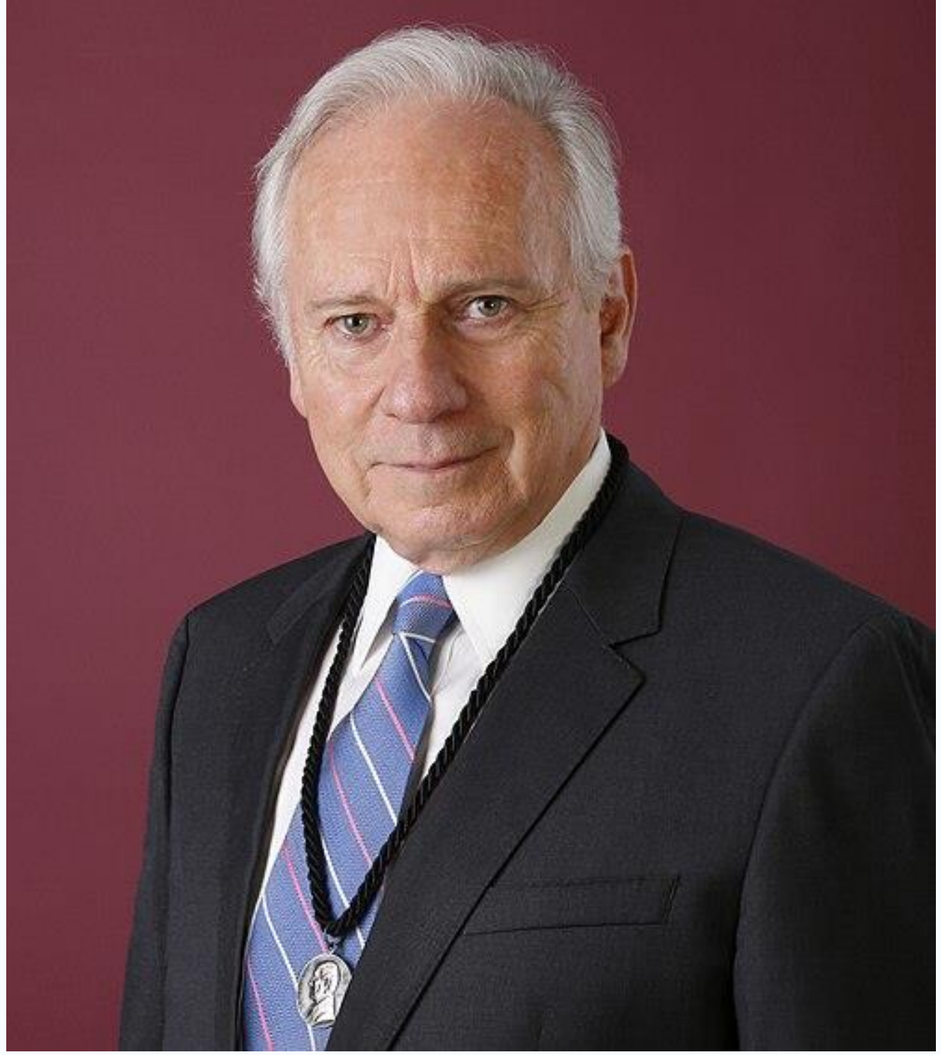


Roberto Neira Roa

Profesor Emérito de la Universidad de Chile

6 de Noviembre del 2025

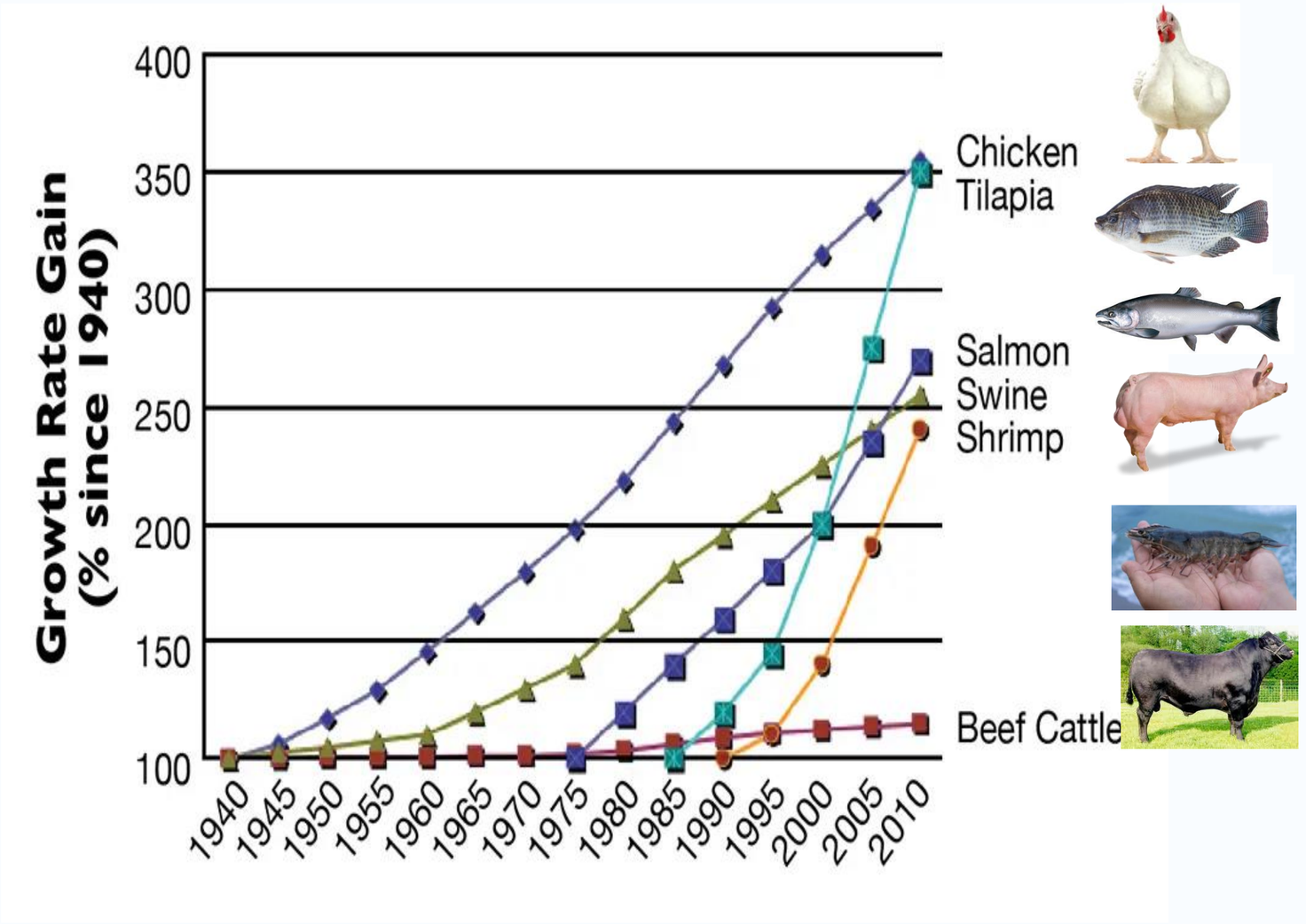
Edición Genética: nueva herramienta para enfrentar los desafíos en Sanidad Animal

José M. Yáñez
Facultad de Ciencias Veterinarias y Pecuarias
Universidad de Chile

MEJORAMIENTO GENÉTICO

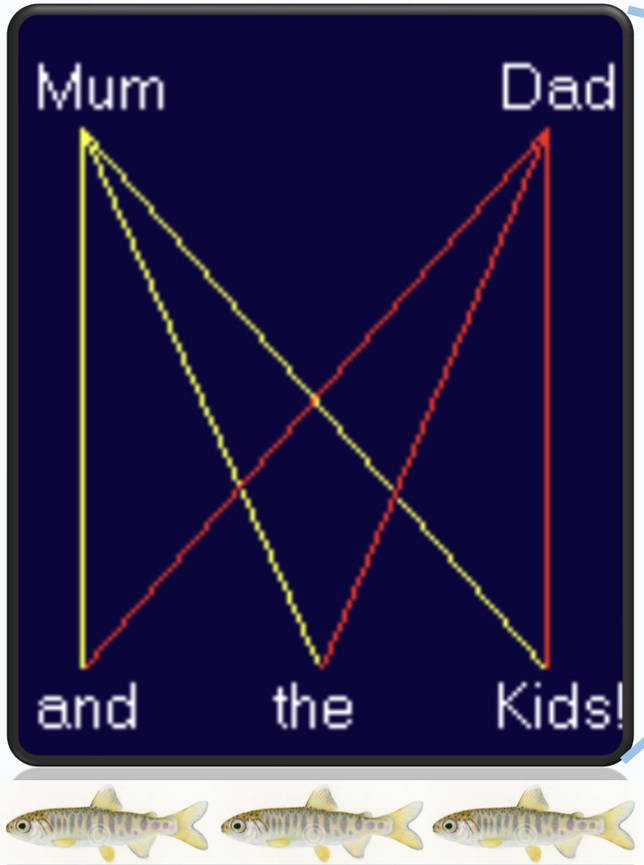
Pilar fundamental para incrementar eficiencia y sostenibilidad de la industria

- ✓ Acelera tasa de crecimiento
- ✓ Incrementa resistencia a enfermedades y sobrevivencia
- ✓ Mayor calidad y rendimiento de producto

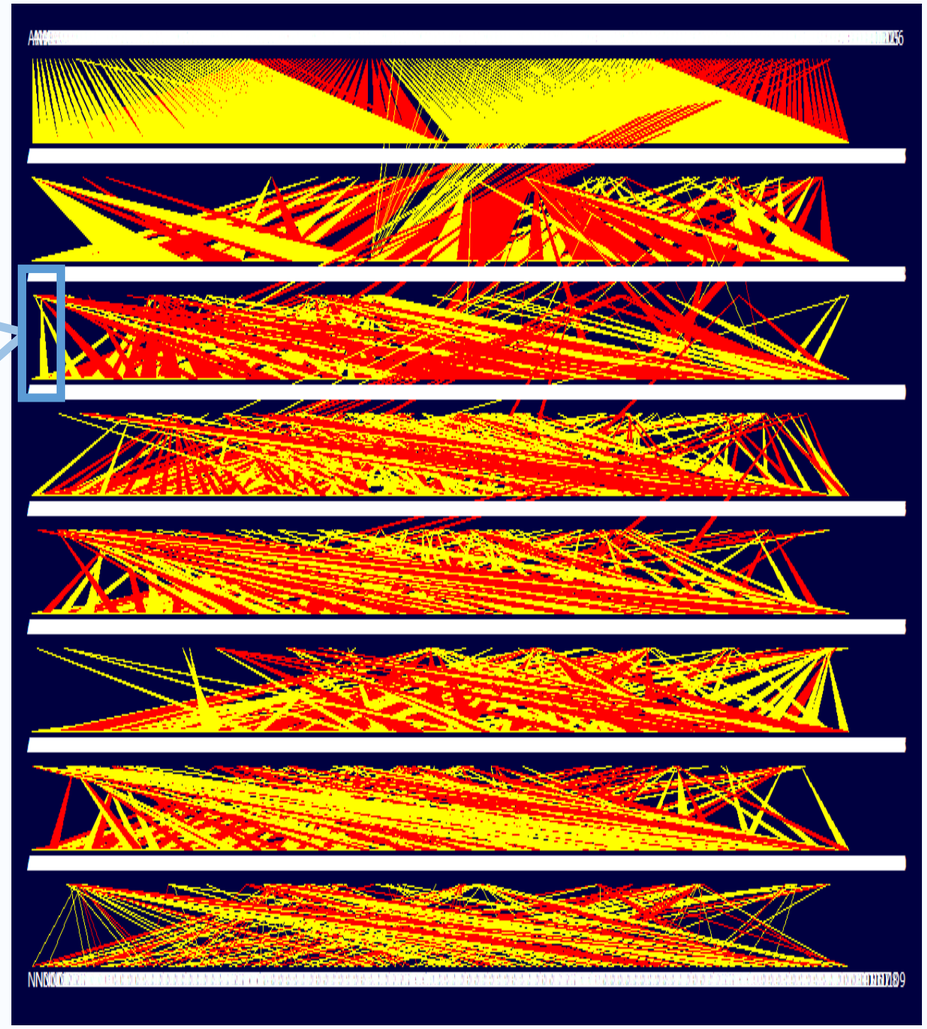


PREDICCIÓN DEL MÉRITO GENÉTICO

1. PEDIGRÍ

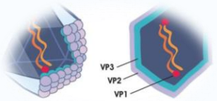


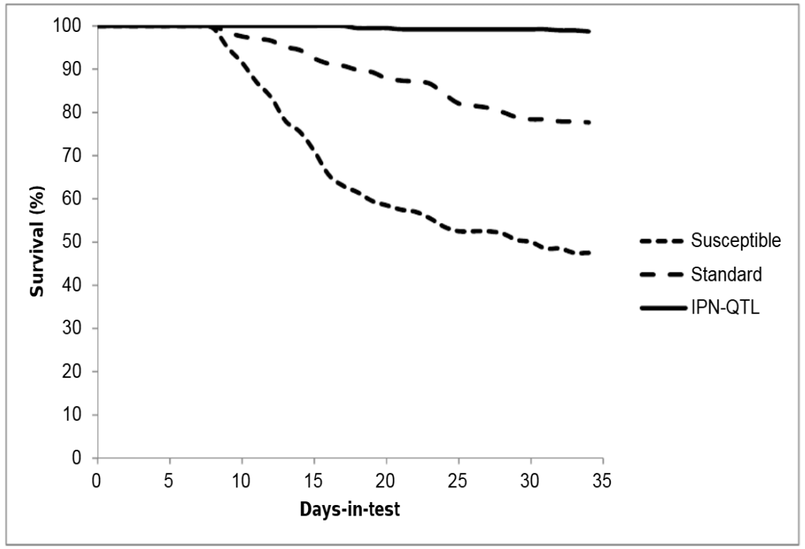
Genealogía salmón coho



2. FENOTIPOS

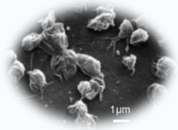
IPN

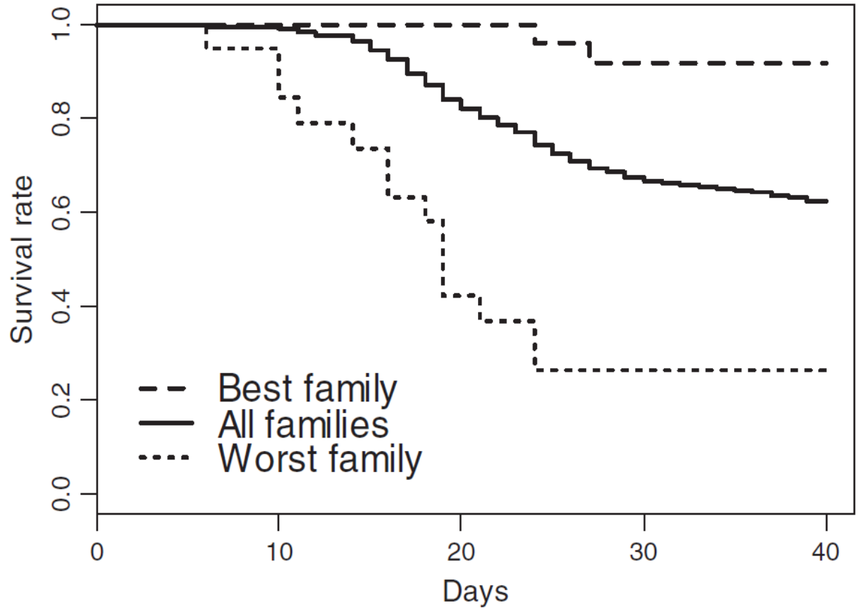




Moen et al. 2015

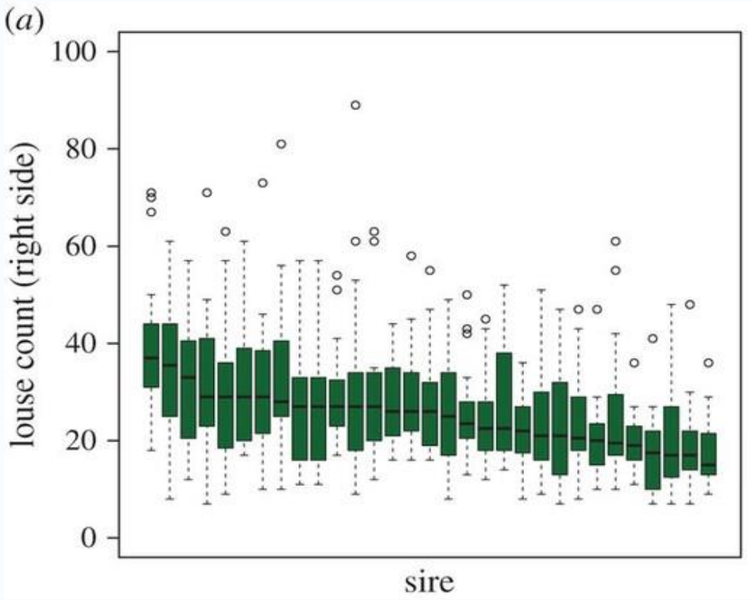
SRS





Yáñez et al. 2013

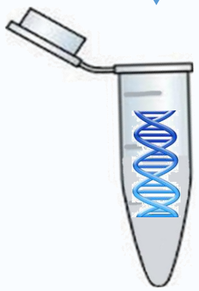
Sea lice



Gharbi et al. 2015

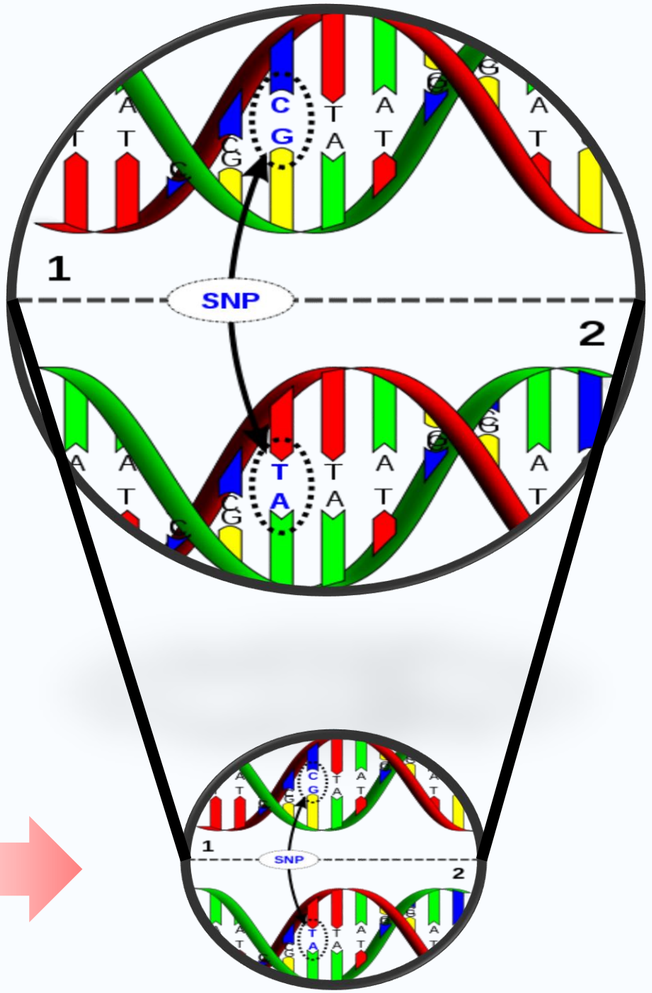
3. GENOTIPOS

SINGLE NUCLEOTIDE POLYMORPHISMS (SNP)



Purificación
de DNA

Secuenciación



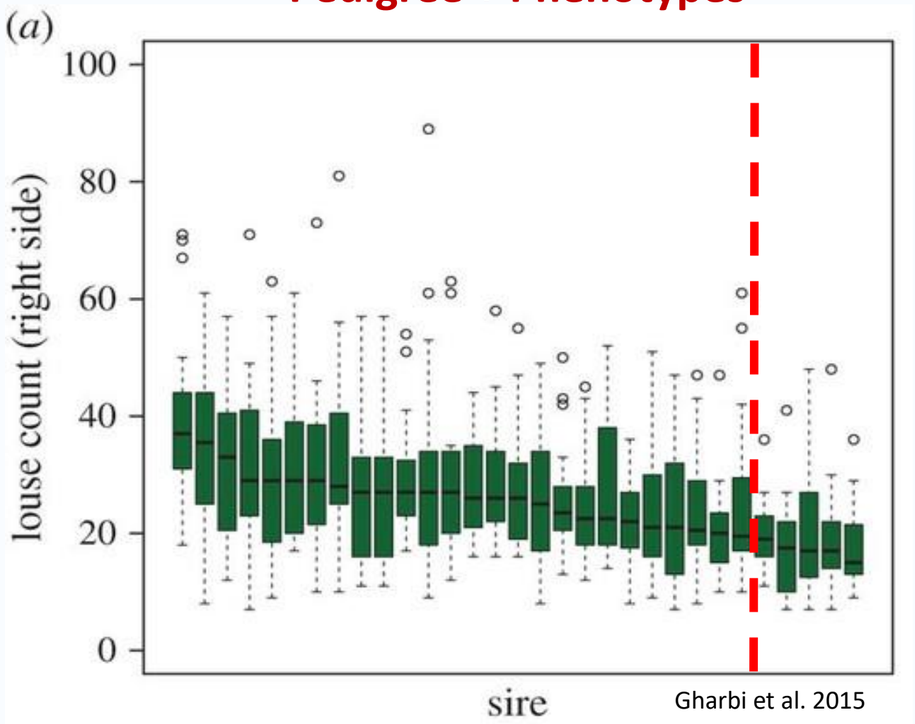
Descubrimiento de
SNPs

Genotipado de
alto rendimiento

TRADITIONAL SELECTION VS GENOMICS

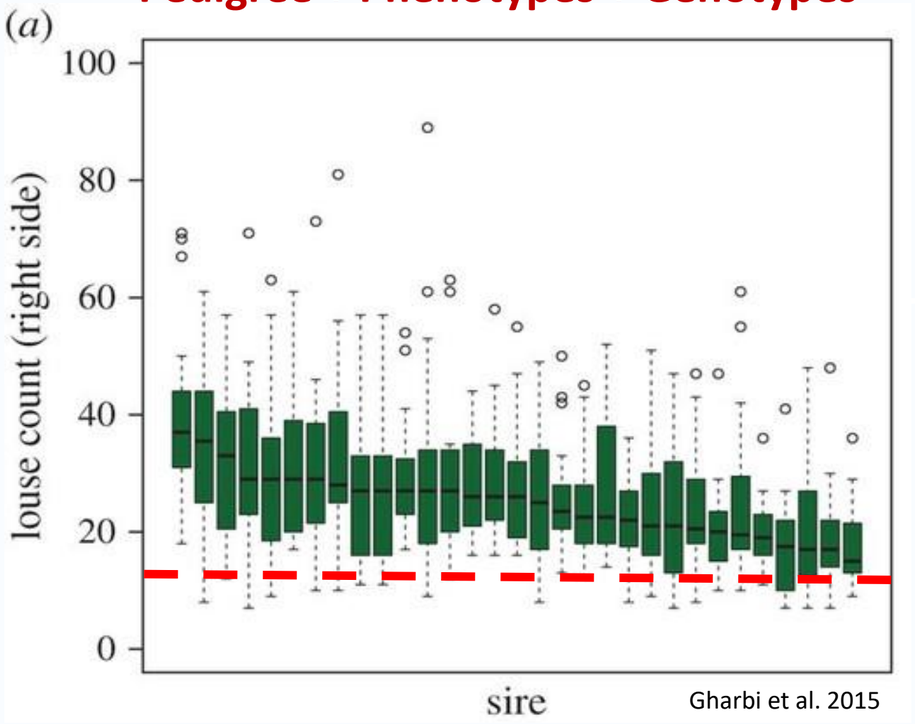
Sea lice

Pedigree + Phenotypes



Gharbi et al. 2015

Pedigree + Phenotypes + Genotypes



Gharbi et al. 2015

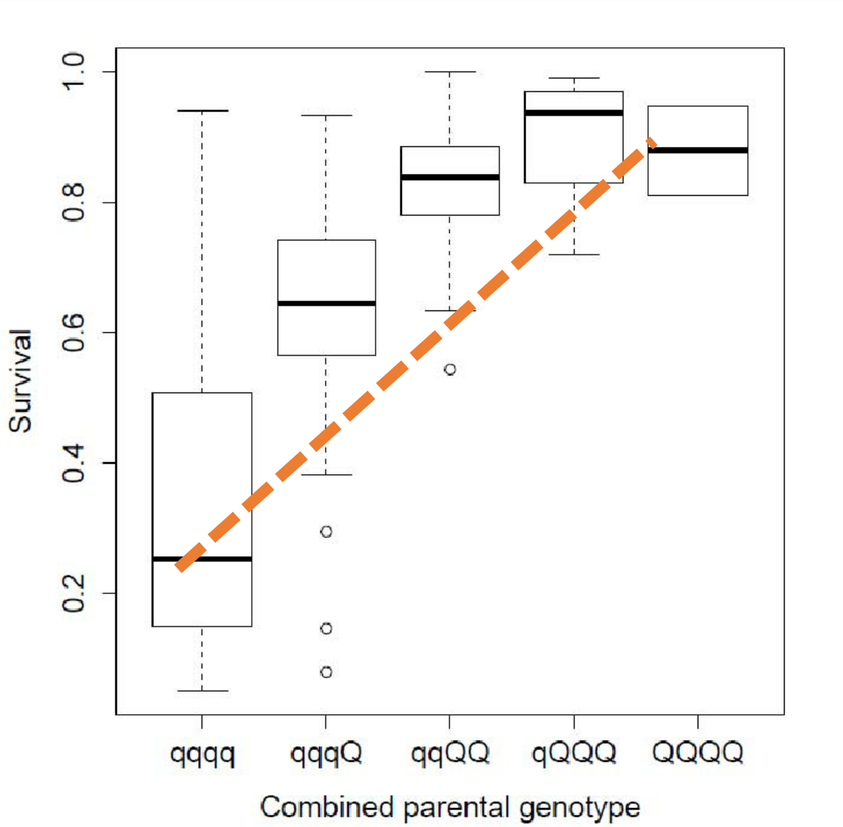
Selection of most resistant families

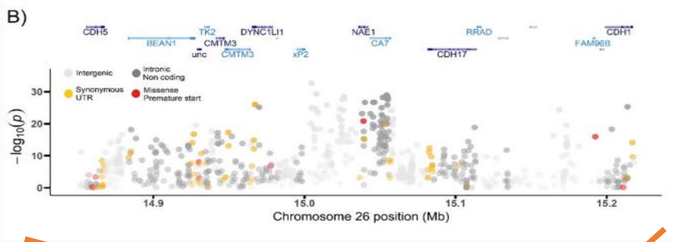
- **Low accuracy:** exploits only within-family variation
- **Low selection intensity:** predisposes to higher inbreeding

Selection of most resistant individuals

- **High accuracy:** exploits within- and between family variation
- **High selection intensity:** lower inbreeding levels

GENOME-WIDE ASSOCIATION STUDIES (GWAS) & QUANTITATIVE TRAIT LOCI (QTL)



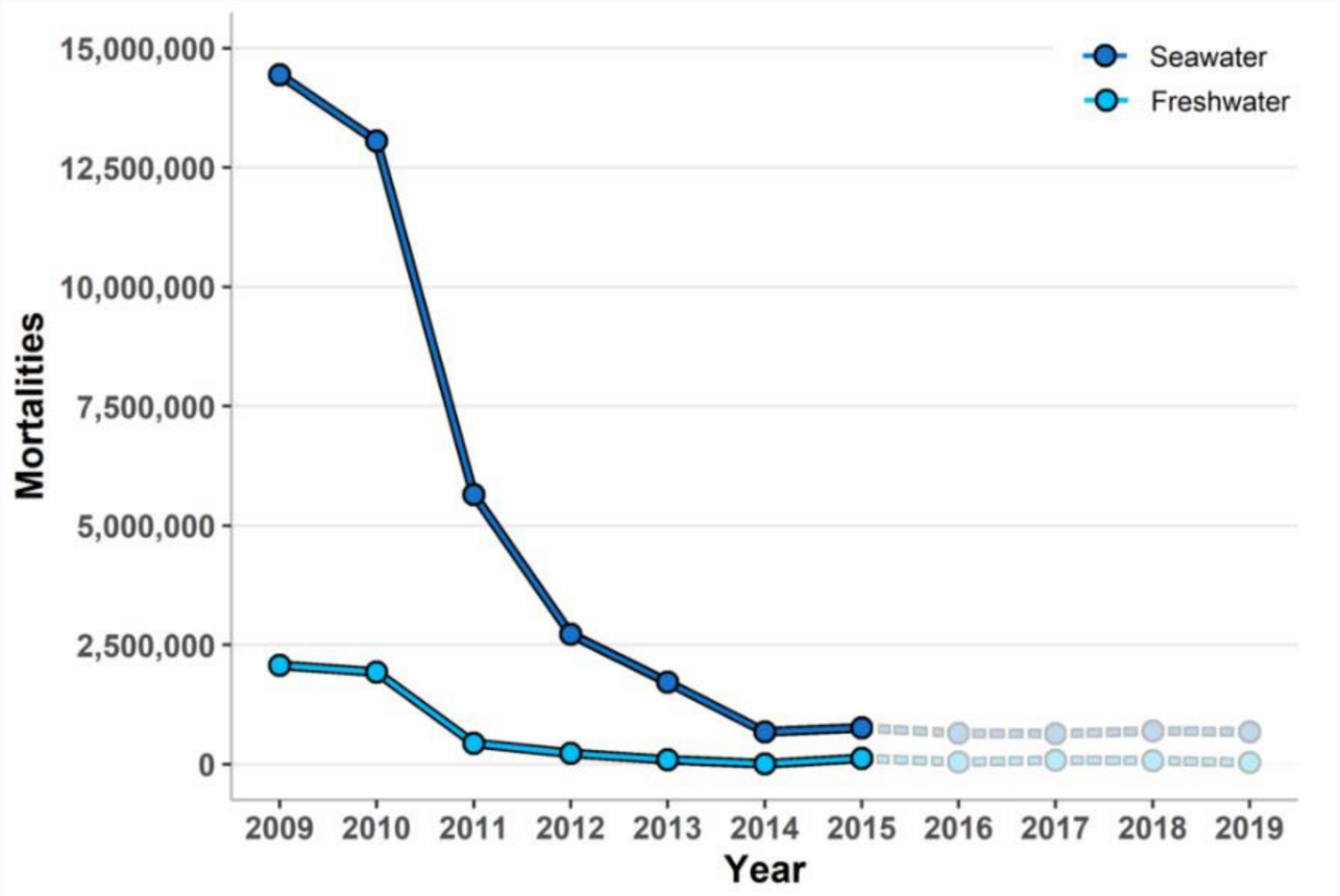


Manhattan Plot

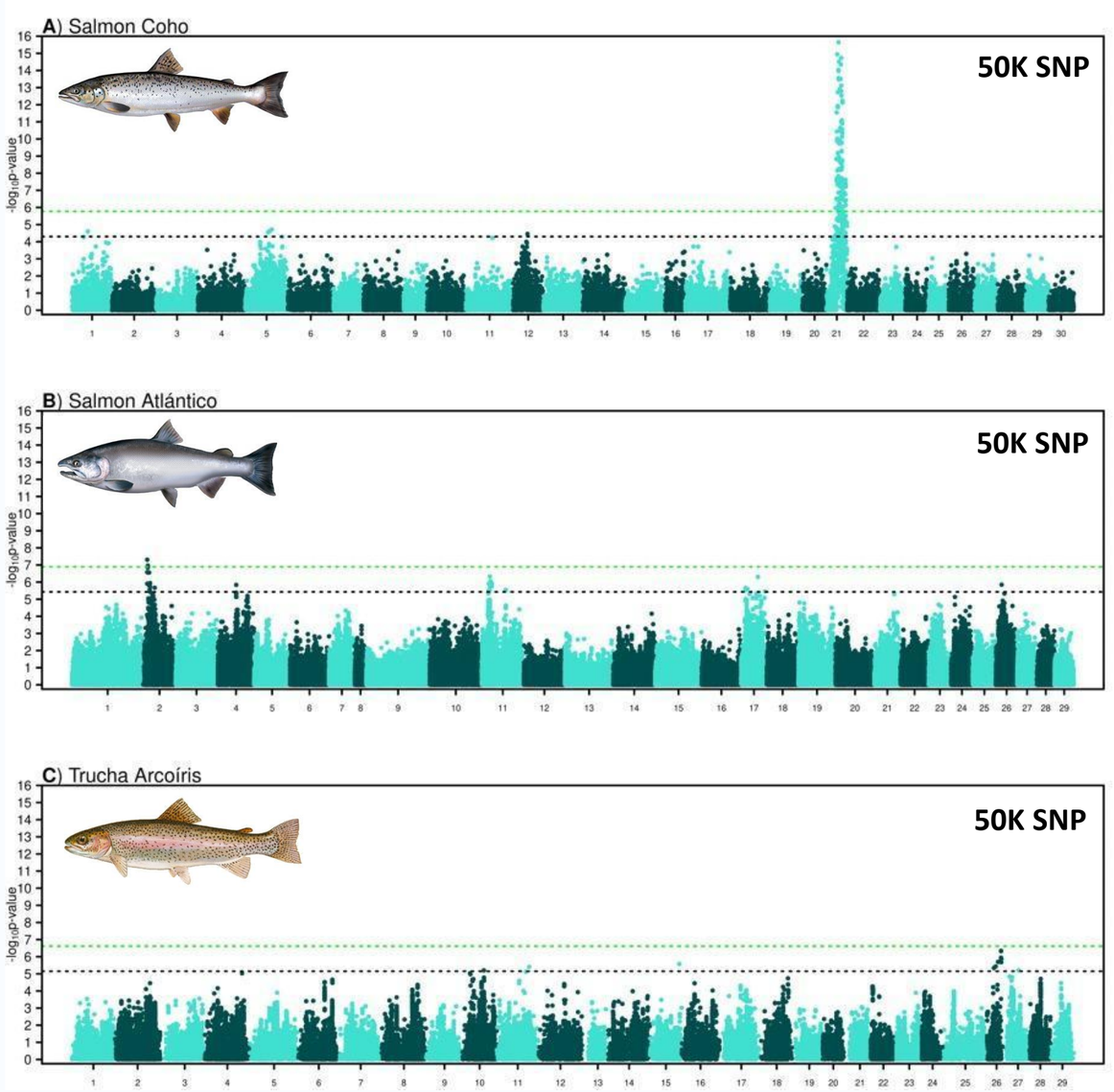
IPN Resistance in Atlantic salmon

p-value **= 0.00000000000000000000000000005**

QTL FOR IPN VIRUS RESISTANCE



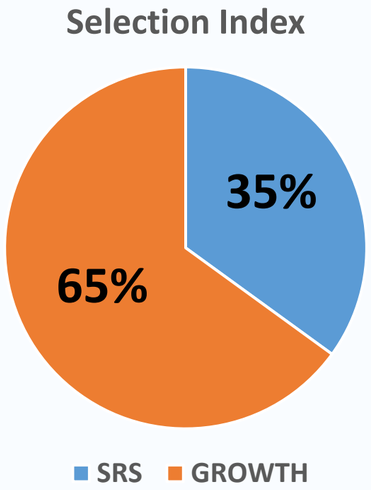
GWAS SRS RESISTANCE (50K SNP)

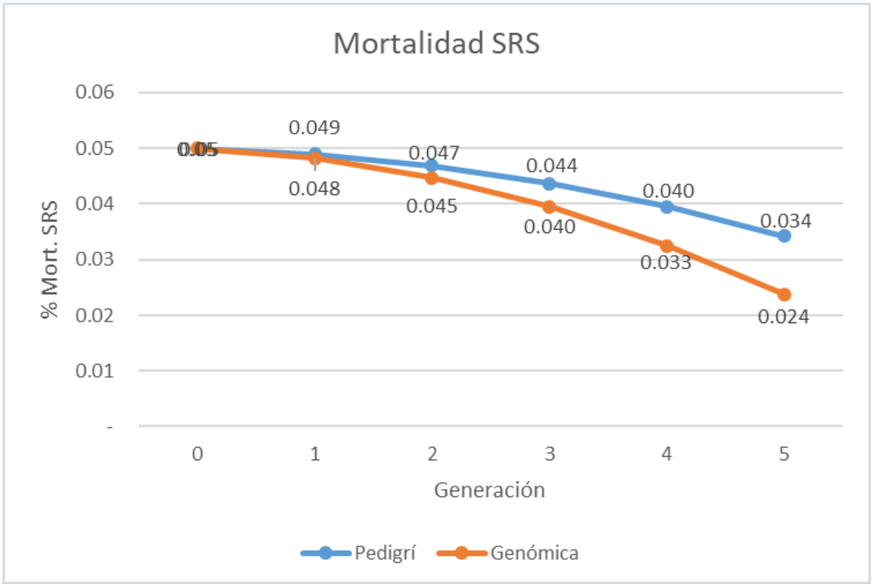


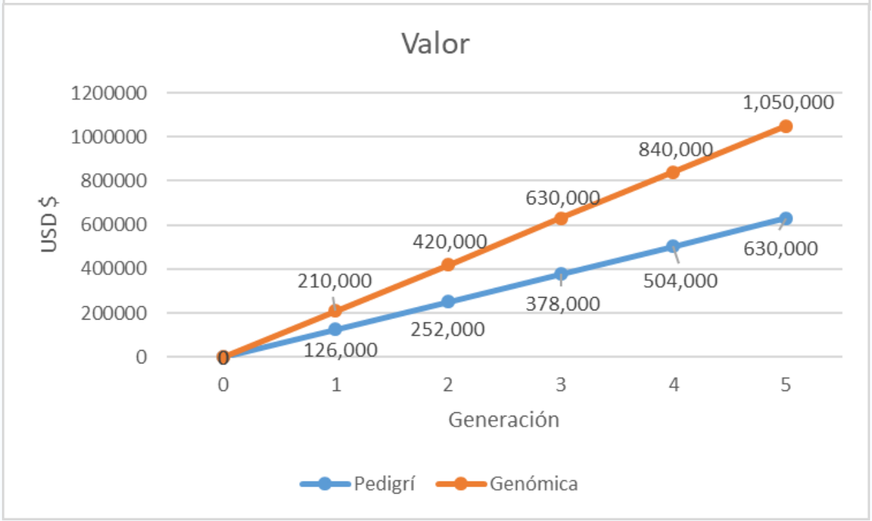
EXPECTED SELECTION RESPONSE

Assumptions

Item	Valor
Biomasa anual (tons)	10,000
Precio ($ USD/k)	6
Mort. total (%)	10
Mort. SRS (%)	5
Perdidas Mort. (tons)	1,000
Perdidas Mort. ($ USD)	12,000,000
Perdidas SRS (tons)	500
Perdidas SRS ($ USD)	6,000,000





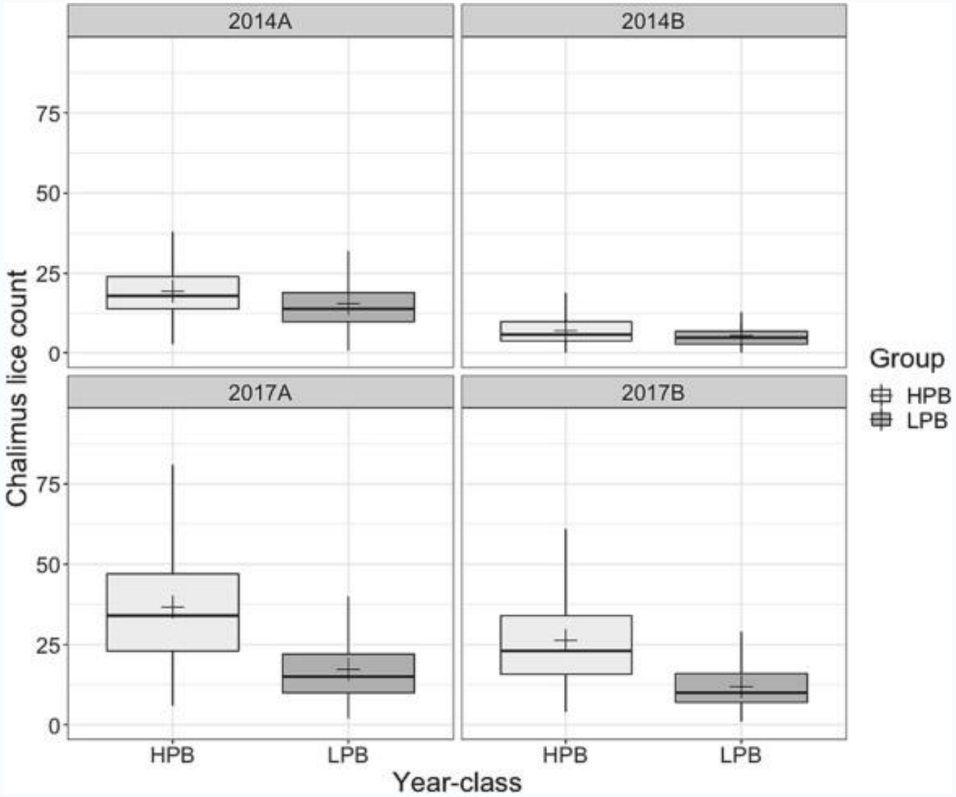


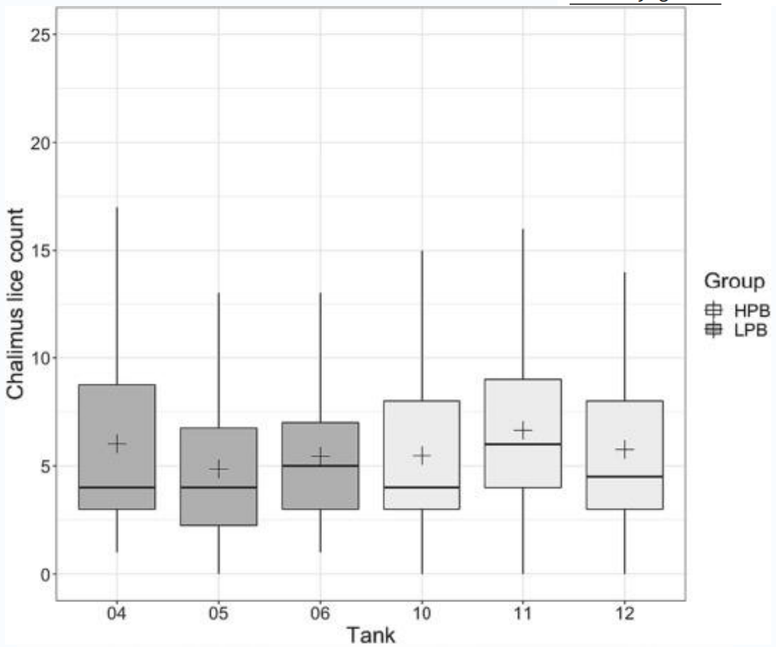
Genomics vs pedigree

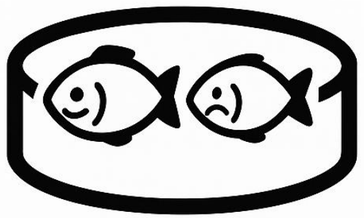
Up to 30% increase in survival (Gen 5)

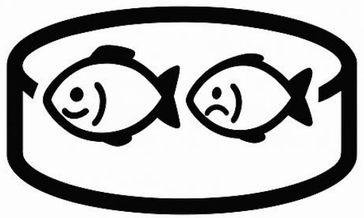
~ 60% more ROI per generation

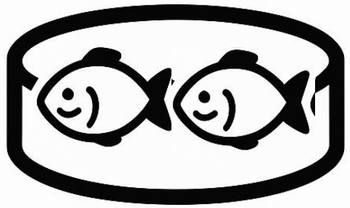
GENOMIC SELECTION FOR SEA LICE BURDEN

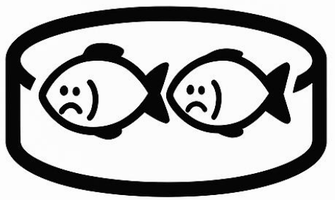












ELSEVIER

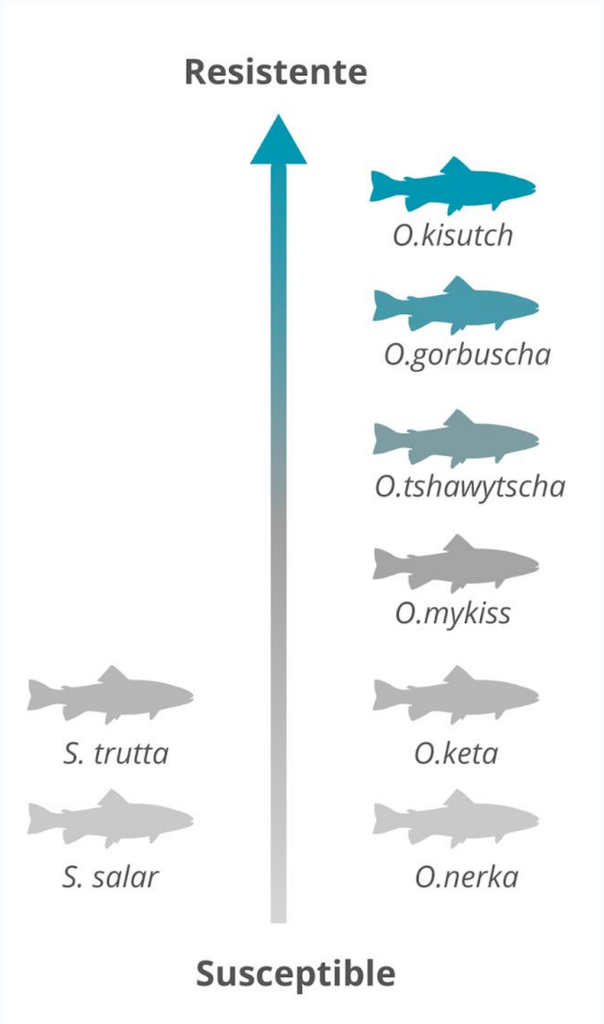
Aquaculture
Volume 581, 25 February 2024, 740438

Genetic selection for reduced parasite load in Atlantic salmon: Zero-sum game or a tool for group-level protection against sea lice?

Jørgen Ødegård [a], Matias Medina [a], Jacob S. Torgersen [a], Sven A. Korsvoll [a], Robert Deerenberg [b], José M. Yáñez [c d], Daniela Cichero [b], Paulina Lopez [b], Thomas Moen [a], Sissel Kjøglum [a]

Slight or null differences between HPB and LPB when challenged in separate tanks

SEA LICE RESISTANCE: COHO VS SALAR



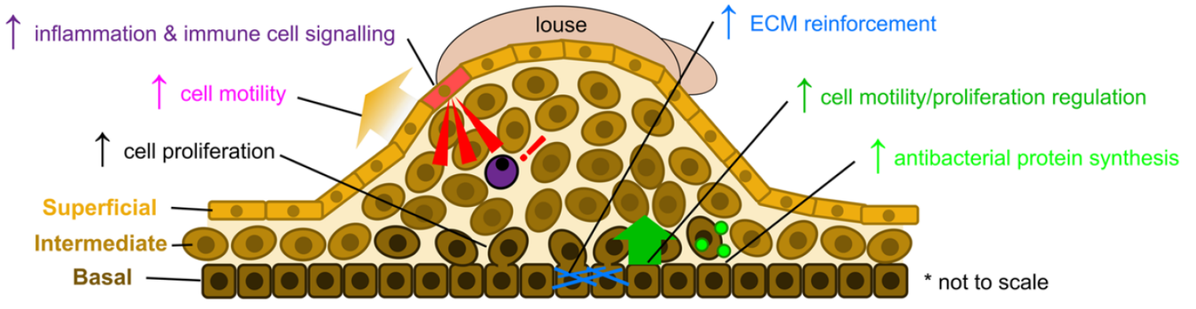
Salisbury *et al. BMC Biology* (2024) 22:160
https://doi.org/10.1186/s12915-024-01952-8

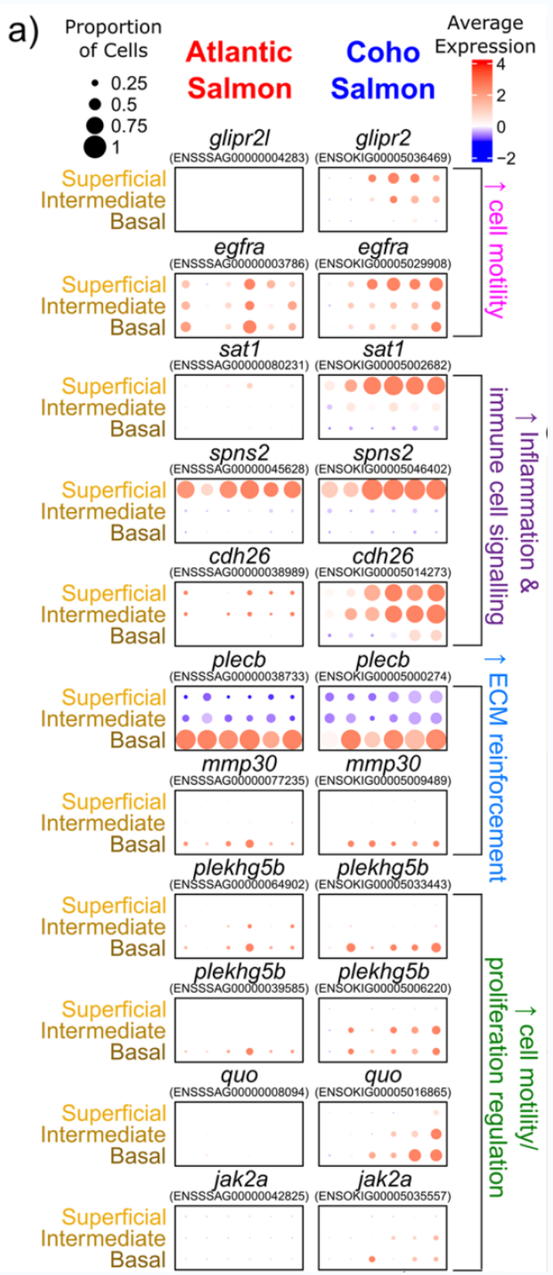
BMC Biology

RESEARCH ARTICLE Open Access

Keratinocytes drive the epithelial hyperplasia key to sea lice resistance in coho salmon

S. J. Salisbury[1*†], R. Ruiz Daniels[1†], S. J. Monaghan[2], J. E. Bron[2], P. R. Villamayor[1,3], O. Gervais[1], M. D. Fast[4], L. Sveen[5], R. D. Houston[6], N. Robinson[5,7*] and D. Robledo[1,3*]





GENE EDITING (CRISPR/CAS9)

EDIGEN

- Permite modificar el ADN de un organismo
- Más rápido, barato, preciso y eficiente que otros métodos de ingeniería genética
- Puede replicar cambios que podrían ocurrir de forma natural o por selección tradicional
- No necesariamente implica insertar ADN foráneo **(no transgénesis o GMO?)**

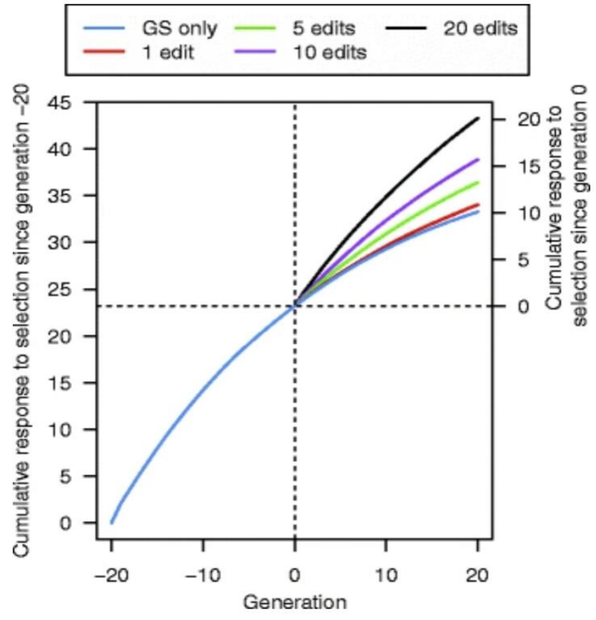
Jenko et al. Genetics Selection Evolution (2015) 47:55
DOI 10.1186/s12711-015-0135-3

GSE Genetic Selection Evolution

RESEARCH ARTICLE Open Access

Potential of promotion of alleles by genome editing to improve quantitative traits in livestock breeding programs

Janez Jenko[1], Gregor Gorjanc[1], Matthew A Cleveland[2], Rajeev K Varshney[3], C. Bruce A Whitelaw[1], John A Woolliams[1] and John M Hickey[1*]



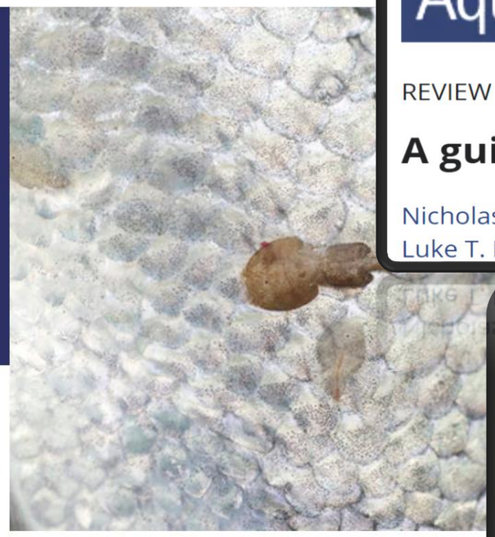
Nofima

Research Services Results About

CrispResist

Harnessing cross-species variation in sea lice resistance

Do Pacific salmon species carry a secret they could share with Atlantic salmon? What is it in the genes that make these relatives of Atlantic salmon less susceptible to lice? Researchers is looking for the answers to these questions, using the gene editing method CRISPR-Cas9.



Sea lice on salmon. Photo: Helge Skodvin, Nofima.

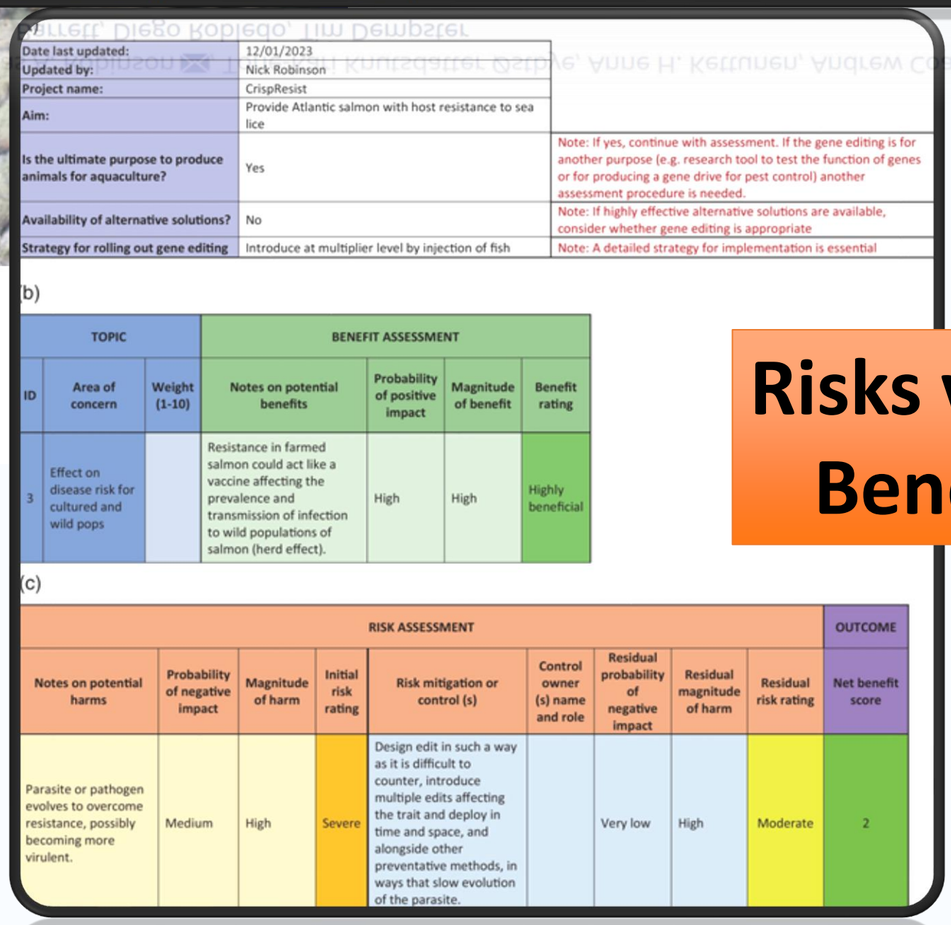
REVIEWS IN Aquaculture

Reviews in Aquaculture homepage

REVIEW | Open Access

A guide to assess the use of gene editing in aquaculture

Nicholas A. Robinson, Tone-Kari Knutsdatter Østbye, Anne H. Kettunen, Andrew Coates, Luke T. Barrett, Diego Robledo, Tim Dempster



Date last updated:	12/01/2023
Updated by:	Nick Robinson
Project name:	CrispResist
Aim:	Provide Atlantic salmon with host resistance to sea lice

Is the ultimate purpose to produce animals for aquaculture?	Yes	Note: If yes, continue with assessment. If the gene editing is for another purpose (e.g. research tool to test the function of genes or for producing a gene drive for pest control) another assessment procedure is needed.
Availability of alternative solutions?	No	Note: If highly effective alternative solutions are available, consider whether gene editing is appropriate
Strategy for rolling out gene editing	Introduce at multiplier level by injection of fish	Note: A detailed strategy for implementation is essential

(b)

TOPIC			BENEFIT ASSESSMENT			
ID	Area of concern	Weight (1-10)	Notes on potential benefits	Probability of positive impact	Magnitude of benefit	Benefit rating
3	Effect on disease risk for cultured and wild pops		Resistance in farmed salmon could act like a vaccine affecting the prevalence and transmission of infection to wild populations of salmon (herd effect).	High	High	Highly beneficial

(c)

RISK ASSESSMENT									OUTCOME
Notes on potential harms	Probability of negative impact	Magnitude of harm	Initial risk rating	Risk mitigation or control (s)	Control owner (s) name and role	Residual probability of negative impact	Residual magnitude of harm	Residual risk rating	Net benefit score
Parasite or pathogen evolves to overcome resistance, possibly becoming more virulent.	Medium	High	Severe	Design edit in such a way as it is difficult to counter, introduce multiple edits affecting the trait and deploy in time and space, and alongside other preventative methods, in ways that slow evolution of the parasite.		Very low	High	Moderate	2

Risks versus Benefits

favet

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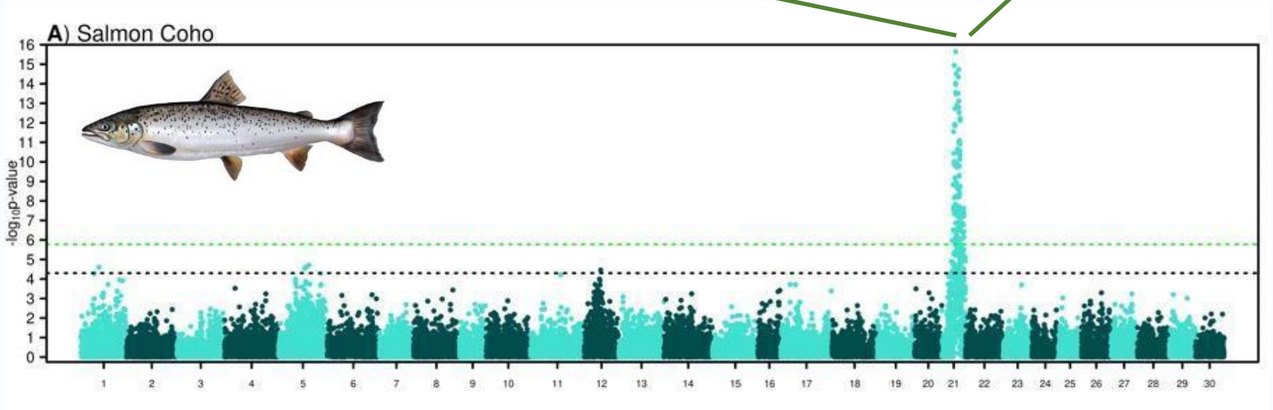
Universidad de Chile

CHILE: SRS RESISTANCE



Functional validation of quantitative trait loci controlling resistance to Salmon Rickettsial Syndrome in coho salmon (*Oncorhynchus kisutch*)

ANID
Agencia Nacional de Investigación y Desarrollo

CONICYT
Ministerio de Educación
Gobierno de Chile

FONDECYT
Fondo Nacional de Desarrollo Científico y Tecnológico

***In vitro* Gene Editing for SRS resistance genes in cell cultures**

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Facultad de Ciencias Veterinarias y Pecuarias
Universidad de Chile

EDIGEN

Iniciativa público-privada que abre un debate amplio e informado sobre la viabilidad de aplicar **edición genética** en animales acuáticos desde una perspectiva científica, normativa y comercial

Objetivo

Generar estrategias de apoyo a la interpretación de la normativa vigente para impulsar la investigación, competitividad y sostenibilidad de la industria, manteniéndola alineada con las tendencias globales

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SAVE THE DATE

19th - 20th Nov, 2025

First International Meeting on Genome Editing in Aquaculture

Puerto Varas, Chile

edigen-favet@uchile.cl

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Facultad favet Ciencias Veterinarias y Pecuarias Universidad de Chile

EDIGEN

SUPPORTED BY Ministerio de Ciencia, Tecnología, Conocimiento e Innovación, Gobierno de Chile

Primer Seminario Internacional de Edición Genética en Acuicultura

Alison Van Eenennaam, Ph.D.
Universidad de California, Davis, Estados Unidos.

Nicholas Robinson, Ph.D.
Nofima, Noruega.
Universidad Deakin, Australia.

Derek Bickhart, Ph.D.
Hendrix Genetics, Países Bajos.

Ross Houston, Ph.D.
Benchmark Genetics, Reino Unido.

Miguel Allende-Conelly, Ph.D.
Instituto Milenio Centro de Regulación del Genoma,
Universidad de Chile.

November 19th - 20th, 2025
Hotel Cabaña del Lago, Puerto Varas, Chile.
Attending and online formats

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El desempeño de una ova no es universal:
depende del ambiente y de las condiciones productivas

Diversificar el origen genético fortalece la resiliencia, asegura la continuidad operativa y mantiene la capacidad de innovación de la industria