/NWIFC 2004)

2) *Integrated programs.* “A hatchery program is an *Integrated Type* if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild.” (HSRG/WDFW/NWIFC 2004)

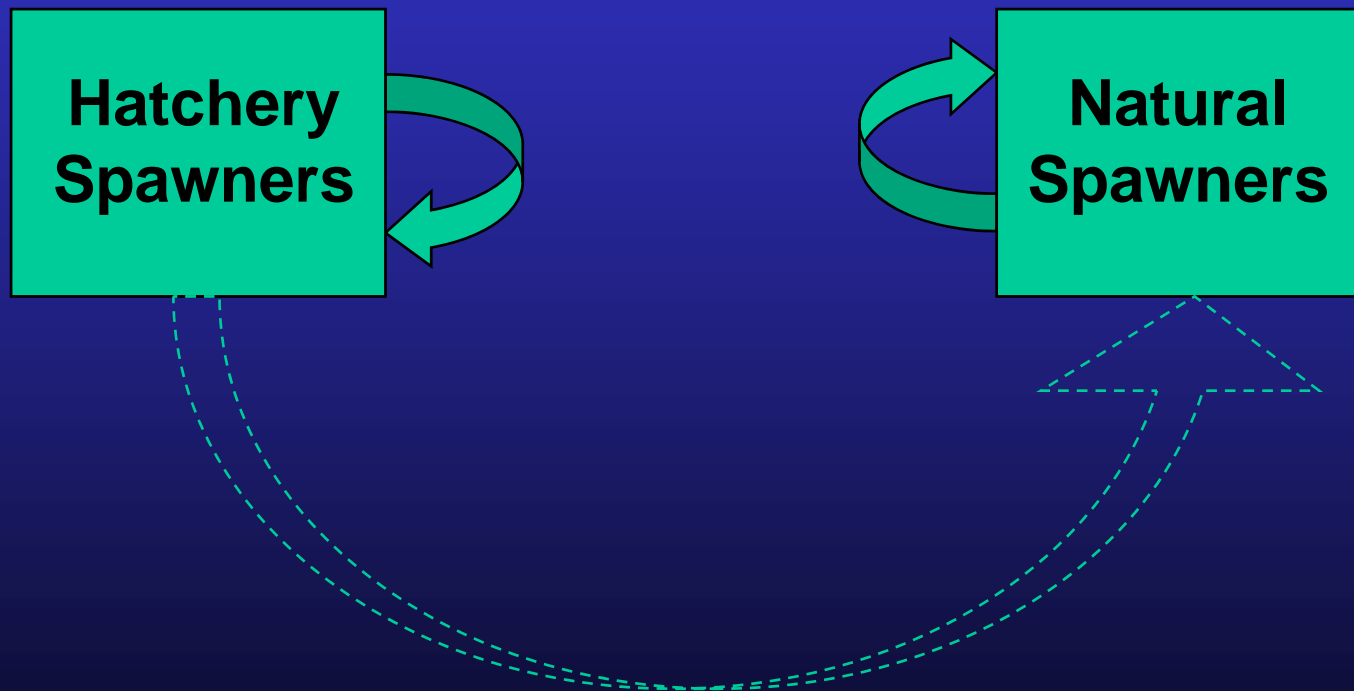
Genetic Relationship Between Hatchery and Natural Components of a Population

(modified from Lynch and O'Hely, 2001)



Segregated Program

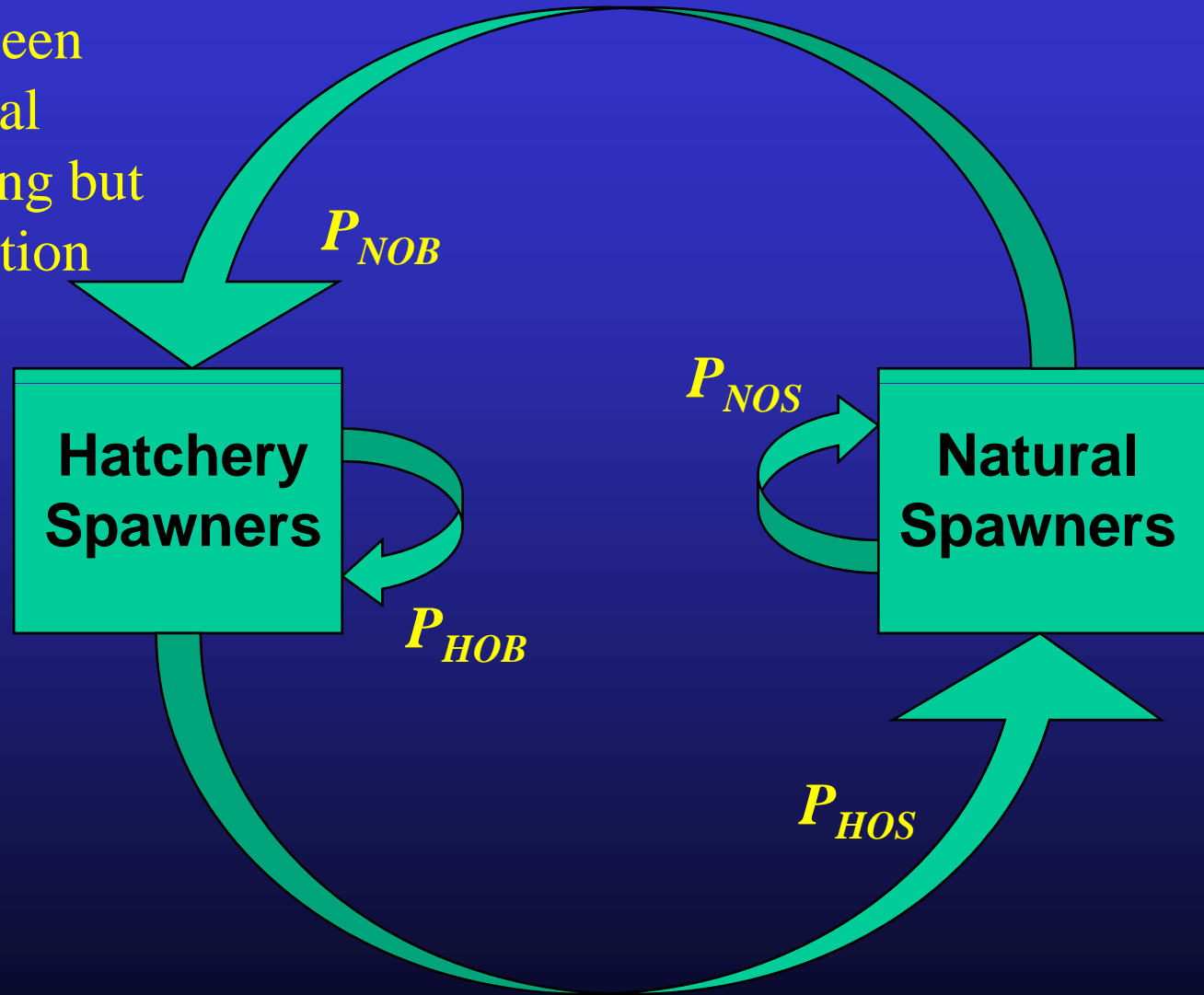
Some gene flow “leakage” between hatchery and natural components, causing domestication impacts to natural component



Impacts are limited by minimizing this gene flow

Integrated Program

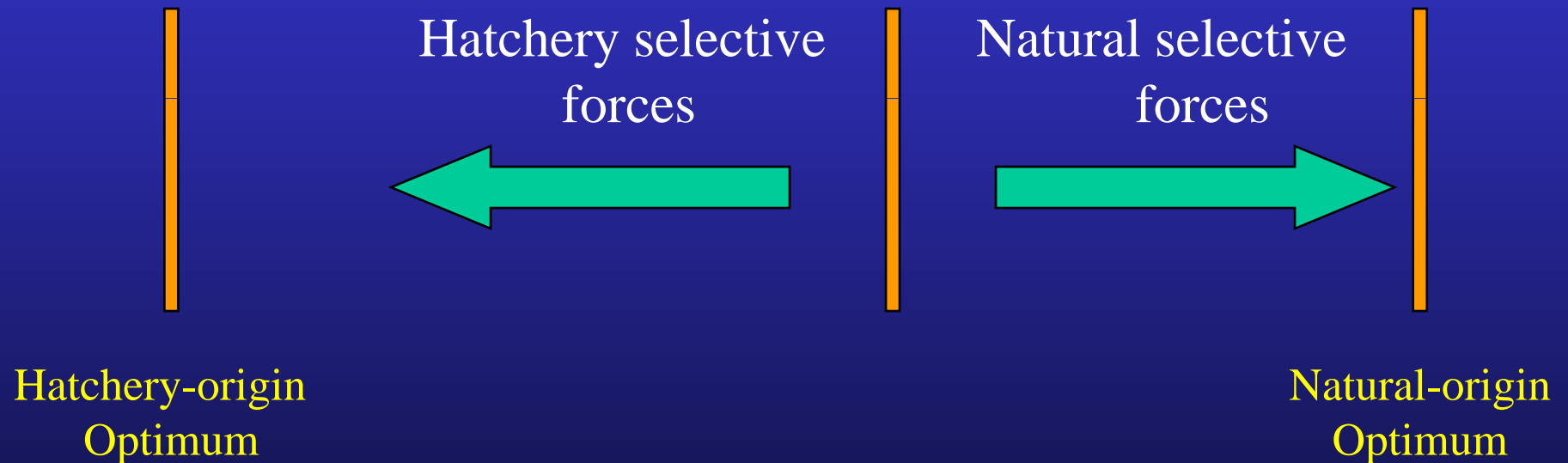
Regular gene between hatchery and natural components, causing but limiting domestication



Impacts are limited by managing *relative* rates of gene flow

The Big Idea

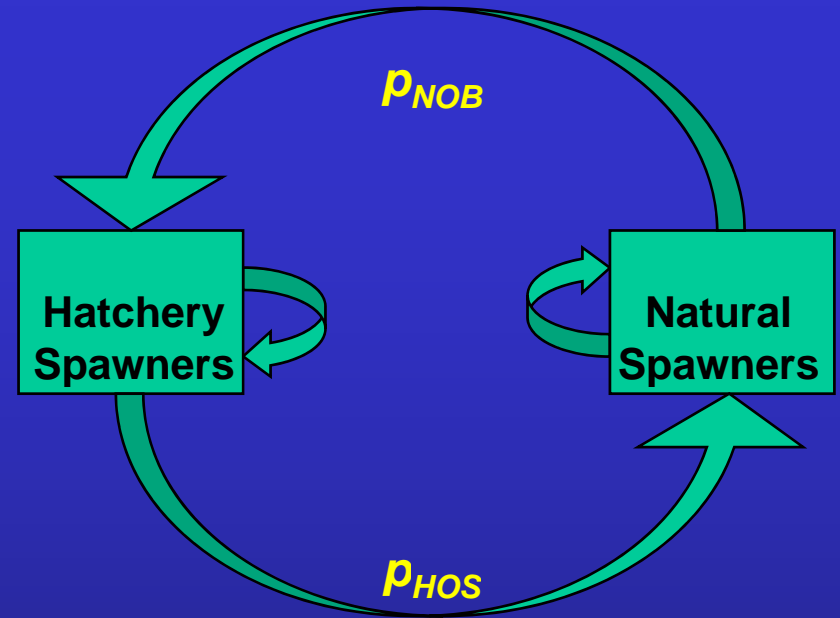
An integrated population lives in two environments, and natural selection in each tugs the population toward that optimum.



The trait mean value will eventually equilibrate at a point z^* , which is expressed as a proportion of the distance from the hatchery-origin optimum to the natural-origin optimum.

Amazingly, z^* is approximated well by the ratio

$$\frac{p_{NOB}}{p_{NOB} + p_{HOS}}$$



p_{NOB} = proportion of broodstock consisting of natural-origin fish

p_{HOS} = proportion of fish spawning naturally consisting of hatchery-origin fish

This ratio is called *proportionate natural influence* or PNI.

Trait Equilibria in Integrated Hatchery Programs

Hatchery
Optimum

Intermediate

Natural
Optimum

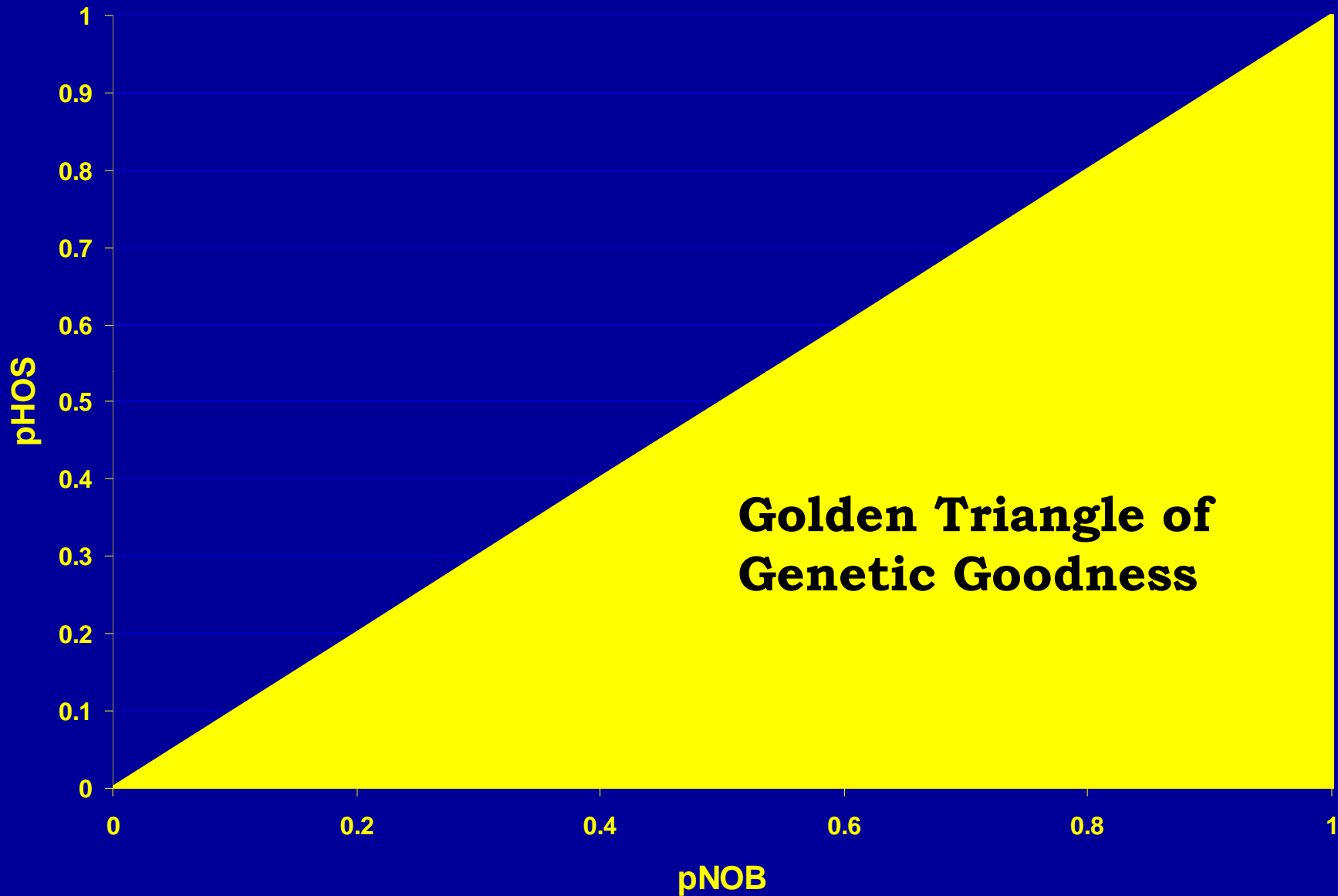
$PNI < 0.5$

$PNI > 0.5$

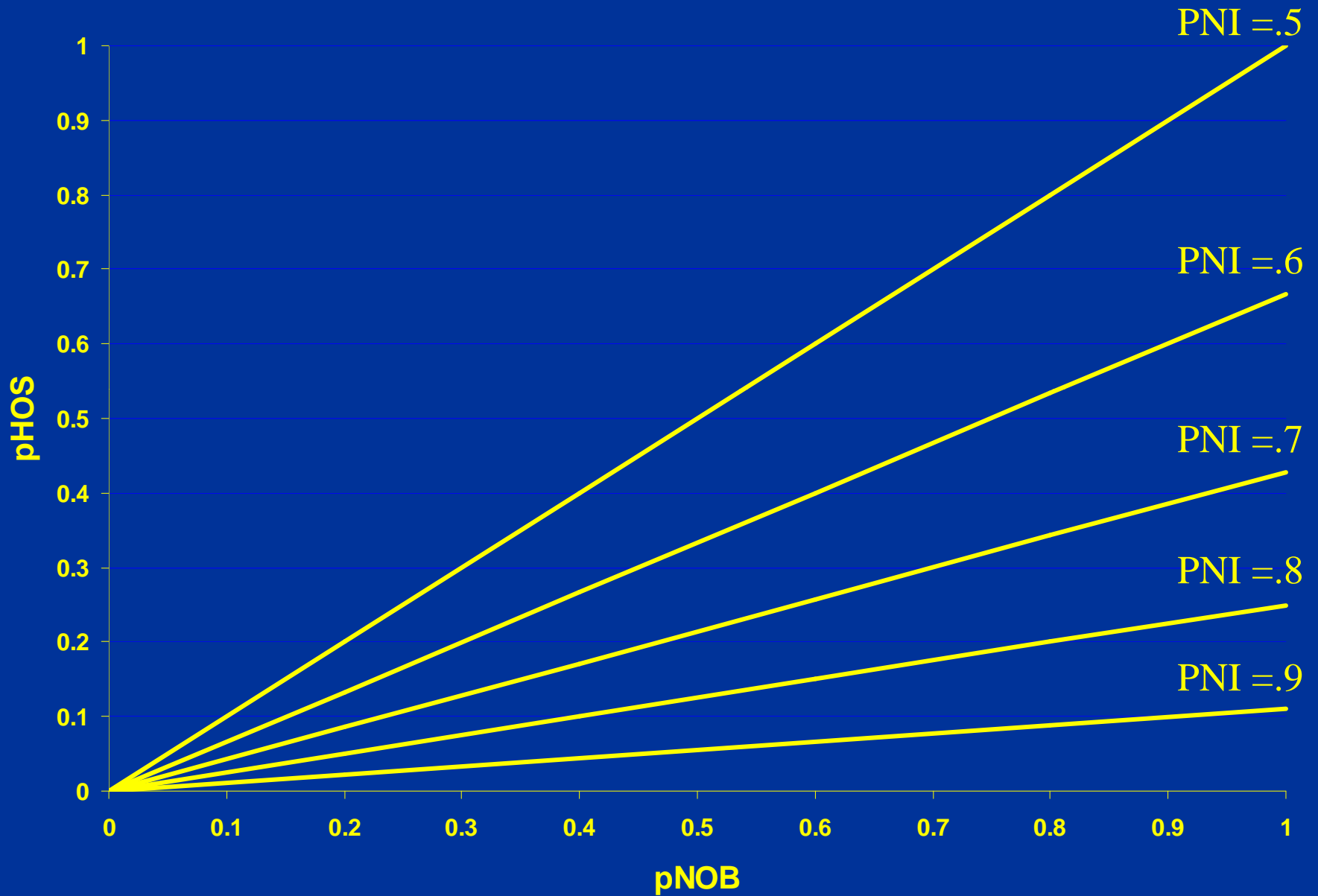
Hatchery selective
forces dominate

Natural selective
forces dominate

Effect of pNOB and pHOS on Proportionate Natural Influence

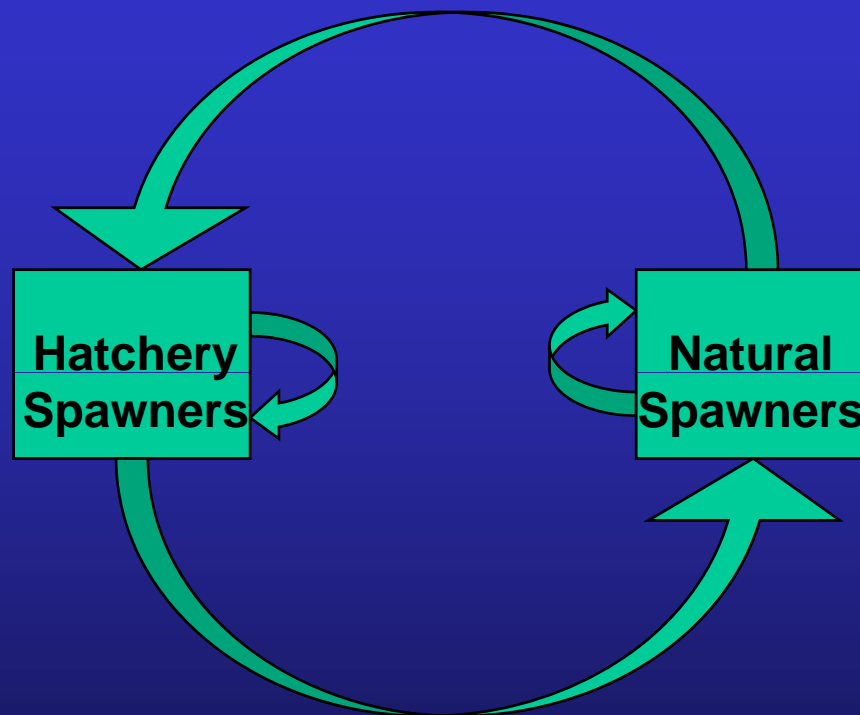


Effect of pNOB and pHOS on Proportionate Natural Influence



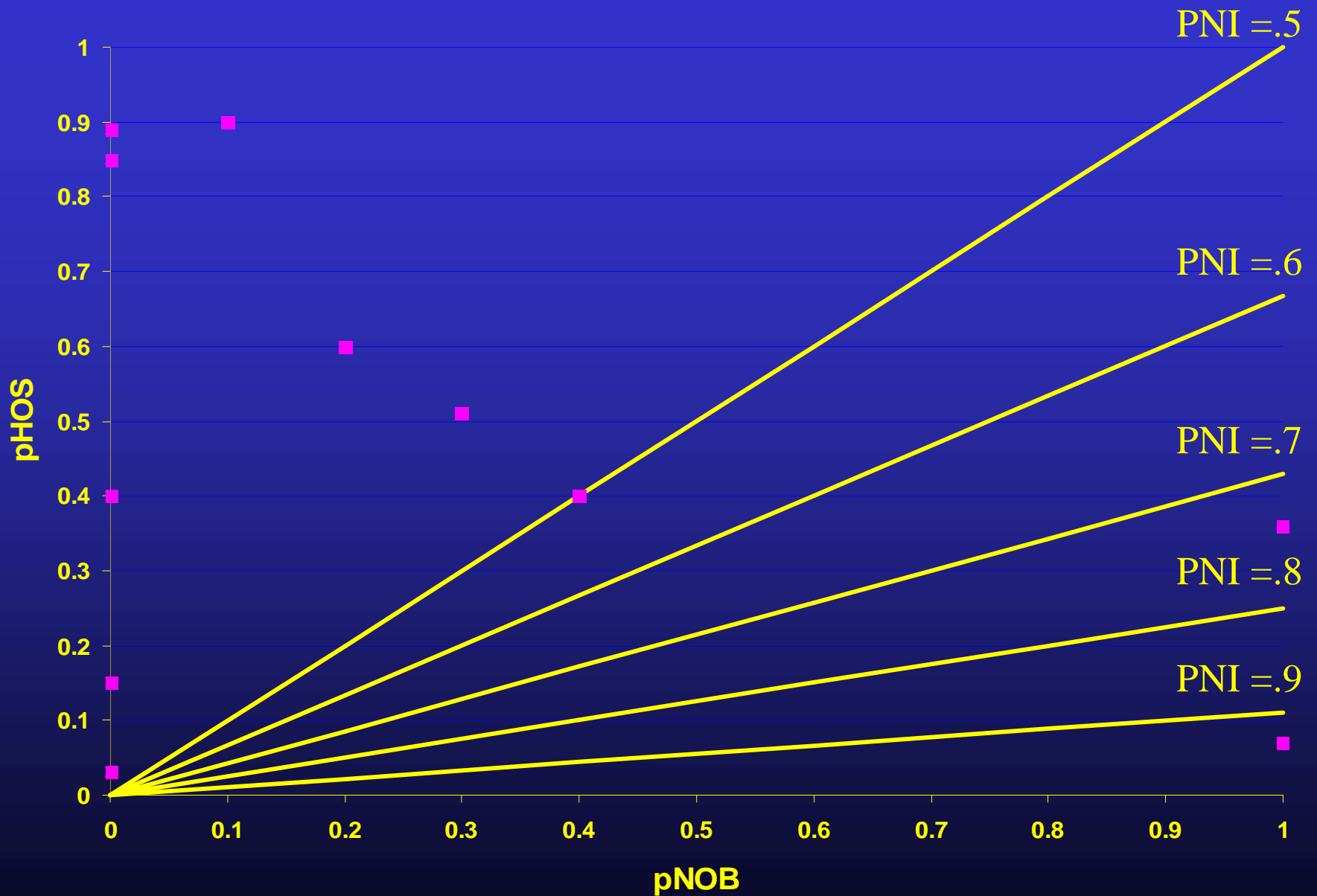
**We already have many
“unintentionally”
integrated salmon
programs.**

**These have
uncontrolled gene
flow rates.**



**Our intent now is to manage gene flow rates, working
to increase PNI.**

Recent PNI in Some Puget Sound Chinook Programs



Importance of PNI Concept

Unifying element for management of integrated hatchery programs, regardless of program purpose

Key part of hatchery reform process and associated tools (AHA)

Justification for existing approaches to supplementation and useful measure for supplementation monitoring

Major Considerations in Achieving Properly Integrated Programs

Ability to control P_{NOB} and P_{HOS}

Ability to identify fish by origin

Ability to remove surplus hatchery fish

Scaling program size and harvest rates to basin productivity and capacity

Choosing appropriate population unit for integration