

Zanieczyszczenie genetyczne środowiska i biotechnologiczne metody ochrony pul genowych dziko-żyjących ryb



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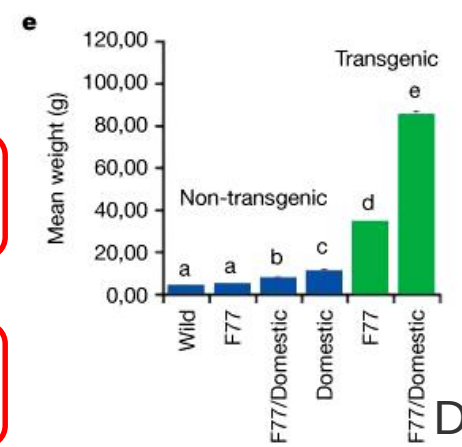
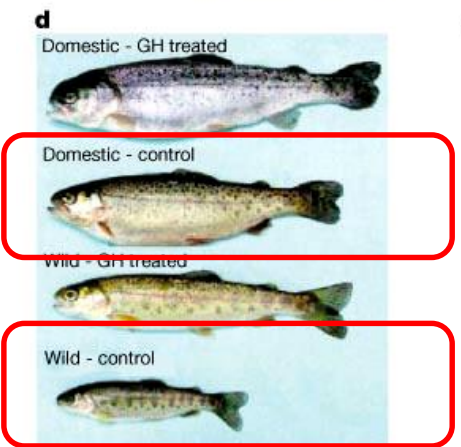
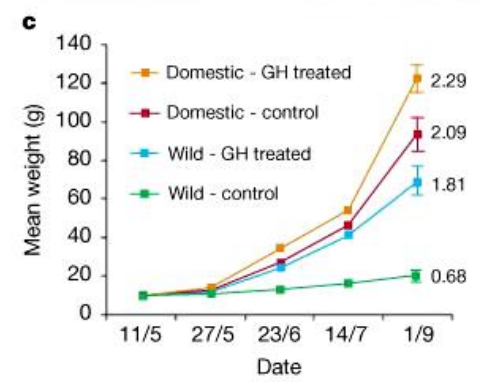
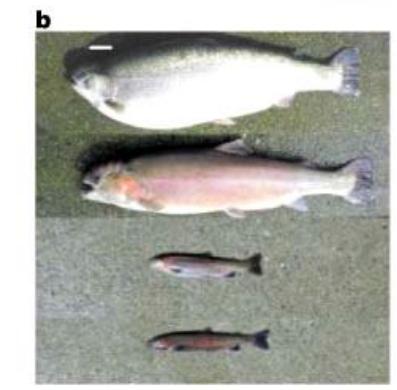
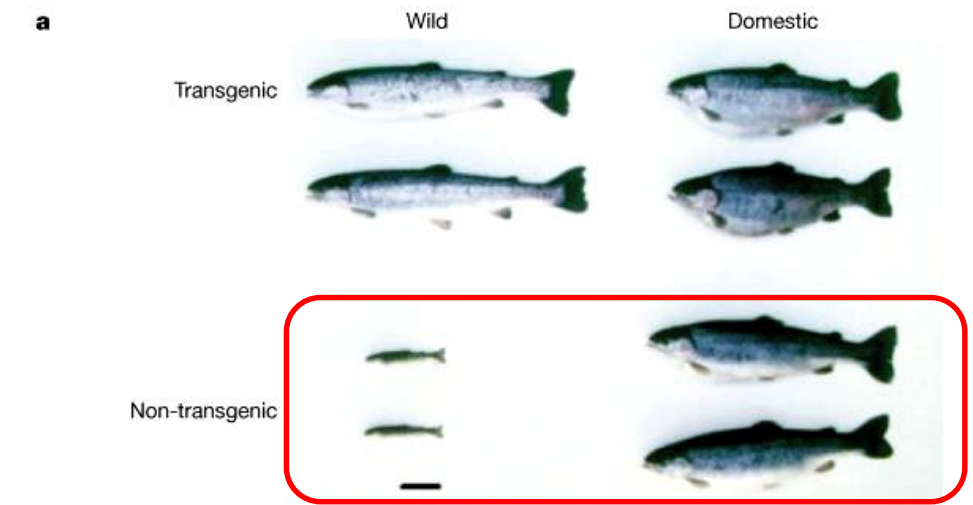
Konrad Ocalewicz
Zakład Biologii i Ekologii Morza
Wydział Oceanografii i Geografii
Uniwersytet Gdański

Zanieczyszczenie genetyczne – wymieszanie się pul genowych organizmów dziko-żyjących i udomowionych, także tych powstających w wyniku manipulacji genetycznych



uzyskane w wyniku selekcji „złote gnu”

Ryby udomowione różnią się genetycznie i fenotypowo od ryb dziko-żyjących



Ryby hodowlane, jeżeli mają szansę uciec to uciekną



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Thousands of salmon escape Marine Harvest farm in Norway

By Christine Blank
February 8, 2018

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Around 56,000 farmed salmon escaped from a Marine Harvest net pen in Nærøy, Trøndelag, Norway.

The escape occurred on 5 February, after a net containing 180,000 salmon was damaged during a maintenance procedure at its farm in Arnøyfjorden. Marine Harvest notified Norway's Directorate of Fisheries, which sent divers to the site. The escaped fish weigh around two kilos (4.41 pounds) each, according to Norway Today.

Marine Harvest is paying fishermen NOK 300 (USD 38, EUR 31) each for escaped fish.

The escaped salmon have been given medication to treat

intestinal worms, according to Marine Harvest. Marine Harvest said it is investigating the incident, in cooperation with the Directorate of Fisheries and suppliers.

Marine Harvest is already receiving criticism about its escape, Norway Today reported.

"In all of Norway, a total of 10,000 salmon escaped in 2017. This incident is five times as many," fish manager Anton Rikstad of the county governor in Trøndelag to Namdalsavis, told the newspaper.



Cermaq salmon escape after fire at Norway fish farm

News by Editorial staff - 31 July 2018

Up to 10,000 salmon may have escaped after a fire broke out at a Cermaq fish farm in Norway.

The fire – at the Ryggefjorden site, Finnmark, Northern Norway – damaged the net cages.

Between 1,000 and 10,000 fish may have escaped, Cermaq said in a press release.

The escaped fish weigh about 500 grams, untreated and fresh. There were about 162,000 fish in the cages when the fire broke out. The Directorate of Fisheries has been notified, the company added.



Norsk

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Escaped farmed fish

Escaped farmed salmon have an impact on wild salmon stocks. Some of the escapees migrate up rivers and spawn with wild salmon. Interbreeding can genetically weaken the wild stocks, which in turn can reduce wild salmon production in the rivers.

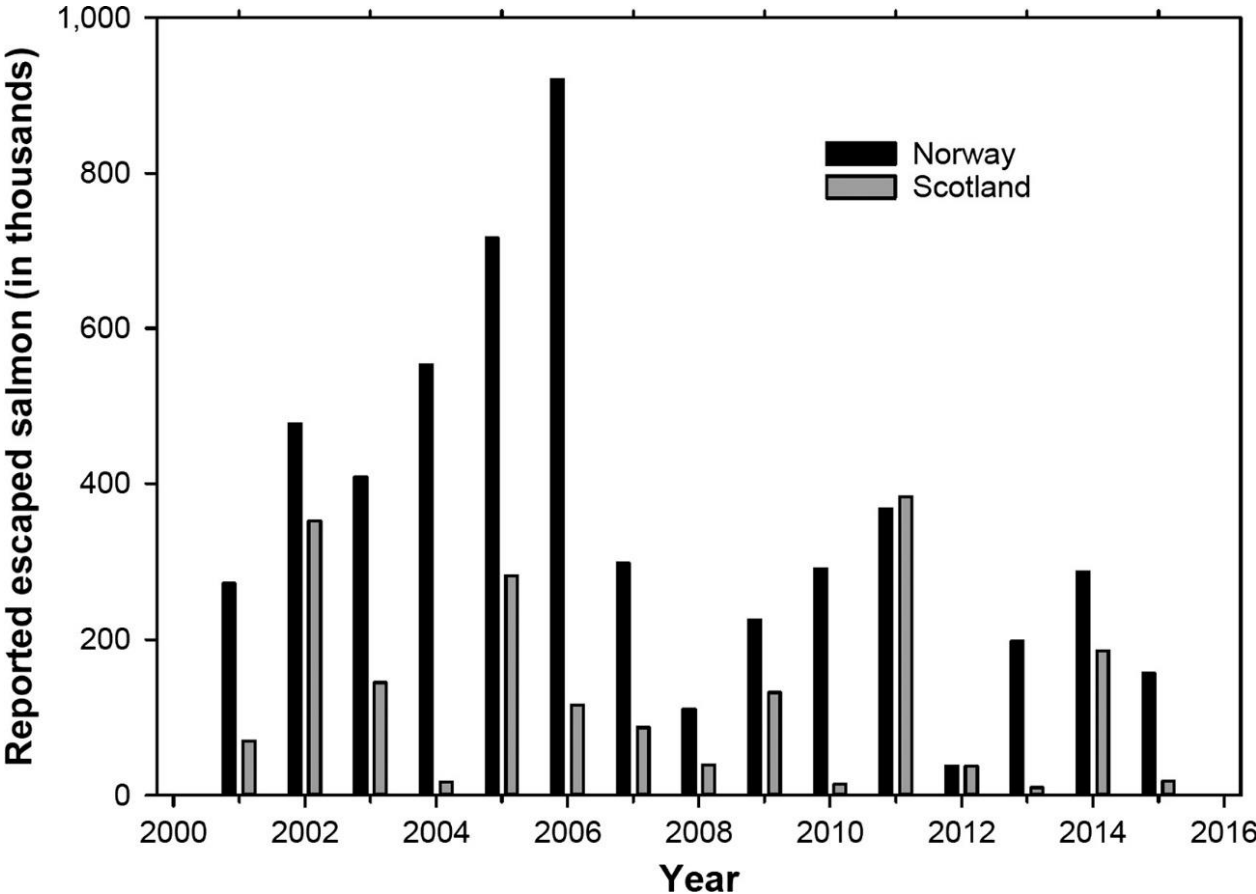
In addition to putting genetic pressure on wild salmon, escaped farmed salmon also carry sea lice infestation and fish diseases. The Norwegian Government's goal is that aquaculture will not contribute to permanent changes in the genetic characteristics of wild fish stocks.



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Half a century of genetic interaction between farmed and wild Atlantic salmon: Status of knowledge and unanswered questions

Kevin A Glover , Monica F Solberg, Phil McGinnity, Kjetil Hindar, Eric Verspoor, Mark W Coulson, Michael M Hansen, Hitoshi Araki, Øystein Skaala, Terje Svåsand



Około 50 tys. jesiotrów syberyjskich uciekło z hodowli do Bałtyku

Autor: PAP Data: 13-09-2017, 18:51

Około 50 tys. jesiotrów syberyjskich i rosyjskich uciekło pod koniec sierpnia br. z hodowli w Jeżyczkach (Zachodniopomorskie) w wyniku podniesienia się poziomu wody w Grabowej. Jak informuje ichtiolog ze Stacji Morskiej na Helu, ryby przedostały się do Bałtyku i stanowią potencjalne zagrożenie dla jesiotra ostronosego.



fot. shutterstock

Celowe wprowadzanie do środowiska ryb gatunków obcych

Ryby łososiowate w Tatrzańskim Parku Narodowym (TPN)



pstrąg potokowy
(natywny dla rzek i
strumieni w Polsce)



**uciekinier z
hodowli**



**niefrasobliwe zarybianie
„obcym” materiałem
zarybieniowym**

Celowe wprowadzanie do środowiska ryb gatunków obcych (krzyżówki międzygatunkowe)



Salmo trutta x *Salvelinus fontinalis* = pstrąg tygrysi



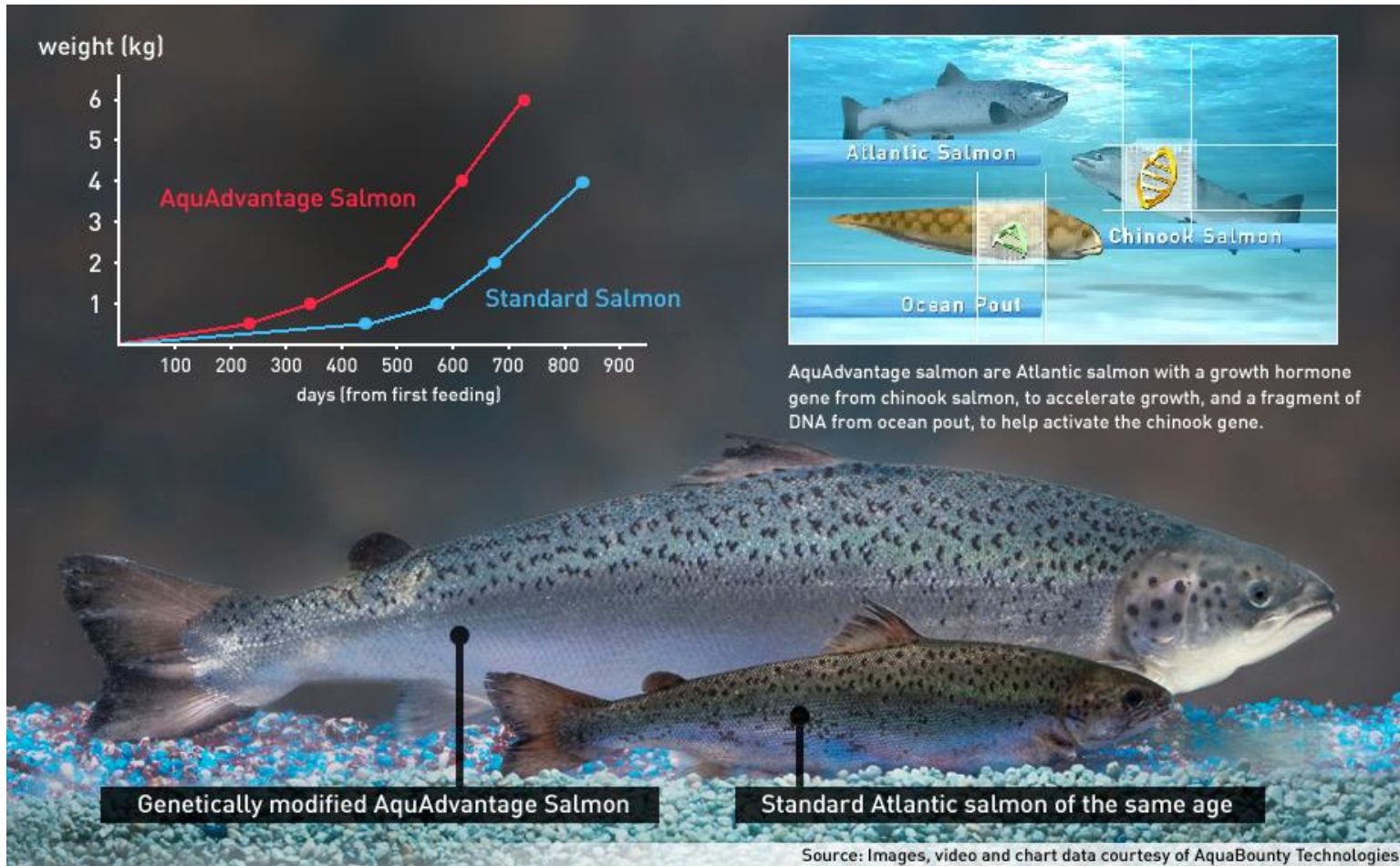
?

Zarybianie rzek - materiał z różnych populacji/stad

Lipień europejski (*Thymallus thymallus* L.)



Ryby genetycznie zmodyfikowane w wyniku transgenezy także mogą dostać się do środowiska naturalnego....



Ryby genetycznie zmodyfikowane w wyniku transgenezy także mogą dostać się do środowiska naturalnego....

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The Zebrafish Model: A Powerful Tool for Answering Complex Questions

We knew the model was brilliant for academic research. Would it be as good for modeling human disease and discovering new drugs in an industrial setting?



Color

- ☐ Cosmic Blue
- ☐ Electric Green
- ☐ Galactic Purple
- ☐ Starfire Red
- ☐ Sunburst Orange

Fish Type

- ☐ Danio



Cosmic Blue Danio



Electric Green Danio



Galactic Purple Danio



Starfire Red Danio



Sunburst Orange Danio

NEWS | PLANTS & ANIMALS

Transgenic glowing fish invades Brazilian streams

Aquarium curiosity appears to be thriving after escape from fish farms and may threaten local biodiversity

11 FEB 2022 • 6:05 PM • BY [SOFIA MOUTINHO](#)



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Genetically modified zebrafish (*Danio rerio*) are sold in fluorescent red, blue, and green. PAULO DE OLIVEIRA/MINDEN

Konsekwencje ucieczek hodowlanych ryb i nierozważnie prowadzonej gospodarki zarybieniowej:

- **Ekologiczne** – konkurencja o pożywienie, konkurencja rozrodcza.
- **Zdrowotne** – przenoszenie czynników chorobotwórczych.
- **Genetyczne** – wymieszanie pul genowych, utrata cennych i lokalnych alleli w wyniku introgresji (proces włączania puli genów jednego gatunku lub populacji do puli innego gatunku lub populacji w wyniku krzyżowania się).

Rozwój akwakultury będzie postępował, ryby hodowlane nadal będą uciekały: jak zatem przeciwdziałać ucieczkom i jak zabezpieczyć dzikie populacje przed udomowionymi osobnikami?

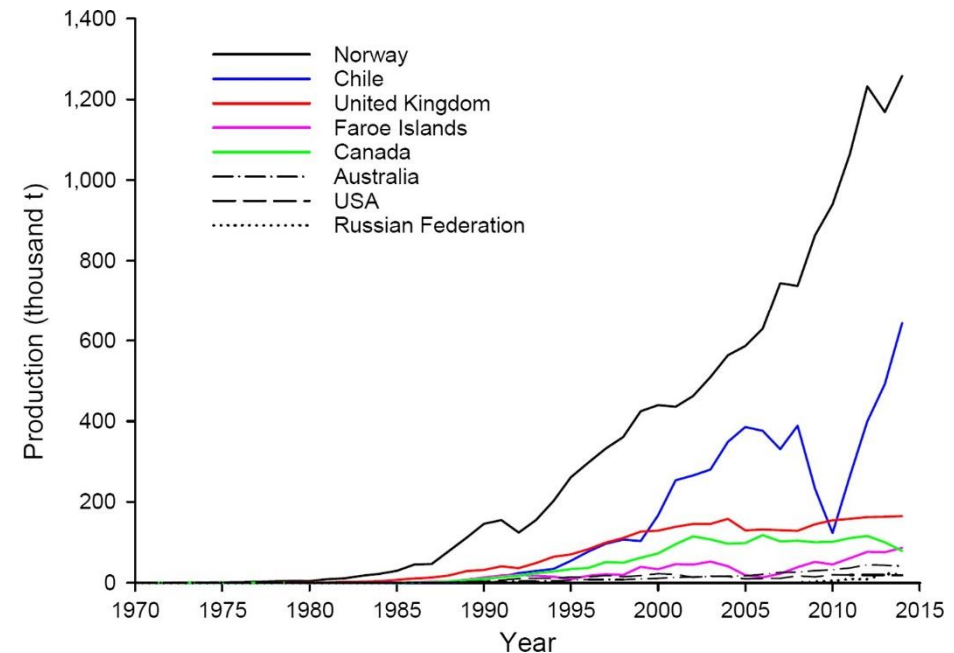
Tak poprowadzić program hodowlany,
aby uciekinierzy nie byli w stanie się
skrzyżować z dziko-żyjącymi
osobnikami....



ORIGINAL ARTICLE | [Open Access](#) |

Half a century of genetic interaction between farmed and wild
Atlantic salmon: Status of knowledge and unanswered questions

Kevin A Glover Monica F Solberg, Phil McGinnity, Kjetil Hindar, Eric Verspoor, Mark W Coulson,
Michael M Hansen, Hitoshi Araki, Øystein Skaala, Terje Svåsand



Jednym z takich programów jest produkcja sterylnych triploidalnych ryb

Rufus Woods triploids taking the bait

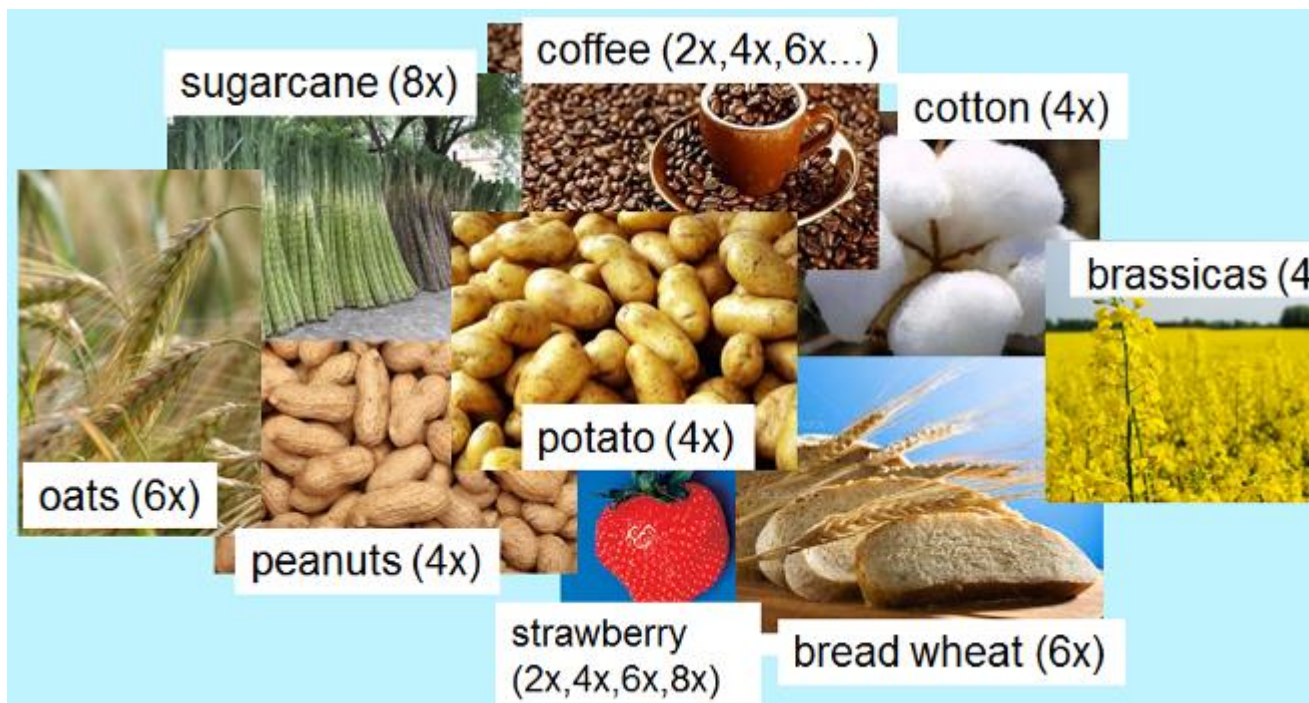
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Lisa Murray of Bellevue with a 13.1 pound triploid rainbow trout caught while bait fishing at Lake Rufus Woods in December 2011. (Anton Jones)

Poliploidalne organizmy są niemal wszędzie



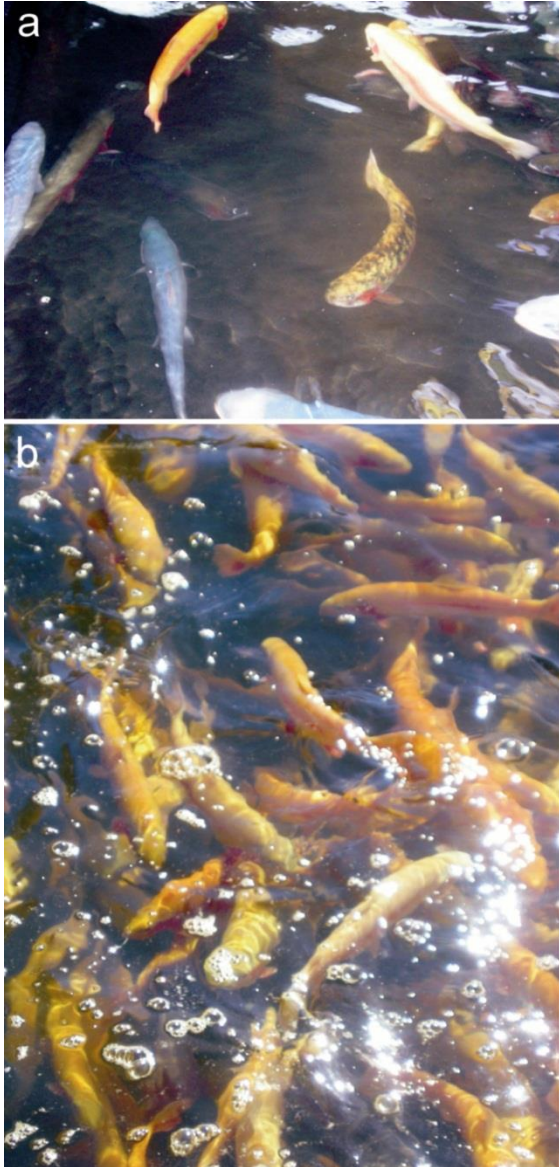
Polyploidy

Examples of Polyploid Plants	
Name	Number
Common wheat	$6N = 42$
Tobacco	$4N = 48$
Potato	$4N = 48$
Banana	$3N = 27$
Boysenberry	$7N = 49$
Strawberry	$8N = 56$

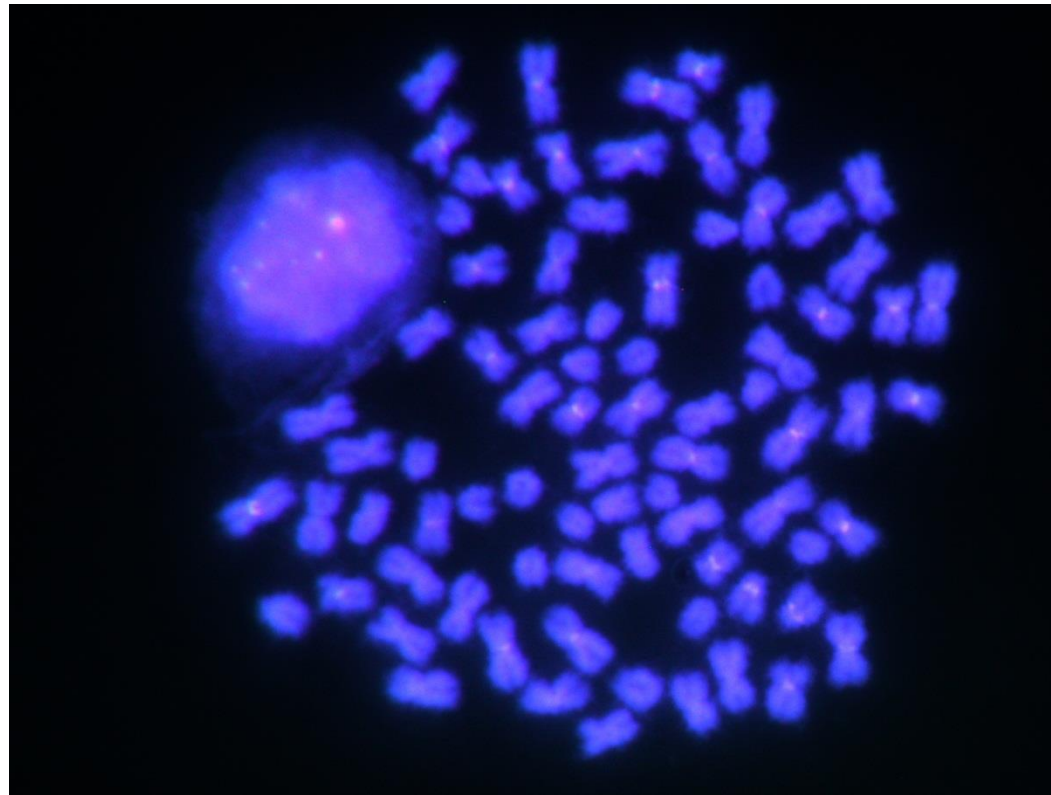
Many **ferns** are polyploid with chromosome number up to $400N$



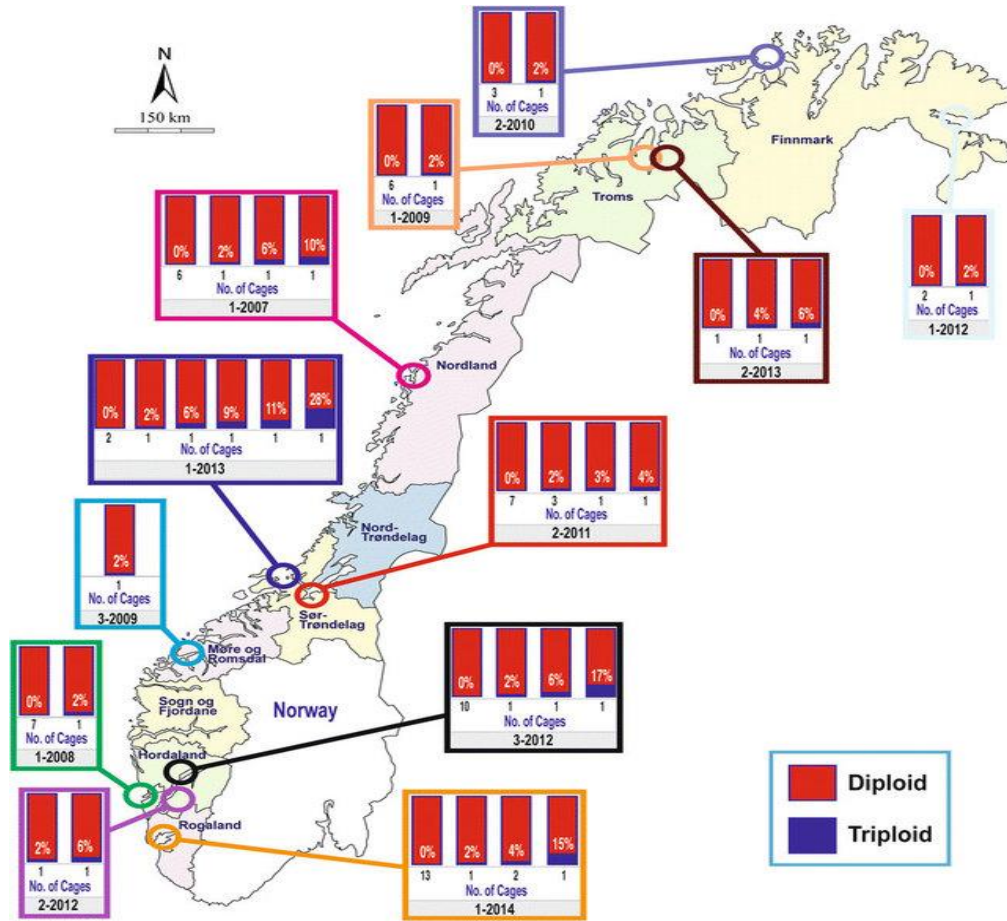
Triploidalne organizmy są niemal wszędzie



Spontaniczna triploidyzacja pstrąga tęczowego $3n=90$



Poliploidalne organizmy są niemal wszędzie



Odsetek spontanicznie triploidalnych łososi sięga nawet 20% (Norwegia)



Aquaculture

Volume 231, Issues 1–4, 5 March 2004, Pages 59–71

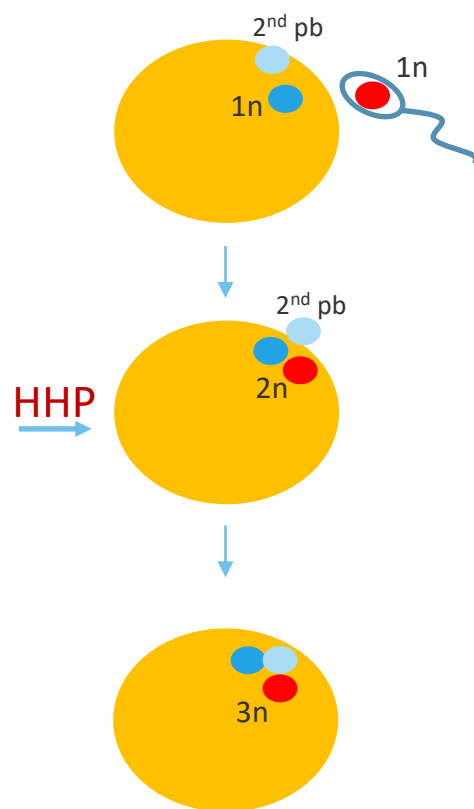


Effects of post-ovulatory oocyte ageing and temperature on egg quality and on the occurrence of triploid fry in rainbow trout, *Oncorhynchus mykiss*

Sandrine Aegerter, Bernard Jalabert

Triploidalne organizmy można uzyskać w warunkach hodowlanych (masowo!!!)

triploidization



pobieranie gamet



inseminacja



Zastosowanie szoku ciśnieniowego po zapłodnieniu: 7 500 – 11 000 psi/3-5 min/20-40 min po inseminacji



inkubacja ikry



analiza ploidności

Triploidalne organizmy w akwakulturze - zalety



<http://abc.net.au>

<http://www.theoutdoorline.com>

TERJE REFSTIE AND TRYGVE GJEDREM

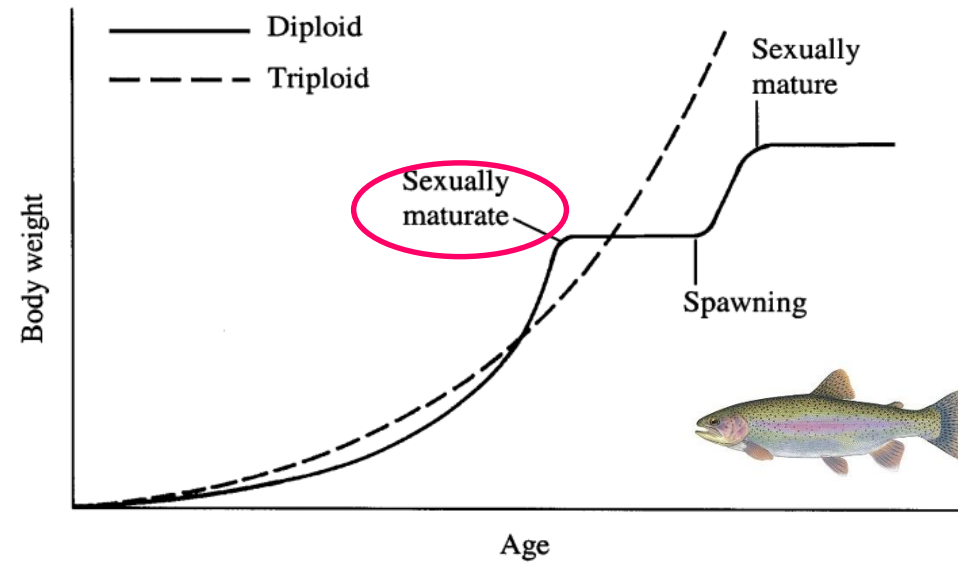


Figure 18.3 Growth curves for diploid and triploid fishes.

Trygve Gjedrem, 2010, Springer

Triploidalne organizmy w akwakulturze - zalety

TERJE REFSTIE AND TRYGVE GJEDREM



Ikra stanowi nawet do ponad 20% masy ciała pstrąga tęczowego

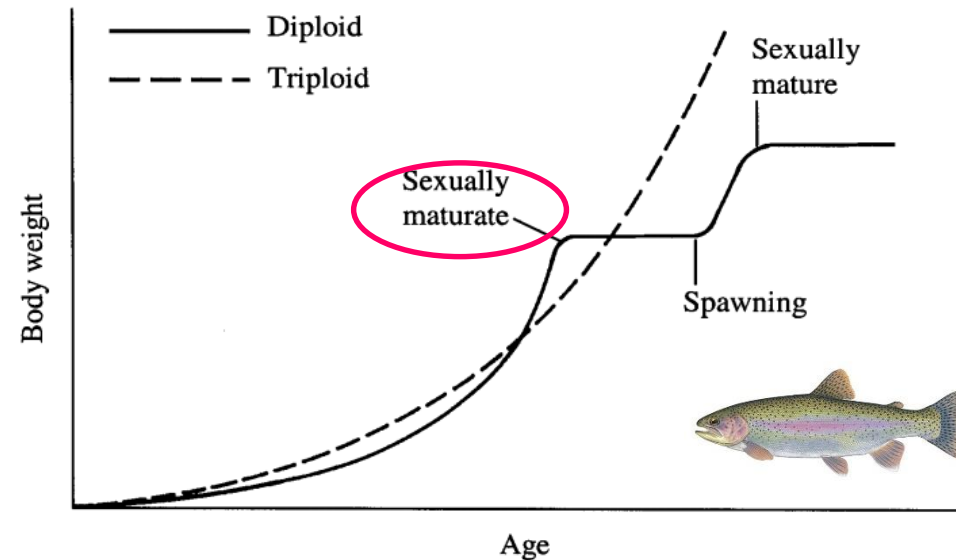


Figure 18.3 Growth curves for diploid and triploid fishes.

Trygve Gjødrem, 2010, Springer

Indukcja rozwoju triploidalnych lipieni



Triploidalne lipienie

Application of high hydrostatic pressure (HHP) shock to induce triploid development in the European grayling (*Thymallus thymallus* L.)

Piotr Hliwa ^a, Ligia Panasiak ^b, Elżbieta Ziomek ^a, Rafał Rożyński ^c, Łukasz Leonowicz ^b, Joanna Grudniewska ^c, Stefan Dobosz ^c, Konrad Ocalewicz ^b 



Funkcjonowanie triploidalnych ryb w warunkach naturalnych

Figure 1: Relative fighting ability of farmed triploid and diploid brown trout

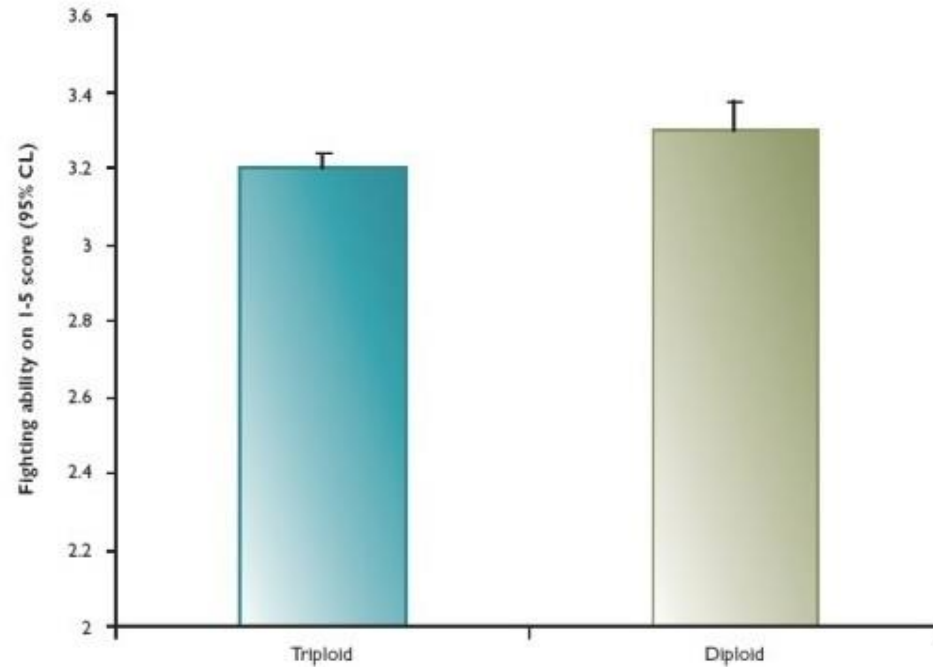
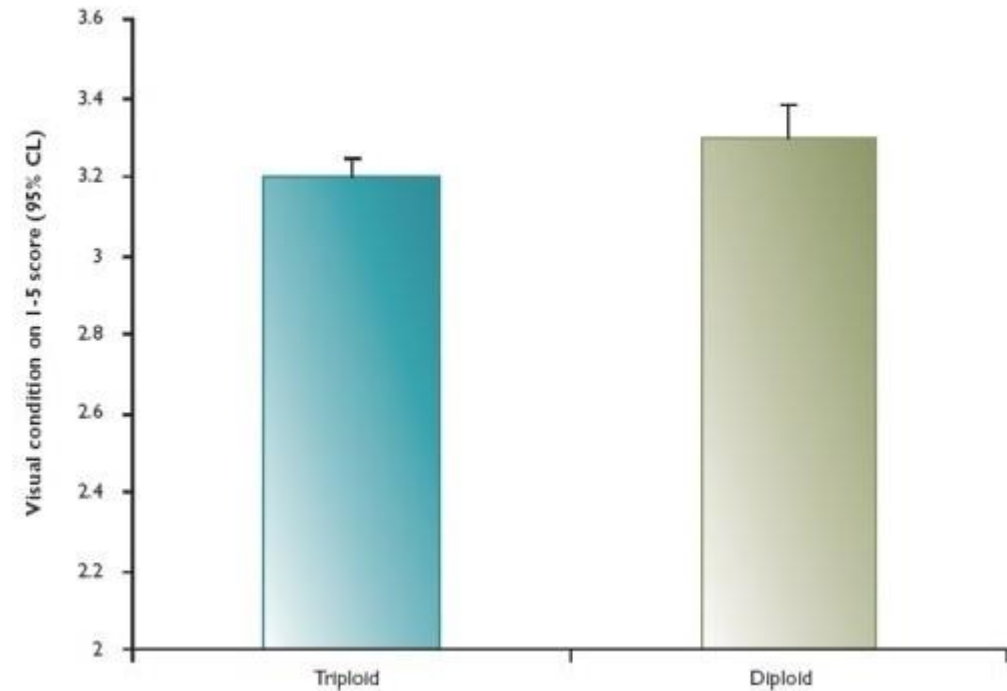


Figure 2: Relative visual condition of farmed triploid and diploid brown trout



Among the anglers surveyed there was very little perceived difference between triploid and diploid trout in terms of fighting ability or visual condition.

Wprowadzanie triploidalnych ryb do środowiska

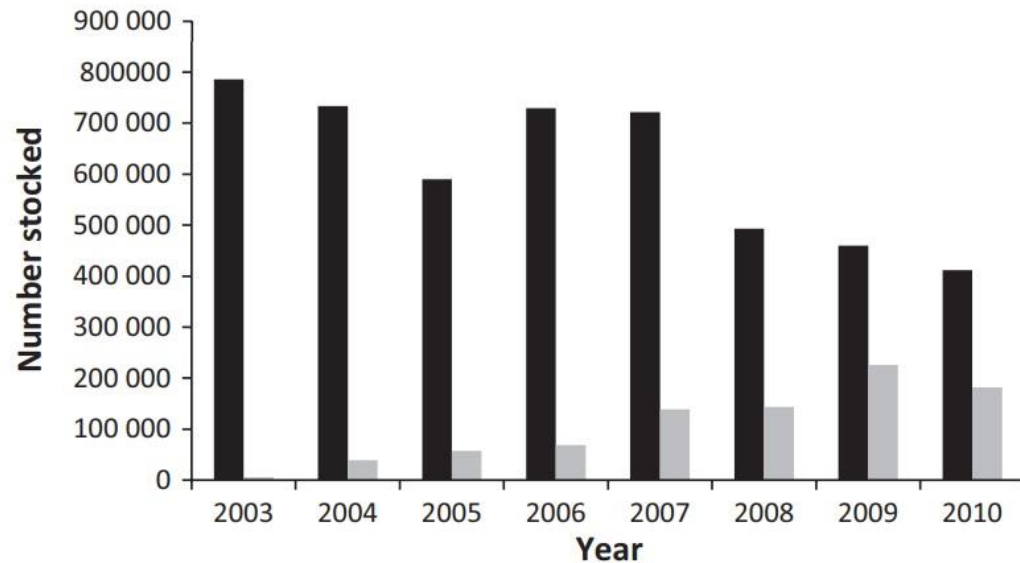


Figure 1. The number of diploid/ unspecified ■ and triploid ■ brown trout stocked into English and Welsh rivers 2003–2010. *Source:* Environment Agency/Cefas Live Fish Movements Database. © Crown copyright.

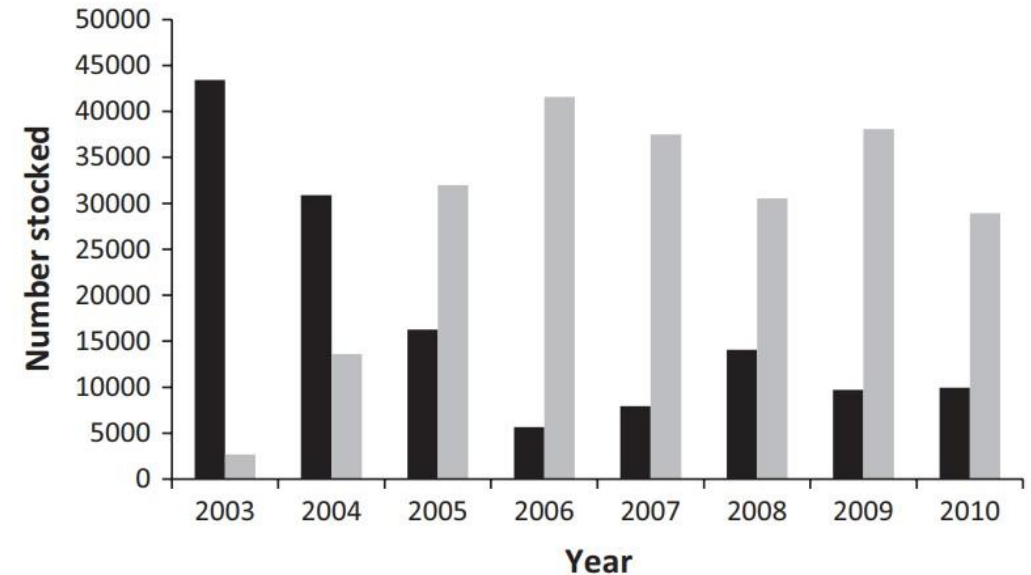


Figure 3. The number of diploid/unspecified ■ and triploid ■ rainbow trout stocked into English and Welsh rivers 2003–2010. *Source:* Environment Agency/Cefas Live Fish Movements Database. © Crown copyright.

Triploidyzacja została wykorzystana podczas produkcji transgenicznego łososa AquaAdvantage



AquaBounty salmon

Triploidalne ryby łososiowate - wady

Journal of Fish Diseases 2016, 39, 1509–1521

doi:10.1111/jfd.12492



Concurrence of lower jaw skeletal anomalies in triploid Atlantic salmon (*Salmo salar* L.) and the effect on growth in freshwater

G Amoroso¹, J M Cobcroft^{1,2}, M B Adams¹, T Ventura² and C G Carter¹

¹ Institute for Marine and Antarctic Studies (IMAS), University of Tasmania, Hobart, TAS, Australia

² Genecology Research Centre, School of Science and Engineering, University of the Sunshine Coast, Maroochydore DC, QLD, Australia

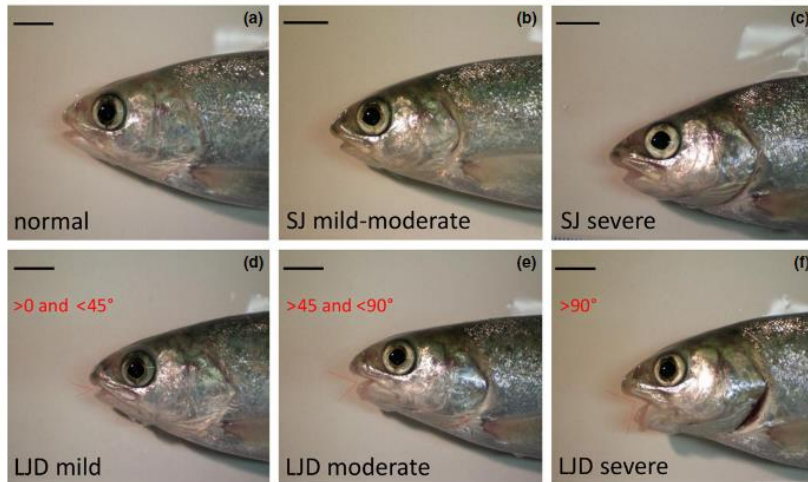


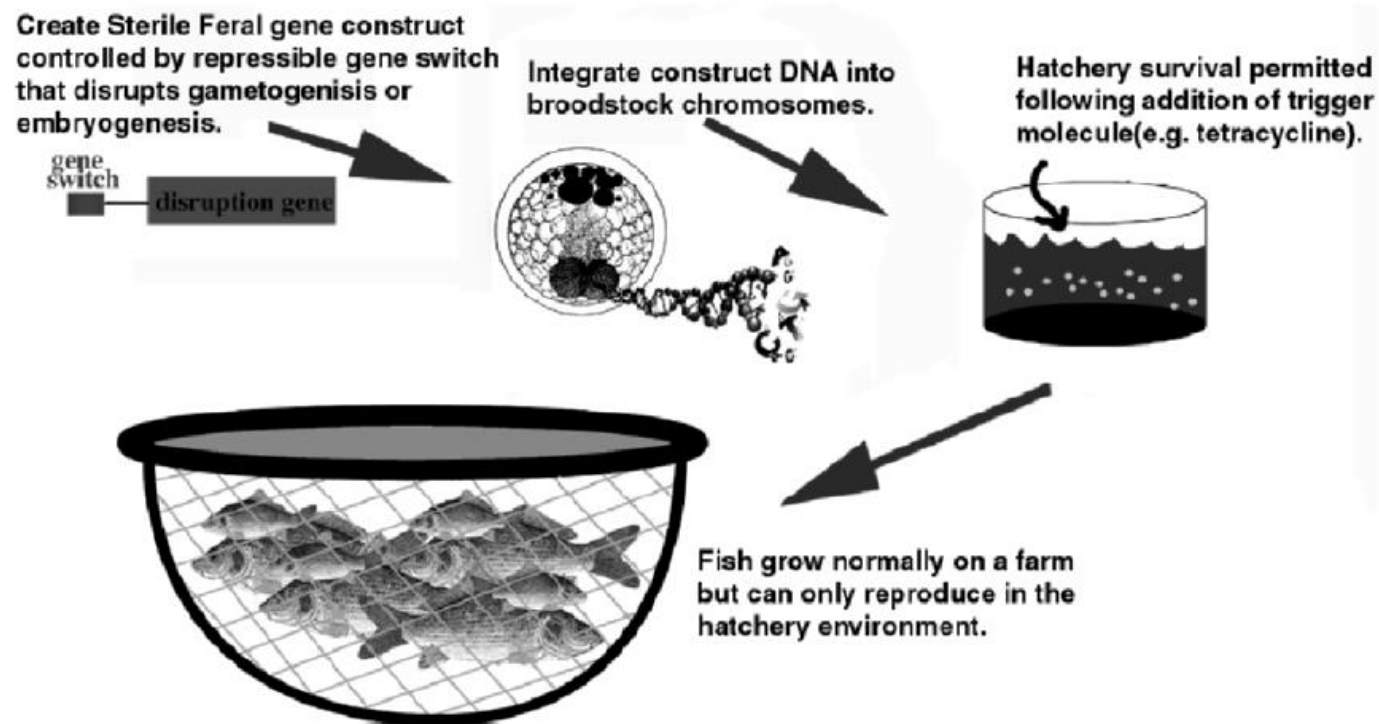
Figure 2 Classification and severity of lower jaw skeletal anomalies affecting Atlantic salmon (*Salmo salar* L.) individuals: (a) normal lower jaw, (b and c) shortened lower jaw (SJ) with severity discriminated as mild-moderate and severe, (d-f) lower jaw deformity (LJD) with three different degrees of severity determined by the angle of downward curvature (values in red text) mild, moderate and severe (scale bars are 1 cm).

1. U ryb triploidalnych częściej ujawniają się wady rozwojowe i deformacje szkieletowe (nawet do kilkunastu procent).
2. Obserwuje się różnice międzygatunkowe dotyczące rodzajów deformacji szkieletowych; pstrąg tęczowy – skolioza, pstrąg źródlany – skolioza i kifoza.
3. Ryby triploidalne są bardziej wrażliwe na niekorzystne warunki środowiskowe; gorzej znoszą skoki temperatur, sub-optymalne temperatury czy niewielki spadek zawartości tlenu w wodzie.

Alternatywne metody produkcji sterylnych ryb: transgeneza

Preventing genetic pollution from aquaculture

109



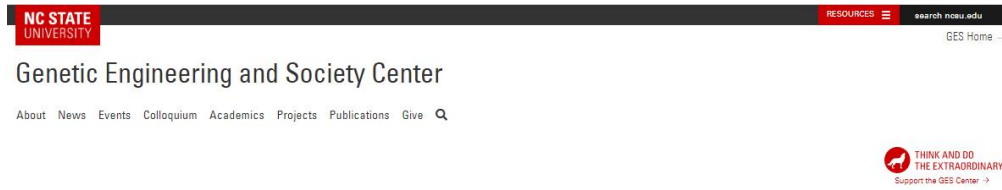
[Ecological and Genetic Implications of Aquaculture Activities](#) pp 103–114 | [Cite as](#)

Preventing Genetic Pollution and the Establishment of Feral Populations: A Molecular Solution

[r M. Grewe Ph.D.](#) [Jawahar G. Patil Ph.D.](#) [Daniel J. McGoldrick Ph.D.](#) [Peter C. Rothlisberg Ph.D.](#) [Steven J. Hardy Ph.D.](#) [Lyn A. Hinds Ph.D.](#) [Chris M. Hardy Ph.D.](#) [Soma Vignarajan](#) & [Ron E. Thresher Ph.D.](#)

Figure 1. Schematic of “Sterile Feral” concept. Gene switch refers to any spatially and temporally restricted species-specific promoter

Alternatywne metody produkcji sterylnych ryb: edycja genomu przy pomocy metody CRISPR



A Sterile Solution: How Crispr Could Protect Wild Salmon

JULY 21, 2021 | GUEST AUTHOR



Molecular biologist Anna Wargelius leads a research team that has created salmon that they call "sterile parents." The gene-edited fish can have their fertility restored, but will pass on the genetic modification, likely making their offspring sterile. Visual: Eriend A. Lorentzen / Institute of Marine Research

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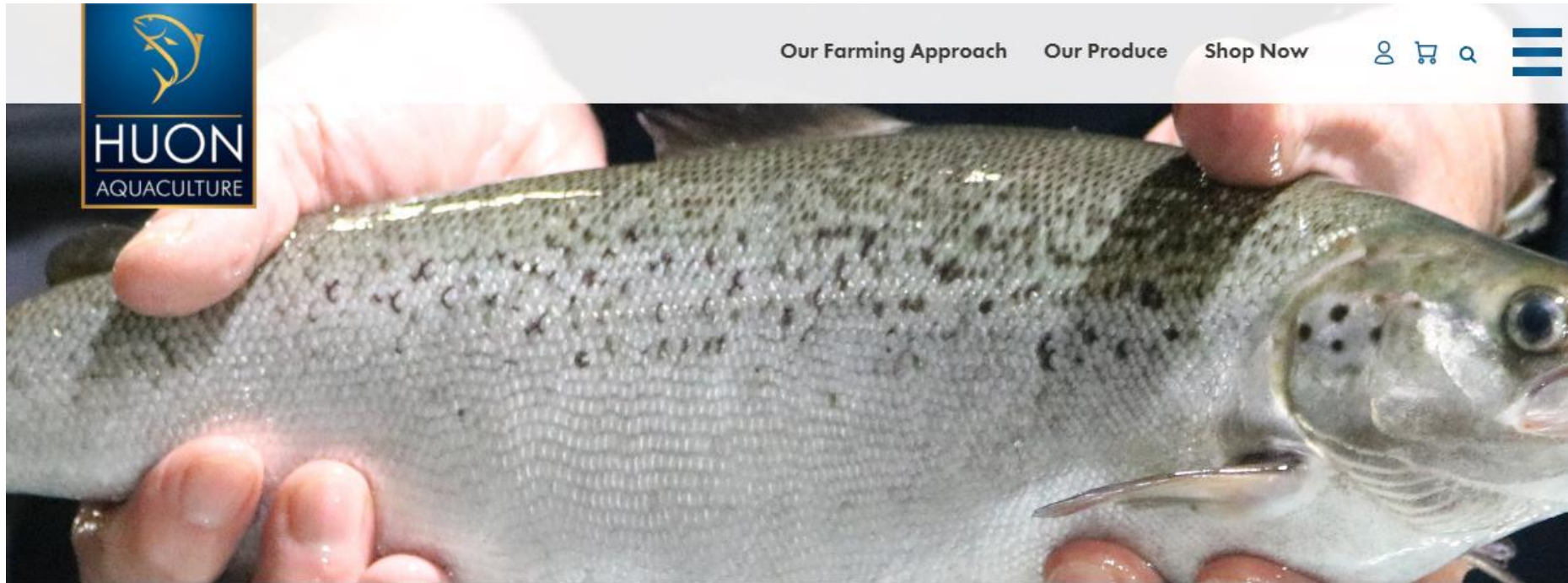
Dnd knockout ablates germ cells and demonstrates germ cell independent sex differentiation in Atlantic salmon

Anna Wargelius¹, Sven Leininger^{1,*}, Kai Ove Skaftnesmo¹, Lene Kleppe¹, Eva Andersson¹, Geir Lasse Taranger¹, Rüdiger W Schulz^{1,2} & Rolf B Edvardsen¹

Introgression of farmed salmon escapees into wild stocks is a major threat to the genetic integrity of wild populations. Using germ cell-free fish in aquaculture may mitigate this problem. Our study investigated whether it is possible to produce germ cell-free salmon in F0 by using CRISPR-Cas9 to knock out *dnd*, a factor required for germ cell survival in vertebrates. To avoid studying mosaic animals, sgRNA targeting *alb* was simultaneously used as a visual tracer since the phenotype of *alb* KO is complete loss of pigmentation. Induced mutations for the tracer (*alb*) and the target (*dnd*) genes were highly correlated and produced germ cell-less fish lacking pigmentation, underlining the suitability of *alb* KO to serve as tracer for targeted double allelic mutations in F0 animals in species with prohibitively long generation times. This is also the first report describing *dnd* knockout in any fish species. Analyzing gene expression and histology of *dnd* KO fish revealed that sex differentiation of the somatic compartment does not depend on the presence of germ cells. However, the organization of the ovarian somatic compartment seems compromised in mutant fish.

Wady:

- iniekcje CRISPRs/Cas9 pojedynczo każdego ziarna ikry,
- sterylność nie jest dziedziczna,
- knock-out DNA – GMO.



[Home](#) / [Newsroom](#) / [Triploids – the facts](#)

— **Triploids – the facts**

In simple terms, a triploid fish is a fish that is sterile. Across the Tasmanian Salmonid Industry, triploids are used to bridge the harvest gap between year classes to ensure continuous supply to the market.

Triploidy occurs naturally in wild populations due to environmental changes (usually water temperature fluctuations).

Uważa się, że triploidalne sterylne ryby są bezpiecznym materiałem zarybieniowym, nie są w stanie skrzyżować się z dzikimi osobnikami



The Wild Trout Trust
We inspire and help people to protect wild trout and their habitat

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Trout Stocking



The Environment Agency in England and Wales now requires all farmed brown trout stocked into rivers and some lakes to be infertile (triploid). These regulations were put in place in January 2015. Details are on the EA website archive - click [here](#).

The Scottish Government has a similar policy - details are [here](#).

This web page contains a lot of information on the topic of stocking farmed trout and includes videos, [scientific papers](#), and [case studies from fishing clubs](#).

3n fish have been used to stock rivers and lakes in UK, USA, Canada.



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Triploid Grass Carp

TRIPLOID GRASS CARP (*Ctenopharyngodon idella*)

ALIAS: Sterile grass carp, triploid white amur

IDENTIFICATION: Triploid grass carp are an elongated, torpedo-shaped fish with a terminal mouth and no barbels. They are dark olive to brownish yellow in color and have large scales along the length of their body.

DIET: Aquatic weeds such as curly-leaf pondweed, coontail and duckweed.

SPAWNING: Triploid grass carp are certified sterile by the U.S. Fish and Wildlife Service and will not reproduce.

USE: Triploid grass carp have been stocked for decades as a natural alternative to chemicals for algae and aquatic weed control.



Rufus Woods triploids taking the bait

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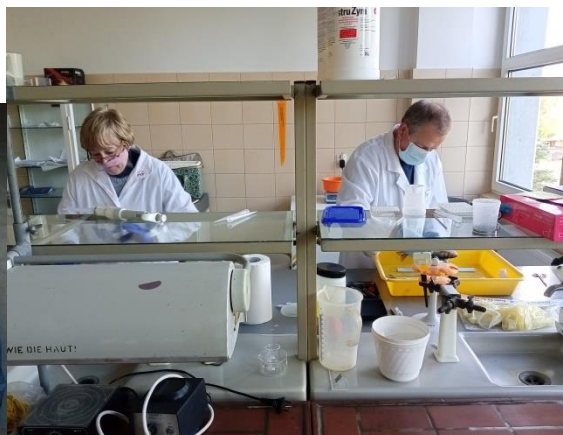


Dziękuję współpracownikom!

Ela i Piotr



Marcin



Łukasz i Robert



Ligia i Rafała



Stefan





Dziękuję za uwagę!



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