EVERYTHING YOU NEED TO KNOW ABOUT

TROUT GENETICS

XELECT

GENETIC SOLUTIONS FOR AQUACULTURE
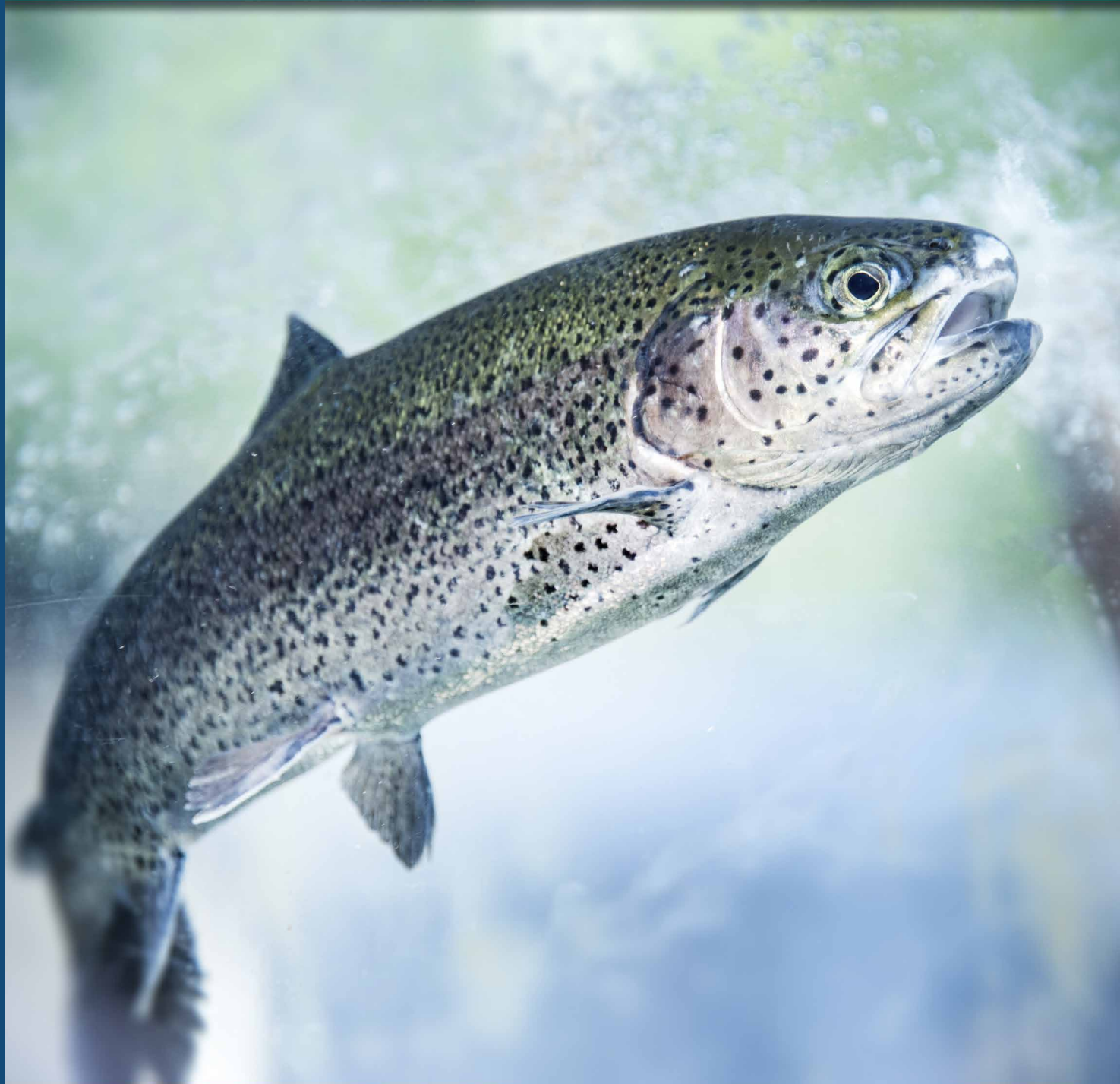
GENETICS: THE BIG PICTURE

For thousands of years humans have used natural variations in genes to create a step change in the quality of our crops and livestock. For example, a modern farmed chicken now grows 400% faster than it did just 50 years ago.

Aquaculture, however, has been much slower to react. It's time to play catch up. The good news is that our industry is perfectly placed to do just that. In recent years we've seen time and time again that a well-managed breeding programme will give a huge return on investment. It's not uncommon to see increases of well over 10% every generation in key traits such as growth just by careful selection using natural genetic diversity.

We've long believed that the latest technologies should be for the many, not the few. There's a lingering myth in aquaculture that genetics is expensive, and that only the largest producers can benefit. The reality is that – due to breakthroughs in computing power and sequencing methods – even small companies should now be able to access the tools they need.

This guide is intended as a quick overview of how genetics is changing the game for trout aquaculture, including:

- *an overview of trout genetics*
- *how how breeding programmes work in practice*
- *tips on how to get started.*

SPOTLIGHT ON TROUT

Trout are highly fecund, so without genetic management they are extremely susceptible to inbreeding. A single female can produce thousands of juveniles. This rapidly leads to "inbreeding depression" – a loss of genetic variation, resulting in increased deformity, reduced vigour and poor survival. Once that happens there's no way back, without purchasing new broodstock animals from a different source.

The good news is that they're also an excellent species to farm, that is highly responsive to genetic backed breeding programmes. The benefits of selection are cumulative over generations, which means that each generation improves on the last. For example, a Rainbow Trout crop can typically take around 48 weeks to harvest at 800g in freshwater. With a 10% improvement in growth for three generations, it would only take 39 weeks to reach 800g. That's an improvement of 9 weeks to harvest. This would also mean a reduction in production costs, because of the lower risk of losses, quicker turnaround time per crop and a big reduction in feed costs.

Comparison of Rainbow Trout freshwater growth over 4 generations with typical gains

Generation 1 — Generation 2 — Generation 3 — Generation 4
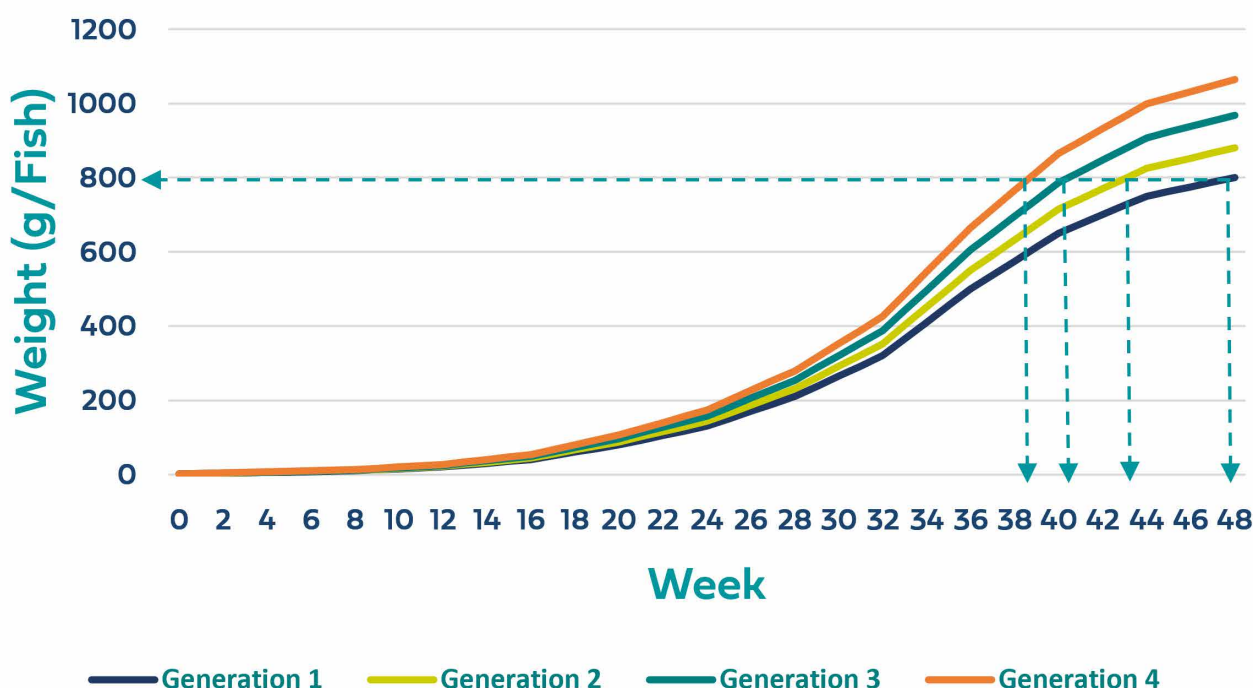
An integrated genetics programme allows you to balance performance with sustainability. The fastest growing animals can be selected but inbreeding rates can also be carefully manged. Other relevant commercial traits can also be included, such as survival, early maturation, deformities, and muscular fat.

In most advanced Rainbow Trout breeding programmes, selecting for disease resistance gives a major return on your investment. In particular Salmonid Rickettsial Syndrome (SRS) accounts for nearly 20% of all Rainbow Trout losses in Chile. Resistance to SRS has a very high 'heritability' (how much of a trait is related to genetics and how much is down to environment) so selecting for disease resistance a very economically effective strategy.

Other minor diseases include Flavobacterium, which causes acute losses (for which genetic resistance has a moderate heritability) and Infectious Pancreatic Necrosis (IPN), with high heritability for resistance. The main external parasite for Rainbow trout reared in the sea is Sealice/Cáligus. Around 53% of all sea farms are affected by this parasite, but genetic programmes can be used to select for resistance with impressive results, which can reduce the number of chemical and physical treatments required.

In short, a genetics programme can have a major impact on the commercial success of any trout operation, giving a return on investment many times over.

TAKE THE TWO MINUTE GENETICS HEALTH CHECK

Is your broodstock in good hands? Find out with our free Genetics Health Check. It takes less than 2 minutes to complete, and gives you a general picture of how you're doing, and what to watch out for in the future.
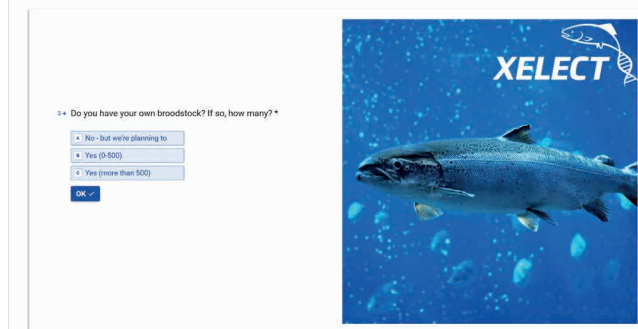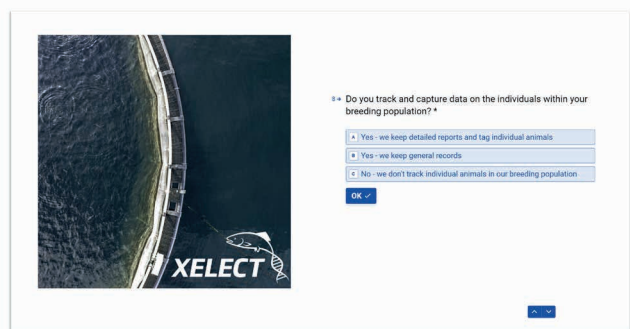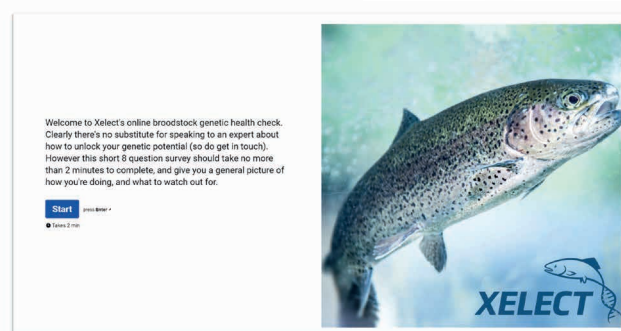
Try it for yourself at:
www.xelect-genetics.com/genetics-health-check

YOU CAN GET A VERY BIG RETURN ON YOUR INVESTMENT

Genetics is an investment, not a cost. With your own broodstock you'll be able to breed fish proven to thrive in your production environment sustainably, year on year.

GAINS ARE CUMULATIVE

The gains you get will build cumulatively from one generation to the next. In other words, you get better fish that just keep on getting better.

IF YOU'RE NOT USING GENETICS YOU'RE LOSING MONEY

For every year that you're not using genetics you're falling behind producers who do. A competitor with an effective breeding programme can quickly overtake the market.

THE COSTS ARE MUCH LOWER THAN YOU THINK

You could, of course, choose to build your own in-house genetics team, but that would require a major internal investment. With Xelect you only need to pay for exactly what you need, and we only ever recommend any actions that we think will give you a return on your investment many times over.

WE'RE MAKING NEW BREAKTHROUGHS ALL THE TIME

Xelect are at the cutting edge of aquaculture genetics, and we're constantly developing new techniques and technologies. For example, we've just launched our new 'smart genomics' programme which combines cutting edge statistical tools and evolutionary algorithms to give incredibly accurate breeding selections at a fraction of the cost of a traditional genomics programme.

Gains from traditional Family Selection compared with "Smart" genomics

Family selection (10%)   Smart Genomics (15%)
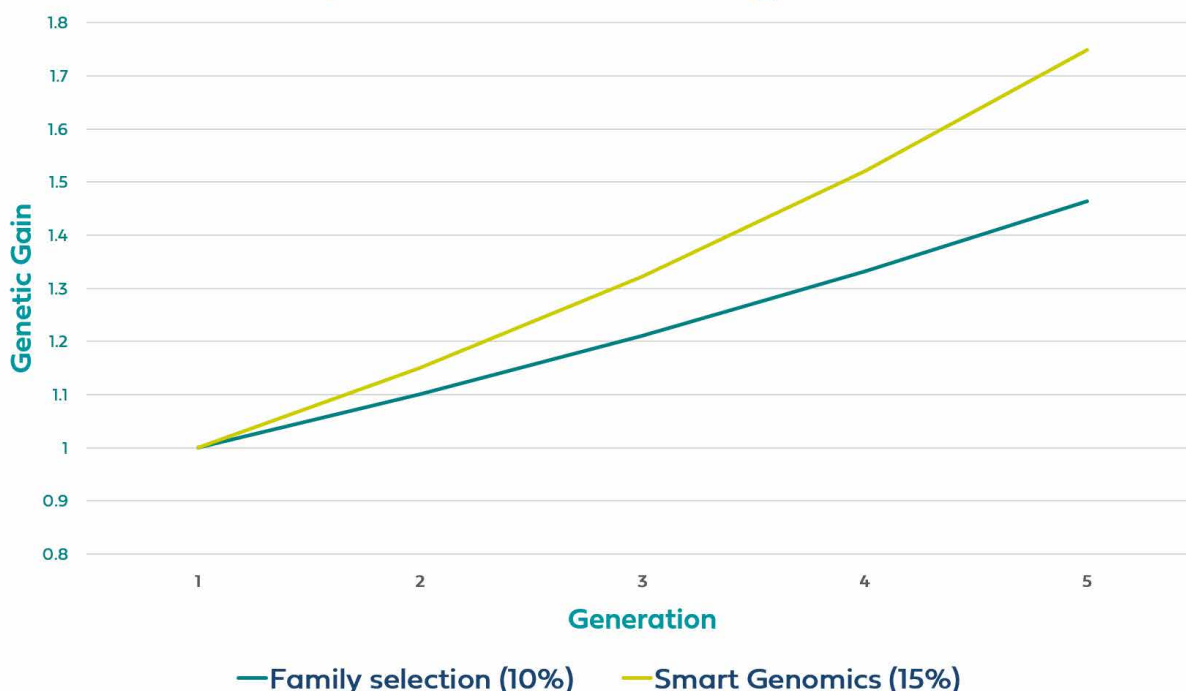
STEP BY STEP: A TYPICAL BREEDING PROGRAMME

Well first things first – there's actually no such thing as a 'typical' breeding programme at Xelect. Rather than an off the shelf solution we prefer to design all of our programmes from scratch, to reflect the priorities and scale of our customers. However there are some general approaches that can provide a framework.

The first thing we do with a customer is to make sure we fully understand the commercial aspects of their production. This allows us to develop programmes that specifically zero in on the traits that will give them the most profitable results.

Typical traits include:

- Growth
- Disease resistance
- Increased feed conversion efficiency
- Appearance (e.g. a particular colour or body shape).

1. YOUR STARTING POPULATION

Establish the first generation of production. We'll take tissue samples from PIT tagged individuals and sequence it in our custom built laboratory, creating a pedigree. We'll also support you with the collection of vital data on key traits such as growth, disease resistance and any other commercially valuable information.

2. OBSERVE UNDER PRODUCTION CONDITIONS

This data is stored in a custom built database, and carefully analysed and evaluated to allow us to assess the performance of the population. From this we'll identify the top performers (breeding candidates). We can also use test populations made up of brothers and sisters of candidate fish so that we can have high levels of confidence in our selections.

3. EVALUATE PERFORMANCE AND PEDIGREE

We then combine the real-world performance and the pedigree (or family structure) of the candidates to identify an overall Breeding Value for each animal (a measure of how likely it is that their high performance will be inherited by future generations).

4. CALCULATE OPTIMAL COMBINATIONS

Our dedicated, proprietary software runs millions of possible breeding combinations to develop a breeding programme that perfectly balances production gains with in-breeding control. This can take into account numerous traits at the same time, such as disease resistance and growth.

5. EVALUATE SECOND GENERATION BROODSTOCK

A new broodstock nucleus is established by crossing the right male and female fish to form a diverse, high potential broodstock for future generations.

6. REPEAT AND OPTIMISE

With every generation production gains should increase faster and faster, as we build up a rich and detailed database of historic performance and real world outcomes. This allows us to further fine tune our calculations, and also to continually refresh and optimise the broodstock.

PICKING THE PROGRAMME THAT'S RIGHT FOR YOU

Simply selecting individual animals on measurable traits (an approach known as "mass selection") can improve performance, however the appearance of a fish alone is not an accurate indicator of its genetic value. This means that gains can be small, or even negative. Even worse, this approach is likely to cause high levels of inbreeding, increased deformities, reduced growth and less fertile fish. There are numerous options for a genetics framework, and Xelect will work with you to decide which approach is right for your scale and priorities.

PEDIGREE SELECTION

Most breeding programmes operate a pedigree (family) selection programme. By measuring traits across a pedigree (family tree) we can calculate an overall breeding value. The rate of genetic gain depends on how much pressure you put on that trait (for example, is it a primary trait of high importance, or a secondary trait?) and what's known as 'heritability' (how much a trait is based on genetic factors, rather than – for example – the environment).

For growth, gains of 10-15% per generations are not uncommon, whilst maintaining inbreeding at low levels.

HIGH DENSITY GENOMIC SELECTION

Genomic selection is a more sophisticated approach, using high numbers of genetic 'markers' located throughout the genome. By genetic analysis of the siblings of selection candidates under production conditions we can develop a genomic prediction model. Genomic selection is particularly useful for destructive traits which can't be measured on broodstock candidates. By testing selection candidates at these markers we can predict their breeding value more accurately than with pedigree selection. Genomic selection can be used to select the best individuals from a broad range of families, giving even more genetic diversity to work with. Genomic selection is regarded as the "gold standard" for advanced breeding programmes and can result in up to 20% greater selection accuracy. However it is typically best suited to larger scale breeding programmes for major producers.

SMART GENOMICS

Xelect have partnered with the world famous Roslin Institute to develop a ground-breaking new approach to bring the benefits of genomic selection to all producers.
With this new technique parents are analysed with powerful, high density panels of genetic markers, but future generations can be genotyped at a lower density, using powerful algorithms to predict breeding values. We are one of the first companies to offer this commercially, and whilst we can't share precise figures for existing customers (due to client confidentiality) we are delivering a high proportion of the gains of tratiditional high density genomic selection for a fraction of the cost.

WANT TO START SIMPLE?
GENEXPERTISE

Even if you're not yet ready for a long-term genetics programme you still need to protect and nurture your broodstock.

GeneXpertise is a quick, simple and affordable way to give your broodstock a boost. We've created a full suite of genetic tools just for trout, and it's a is a great way to kick start your production and safeguard your future, for only a modest investment. We'll analyse up to 475 of your broodstock and then provide you with the practical guidance you need, whether it's getting a heads up on the genetic health of your population or providing you with an initial plan of which crosses to make, and which to avoid. The whole service takes just a few weeks from start to finish.

The one-stop genetic healthcheck includes:

- Expert advice and guidance for your team, including a confidential review of your operation
- A detailed report on the genetics and inbreeding levels for your broodstock
- Practical, profitable recommendations
- Access to our experts.

Find out more at **www.xelect.co.uk/genexpertise**

LABORATORY SERVICES FOR TROUT PRODUCERS

As well as breeding programmes we also offer a range of laboratory and consultancy services to support trout producers of all sizes.

PLOIDY DETERMINATION

Our 24-hour service is valuable for fish breeders looking to improve their processes or to certify their product, and for farms looking to check the quality of supplies. When we receive eggs or tissue samples we can issue a next day Certificate of Ploidy.

SEX DETERMINATION

We can provide rapid sex determination from fertilised ova to adult fish - an excellent way to manage stock control and check supplier quality. Results are usually within 10 days.

GENOTYPING AND RELATEDNESS ANALYSIS

By analysing your broodstock we can help you avoid problems associated with inbreeding and support you with the long-term sustainability of your breeding programme.

XELECT'S MISSION

Xelect is trusted by major producers globally to manage their breeding programmes and to provide critical support services. We don't offer off-the-shelf breeding solutions. Our programmes are completely tailored to the needs of each customer, and delivered in-house to make sure results are on time, every time.

We have designed and managed genetic improvement programmes for 14 species of fish, 2 species of shrimp and Pacific oyster for leading production companies across the Americas, Europe, Africa, SE Asia and Oceania. Our scientific team comprises 13 PhDs with extensive work experience in aquaculture, quantitative genetics, molecular biology, physiology and bioinformatics. Xelect has genetic marker IP and best in class proprietary genetics software.

We work closely with our clients to produce faster growth, increased yield, greater disease resistance, premium traits and more sustainable breeding programmes. From our state-of-the-art laboratory in St Andrews, Scotland we can work internationally with all species of fish, shrimp and shellfish.

Whether you're looking for an extensive breeding program to create a premium product, or just looking for some advice and guidance Xelect can help.

www.xelect-genetics.com
info@xelect.co.uk
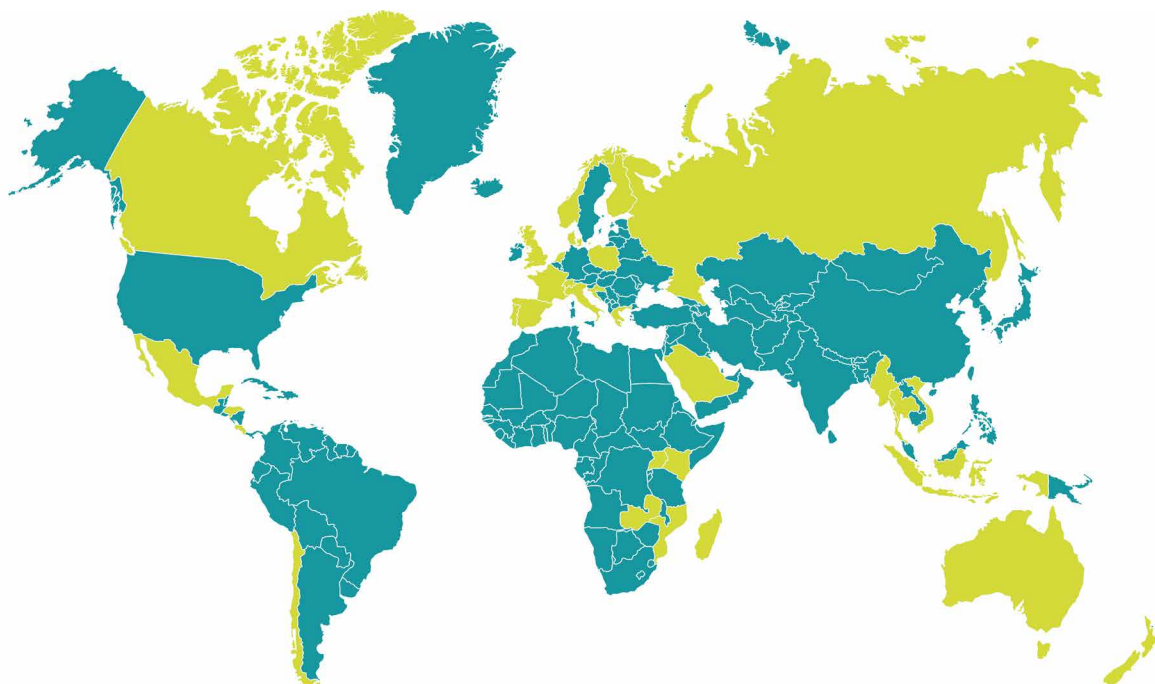
WHAT OUR CUSTOMERS SAY:

OVERALL VALUE
FOR MONEY

QUALITY OF OUR BREEDING
PROGRAMME MANAGERS

OVERALL QUALITY OF
OUR SERVICE

XELECT

GENETIC SOLUTIONS FOR AQUACULTURE