

## Curso de Capacitación

“ Doce (12) puntos de verificación para la vigilancia de enfermedades en organismos acuáticos: una nueva aproximación para asistir equipos multidisciplinarios en países en desarrollo ”



Organización de las Naciones Unidas para la Alimentación y la Agricultura

**ICA**  
Instituto Colombiano Agropecuario



## SESIÓN 9. Lista de chequeo 12 Vigilancia en un marco global

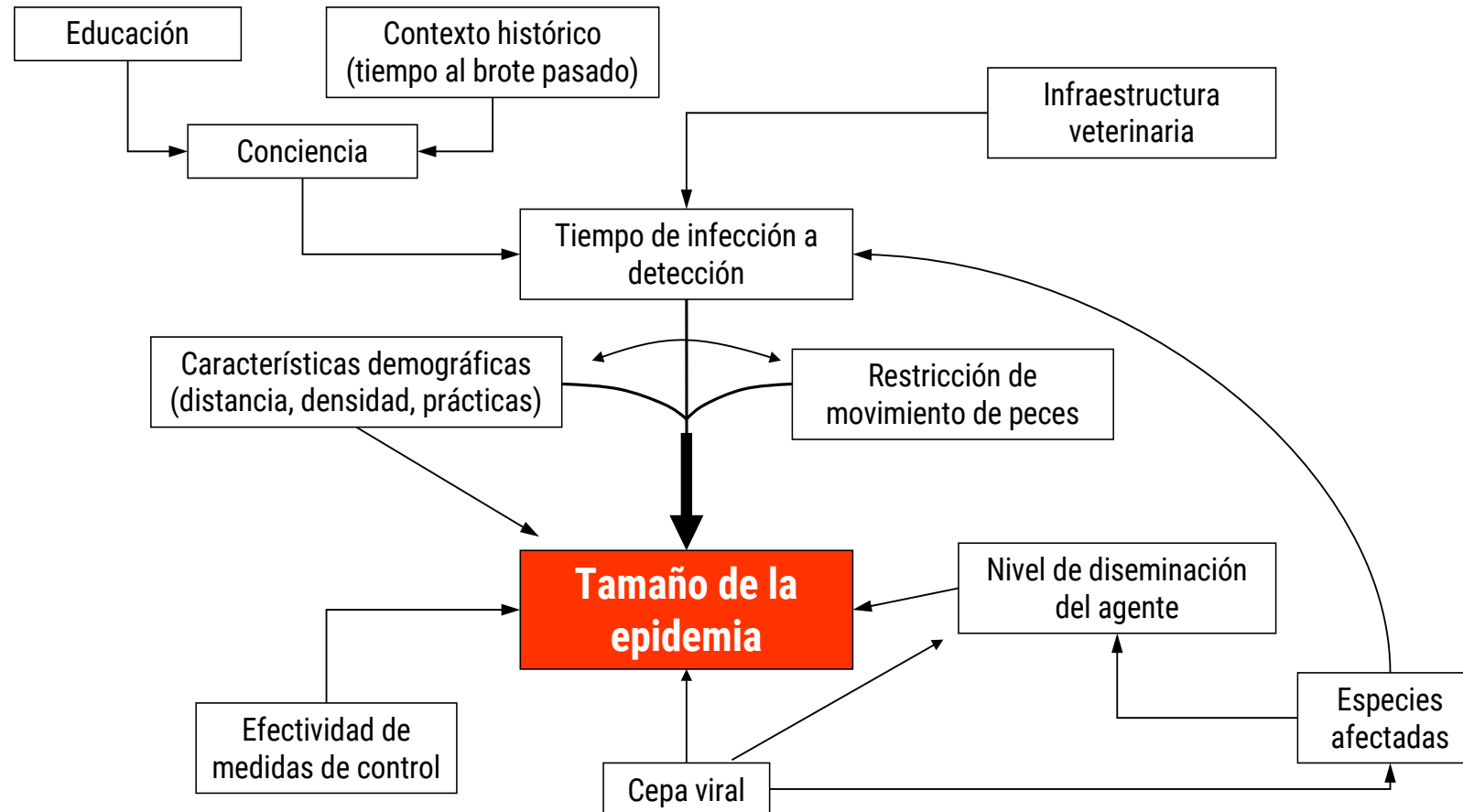
Fernando Mardones  
[femardones@uc.cl](mailto:femardones@uc.cl)

# Lista de chequeo 12

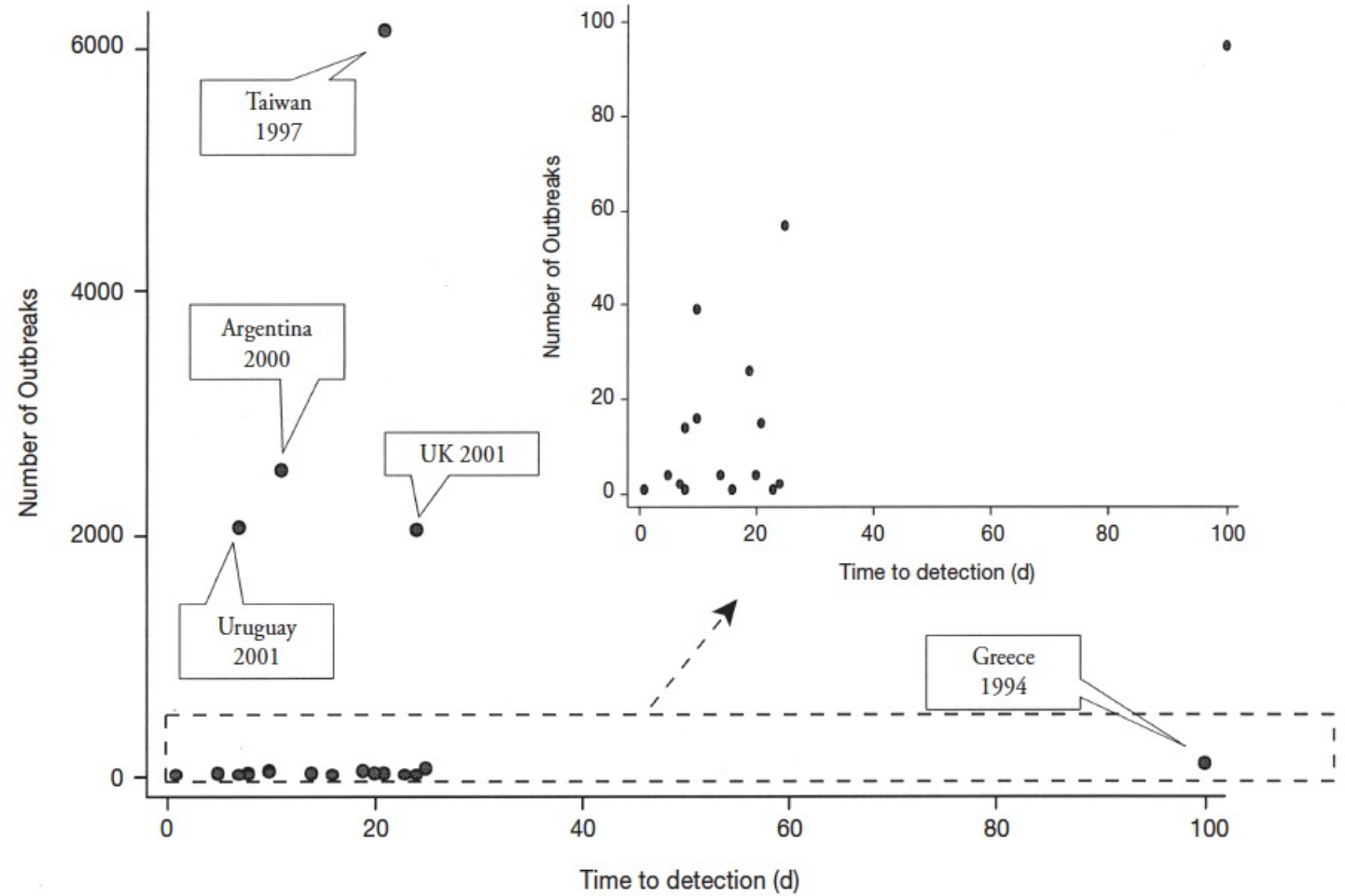
## Vigilancia en un marco global

- Hemos visto que la vigilancia es un componente esencial en la salud de organismos acuáticos.
- Impacta la bioseguridad de las granjas, favoreciendo decisiones con respecto a sus estrategias.
- Esencial para establecer planes de manejo y control.
- Componente esencial bajo el concepto de “Una Salud”, “Salud Planetaria” y Objetivos de Desarrollo Sostenible de las Naciones Unidas.

# Relevancia de la vigilancia y el tamaño de una epidemia



# Importancia de la detección temprana Fiebre Aftosa



McLaws & Riddle, 2007 Can Vet J 48:1051-62



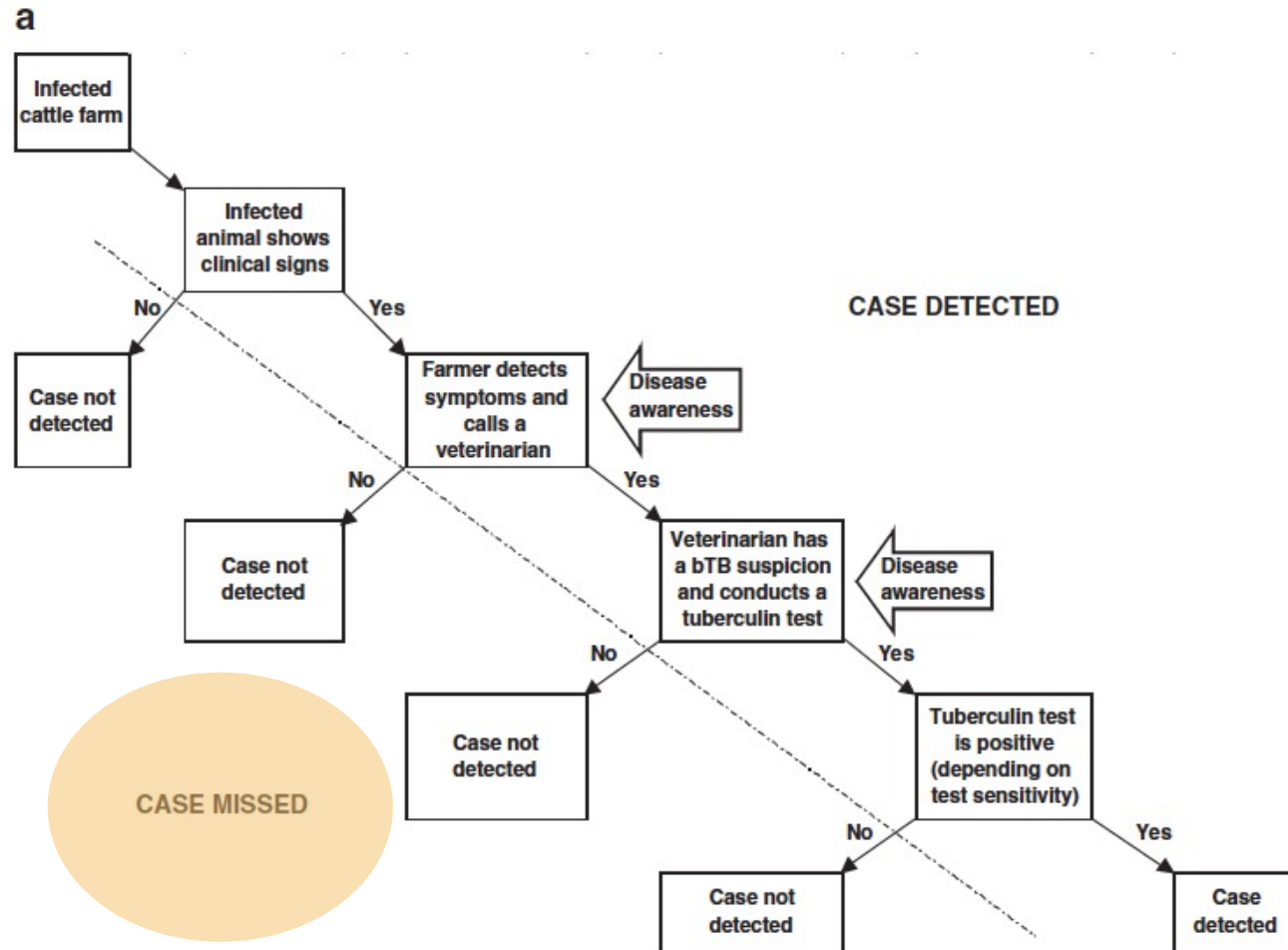
Organización de las Naciones  
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y la Agricultura



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# Eventos para la detección de casos

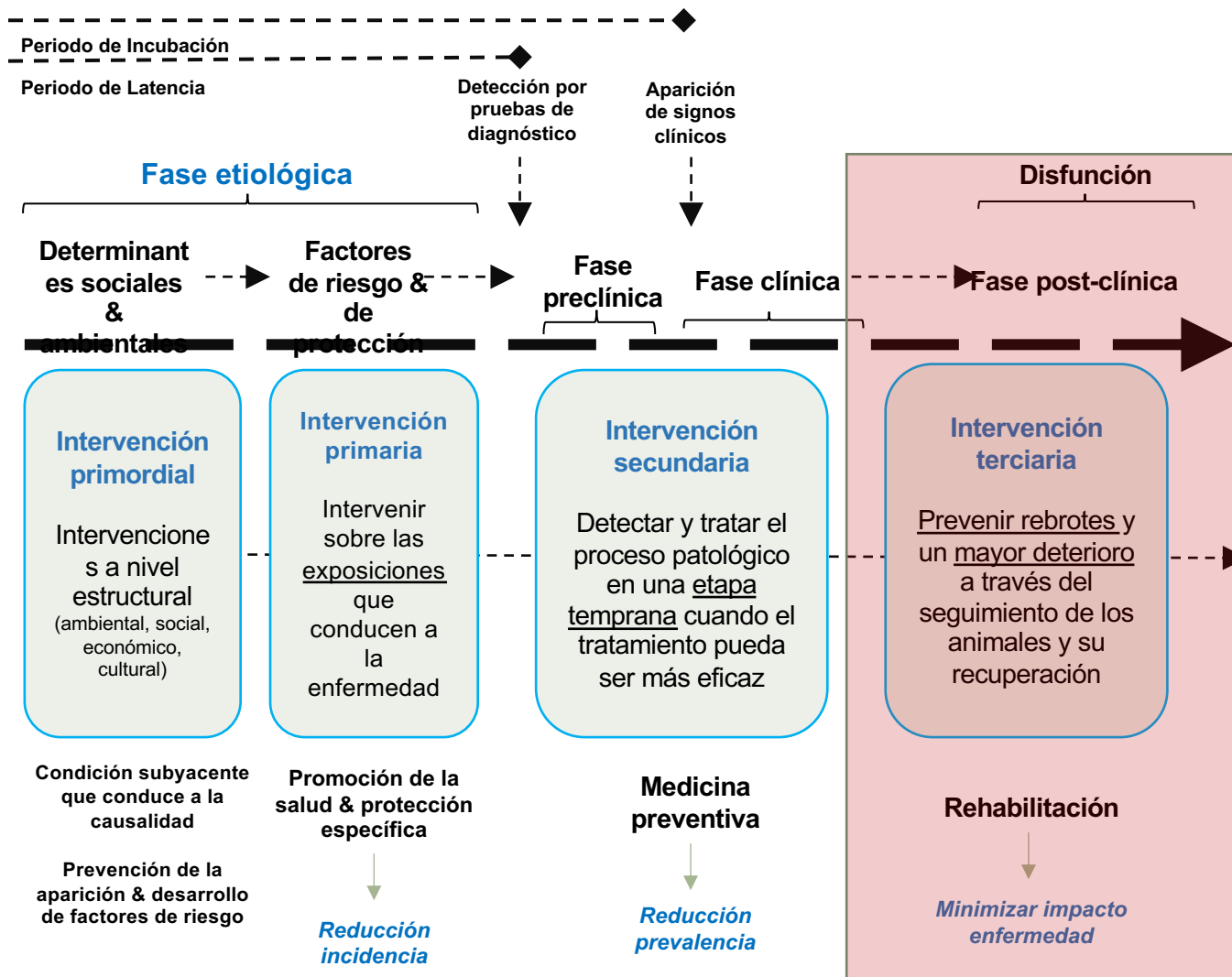
Hadorn and Stark, 2008 Vet. Res. 39:57



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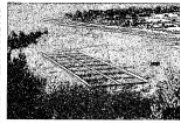
A fisherman and his boat in Puerto Montt, Chile, where he fishes salmon and sells it to a fish market for export to Japan, Europe and America.

### Virus Kills Chile's Salmon and Indicts Its Fishing Methods

**By ALEXEY BARRIONUEVO**  
SANTIAGO, Chile — A disease problem reminiscent of an ecological lack of control in salmon farming, said the World Bank, is now threatening the industry in Chile. A lack of oversight in the industry, the bank says, is the main reason why the salmon industry in Chile is in a state of crisis. The bank says that the industry is heavily dependent on antibiotics, which has allowed harmful strains of bacteria to build immunity, and Chilean harvest close proximity and frequently over-crowded fish pens have led to the rapid spread of the disease.

As a result, Chile's share of global salmon production is expected to fall to 20% in 2010 from 35% in 2006, according to a recent study by the Chilean Association of Banks.

The virus first hit Chile in 2007 but worsened late last year. It comes at a bad time for Chile's



Salmon pens in the Gulf of Reloncavi, Chile, are blamed for water pollution and potentially unhealthy fish.

THE WALL STREET JOURNAL  
Big Salmon Exporter Fights Virus --- Chile's Share of Global Output Expected to Fall; Pickup Unlikely Until 2011  
Risa Grais-Targow Wall Street Journal, (Eastern edition), New York, N.Y., July 7, 2009, pg. B 6

## Big Salmon Exporter Fights Virus

Chile's Share of Global Output Expected to Fall; Pickup Unlikely Until 2011

**By RISA GRAIS-TARGOW**  
SANTIAGO—A virus is crippling Chile's famed salmon industry, dumping exports and squeezing fish producers.

Chile is currently the world's second-largest exporter of salmon and trout, with salmon exports of a record \$2.4 billion in 2008. But producers with infected salmon can't harvest until the virus is eliminated from their farms. As a result, reports have begun to fall and are likely to decline even more in 2010. The harvest cycle typically takes two years, so the industry isn't expected to pick up until 2011.

The fish virus—infectious salmon anemia—is a continuing threat to big fish farms the world over. Norway, the world's largest salmon producer where the disease originated in the 1980s, has implemented measures to control it, including vaccines and limiting fish numbers. But Chile's industry is heavily reliant on antibiotics, which has allowed harmful strains of bacteria to build immunity, and Chilean harvest close proximity and frequently over-crowded fish pens have led to the rapid spread of the disease.

As a result, Chile's share of global salmon production is expected to fall to 20% in 2010 from 35% in 2006, according to a recent study by the Chilean Association of Banks.

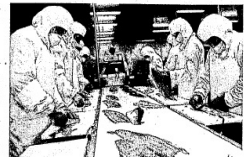
The virus first hit Chile in 2007 but worsened late last year. It comes at a bad time for Chile's



Chile is currently the world's second-largest exporter of salmon and trout. Above, farmed salmon cages in southern Chile; right, workers process farmed salmon fillets.

...and that guarantees cooperation to the banks with producers' water and farming rights if producers are unable to repay their debts.

This is a drastic re-design of the way we produce," Salmon-Chile President Cesar Barros says, as the requirements are ex-



nature International weekly journal of science

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Archive | Volume 465 | Issue 7300 | Correspondence | Opinions | Article

NATURE | CORRESPONDENCE | OPINION

## Call for cooperation to contain damage by Chile's salmon farms

Heike Vester & Marc Timme

Affiliations

Nature 465, 869 (17 June 2010) | doi:10.1038/465869d  
Published online 16 June 2010

### Science News

## Impacts of Chilean Salmon Farms On Coastal Ecosystem Discovered Accidentally

ScienceDaily (June 22, 2010) — Until recently, the disastrous scale of the threat posed by salmon farms to the fauna and National Park of the Aysén region of southern Chile was entirely unknown. The unexpected discovery was made by researchers from the Max Planck Institute for Dynamics and Self-Organization and the University of Göttingen, who were studying acoustic communication among the native whales in the region. The researchers not only discovered that the salmon industry is rapidly spreading to the hitherto largely unspoiled south of the region; they also documented the previously unknown threat to the region's native sea lions.



This is an abandoned salmon farm in a fjord north of the Aysén region of Chile. (Credit: Image: Heike Vester, MPI for Dynamics and Self-Organization)



## Norwegians Concede a Role In Chilean Salmon Virus

**By ALEXEY BARRIONUEVO**  
SÃO PAULO, Brazil — A virus that has killed millions of salmon in Chile and ravaged the fish farming industry there was probably brought over from Norway, a major salmon producer has acknowledged.

Cermaq, a state-controlled Norwegian aquaculture company that has become one of the principal exporters of salmon from Chile, has endorsed a scientific study concluding that salmon eggs shipped from Norway to Chile are the "likely rascals" for the outbreak of the virus in 2007, according to Lise Bergan, a company spokeswoman.

But, she argued, "the report didn't pinpoint any company" as the culprit.

The virus, infectious salmon anemia, or ISA, was first reported at a Chilean salmon farm owned by Marine Harvest, another Norwegian company. It quickly spread through southern Chile, racking a fishing business that had become one of the country's major exporters during the past 15 years. The Chilean industry, whose major clients include the United States and Brazil, suffered more than \$2 billion in losses, saw its production of Atlantic salmon fall by half and had to lay off 24,000 workers.

The outbreak in Chile also revealed structural problems within the industry, including over-crowding in pens that environmentalists say probably helped speed the spread of the virus. Since then, the industry and the Chilean government have instituted a wide range of reforms to try to contain outbreaks, but despite extensive efforts to rein it in the virus continues to spread.

Last week, Chilean authorities said 33 production centers were

Patrick Dempster, general manager of Aqua Gen in Chile, said that Aqua Gen complained about the study because in 2010 they became the principal exporter of salmon eggs to Chile and were worried about losing business over concern about any vertical transmission connection with Norway.

The commission ruled on April 6 that there had been no scientific misconduct, clearing the three authors from the University of Bergen. Mr. Dempster said Aqua Gen stood by a study from the University of Prince Edward Island that concluded that the virus most likely entered Chile in 1996, when Aqua Gen was not exporting fish eggs to Chile. He noted that between 1996 and 2007 "a multitude" of Chilean and Norwegian companies sent eggs from Norway to Chile.

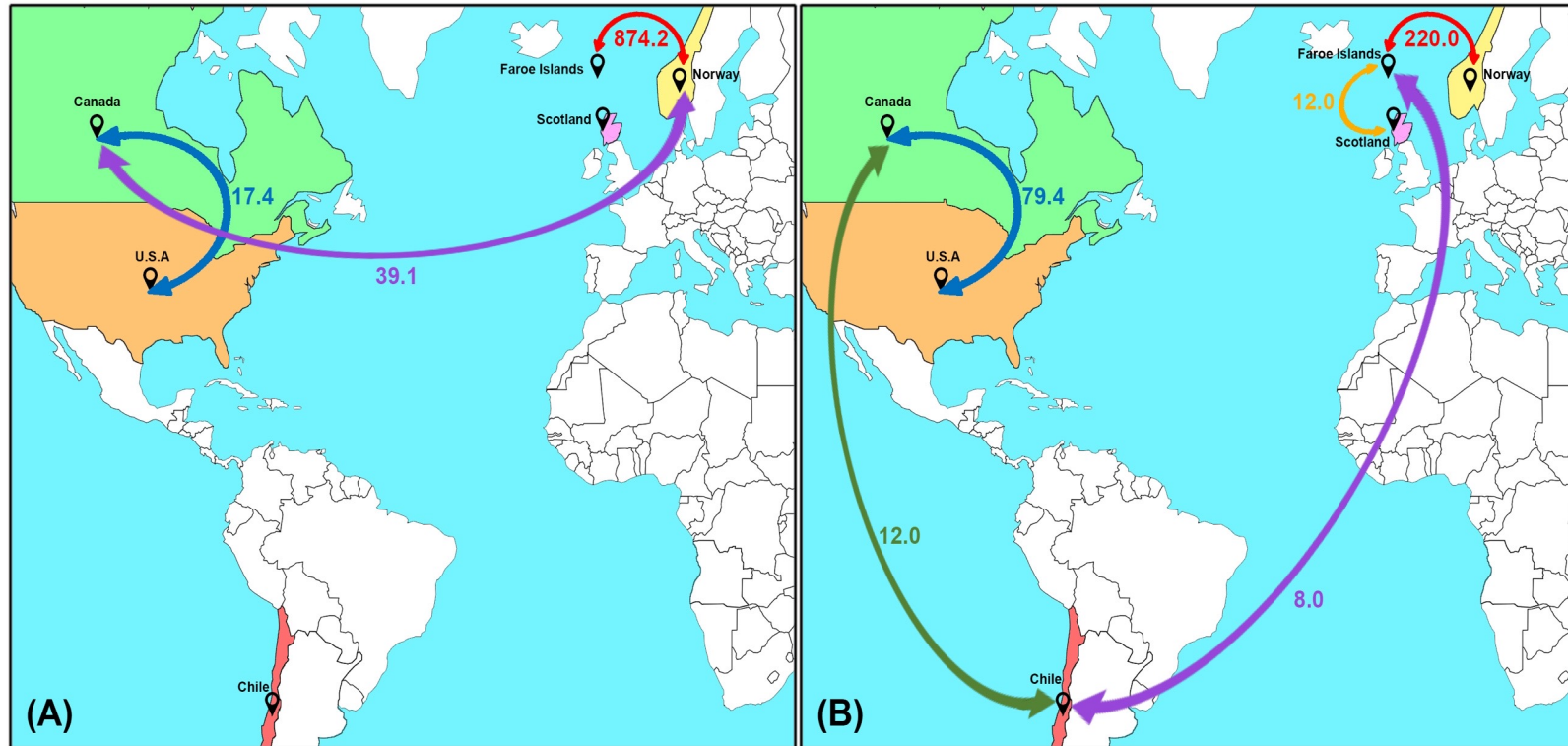
"We initiated that research because we wanted to understand how ISA was transmitted," Mr. Bergan said. "Before that, the scientific consensus" was that the virus "could not be transmitted by eggs."

But while Cermaq has accepted the study's findings, Chile's own National Fishing Service, Serapesca, said it did not necessarily support them. Instead, Serapesca referred to the conclusion of the World Organization for Animal Health, which has

An outbreak in 2007 revealed structural problems in the farmed-fish industry.



# Rutas de dispersión del virus ISA



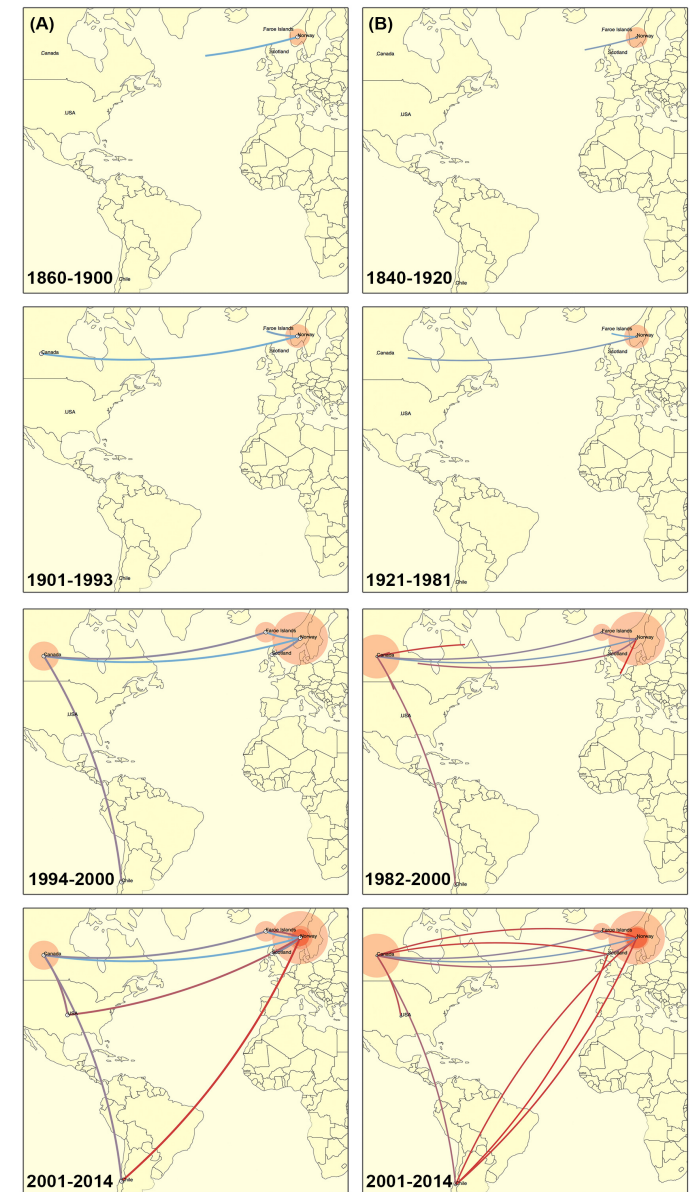
*Mardones et al 2021 (internal review) used Bayesian stochastic search variable selection (BSSVS) to fit phylogeographic models to the FP gene (A) and HE gene (B) sequence dataset and inferred geographic connections (transmission routes) using Bayes factors (BF).*



# Dispersión ISAv espacio-temporal

- Desde 1860 a 2014 a partir del gen FP (A)
- Desde 1840 a 2014 a partir del gen HE (B)

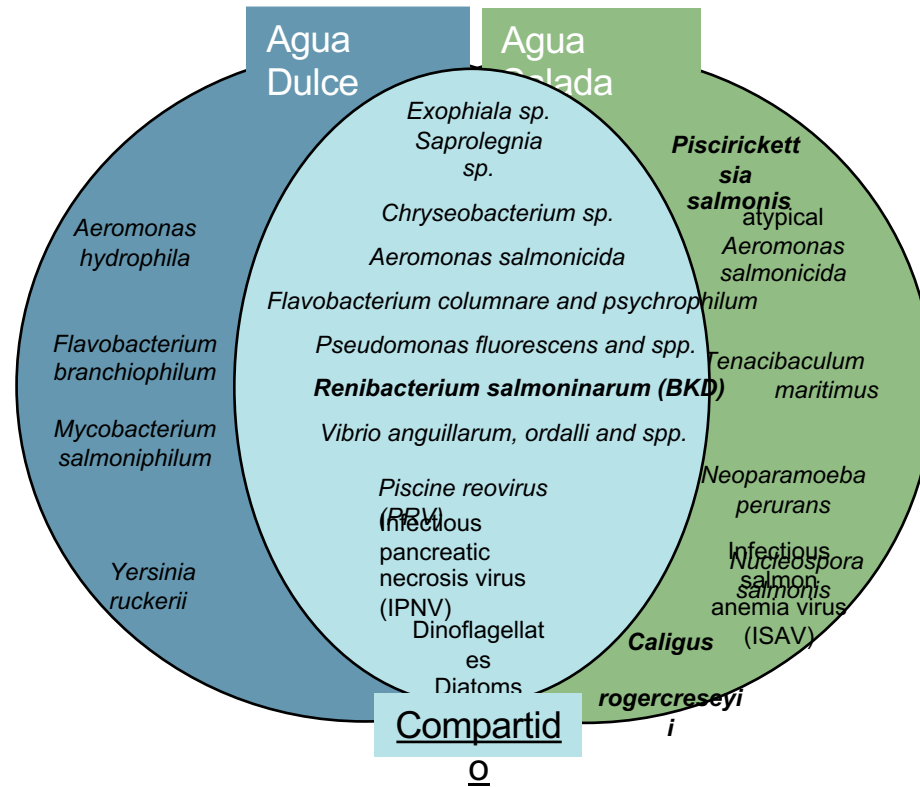
Global maximum clade credibility (MCC) phylogenies of FP and HE gene of ISA virus annotated with spatial discrete traits shown at intervals of years onwards.



# Patógenos en la Industria del salmón de Chile

27 patógenos identificados en la Industria

(Reportes de Vigilancia Epidemiológica, Sernapesca 2015)

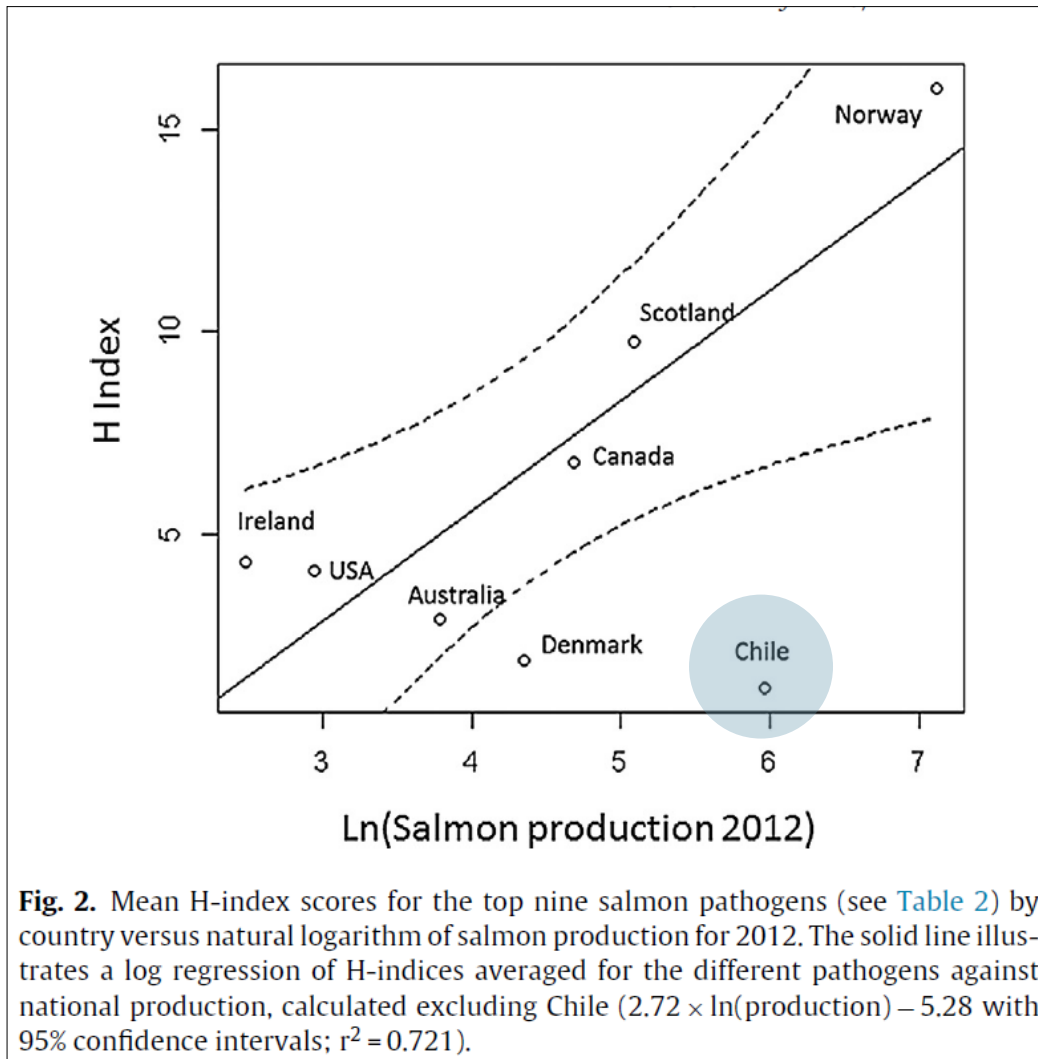


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# Producción salmón vs Producción Científica



Preventive Veterinary Medicine 126 (2016) 199–207

Contents lists available at ScienceDirect

**Preventive Veterinary Medicine**

journal homepage: [www.elsevier.com/locate/prevetmed](http://www.elsevier.com/locate/prevetmed)

Using the H-index to assess disease priorities for salmon aquaculture

Alexander G. Murray<sup>a,\*</sup>, Maya Wardeh<sup>b,c</sup>, K. Marie McIntyre<sup>b,c</sup>

<sup>a</sup> Marine Laboratory Marine Scotland Science, 375 Victoria Road, Aberdeen AB11 9DB, UK  
<sup>b</sup> Health Protection Research Unit in Emerging and Zoonotic Infections, University of Liverpool, L69 7BE, UK  
<sup>c</sup> Department of Epidemiology and Population Health, Institute of Infection and Global Health, University of Liverpool, Leahurst Campus, Chester High Road, Neston, Cheshire CH64 7TE, UK

# Vacíos en el conocimiento

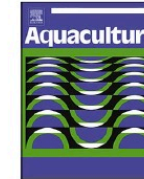
Aquaculture 482 (2018) 211–220



Contents lists available at ScienceDirect

Aquaculture

journal homepage: [www.elsevier.com/locate/aquaculture](http://www.elsevier.com/locate/aquaculture)



Identification of research gaps for highly infectious diseases in aquaculture:  
The case of the endemic *Piscirickettsia salmonis* in the Chilean salmon  
farming industry



Fernando O. Mardones<sup>a,\*,1</sup>, Felipe Paredes<sup>b,c,1</sup>, Matías Medina<sup>d</sup>, Alfredo Tello<sup>e</sup>, Victor Valdivia<sup>b</sup>,  
Rolando Ibarra<sup>e</sup>, Juan Correa<sup>f</sup>, Stefan Gelcich<sup>b,f,\*,1</sup>

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<sup>b</sup> Center for Applied Ecology and Sustainability (CAPES), Pontificia Universidad Católica de Chile (PUC), Santiago, Chile

<sup>c</sup> Departamento de Areas Protegidas, Ministerio de Medio Ambiente, Santiago, Chile

<sup>d</sup> Blue Genomics Chile, San Francisco 328, Puerto Varas, Chile

<sup>e</sup> Instituto Tecnológico del Salmón (INTESAL de SalmonChile), Av. Juan Soler Manfredini 41, OF 1802 Puerto Montt, Chile

<sup>f</sup> Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile (PUC), Santiago, Chile

industry of those countries are less detrimental than in Chile. Based on a comprehensive literature review and a participatory priority-setting workshop with key stakeholders, we show how science-based research on SRS has evolved over time and identify 8 main research areas which should be addressed. These areas, termed epidemiology, ecology and environmental science, microbiology, immunology, pharmacology, “Omics”, human dimensions and vaccine development include a set of 52 specific research questions to be tackled. These research



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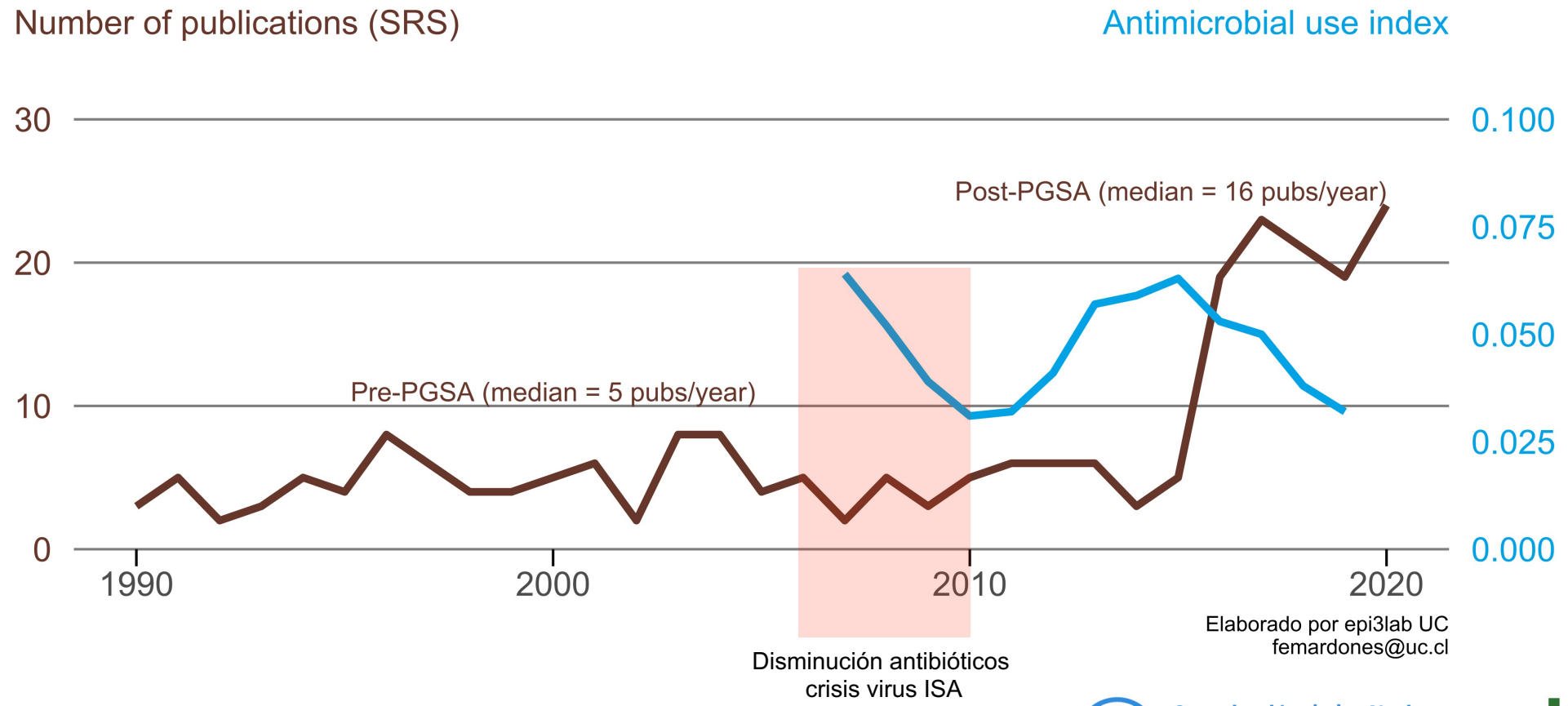


# Fondo de Inversión Estratégica


## \$22 M USD



# Relación Información científica vs consumo de antimicrobianos



Elaborado por epi3lab UC  
femardones@uc.cl

ORIGINAL ARTICLE  WILEY

### Cost-effectiveness of longitudinal surveillance for *Piscirickettsia salmonis* using qPCR in Atlantic salmon farms (*Salmo salar*) in Chile

Marina K. V. C. Delphino<sup>1</sup> | Fernando O. Mardones<sup>2</sup> | Joaquin Neumann Heise<sup>2</sup> | Alicia Gallardo<sup>3</sup> | Daniel Jimenez<sup>4</sup> | Andrea Peña<sup>5</sup> | Marco Rozas-Serri<sup>6</sup> | Ian A. Gardner<sup>1</sup>

Preventive Veterinary Medicine 137 (2017) 147–156

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: [www.elsevier.com/locate/prevetmed](http://www.elsevier.com/locate/prevetmed)

Veterinary epidemiology: Forging a path toward one health

Fernando O. Mardones<sup>\*,1</sup>, Marta Hernandez-Jover<sup>1</sup>, John A. Berezowski<sup>1</sup>, Ann Lindberg<sup>1</sup>, Jonna A.K. Mazet<sup>2</sup>, Roger S. Morris<sup>1</sup>



### Aims/Purpose of aquatic diseases surveillance

- Set with respect to disease
- Set with respect to disease presence
- Set with respect to level of certification
- Set with respect to timeframe




### Quality assurance

- Auditing
- Corrective measures

Received 4 May 2020 | Revised 30 June 2020 | Accepted 2 July 2020

DOI: 10.1016/j.pri.2020.07.002

ORIGINAL ARTICLE  WILEY

Bayesian estimation of diagnostic sensitivity and specificity of a qPCR and a bacteriological culture method for *Piscirickettsia salmonis* in farmed Atlantic salmon (*Salmo salar* L.) in Chile

Emilie Laurin<sup>1</sup> | Ian A. Gardner<sup>2</sup> | Andrea Peña<sup>3</sup> | Marco Rozas-Serri<sup>4</sup> | Jorge Gayosa<sup>5</sup> | Joaquin Neumann Heise<sup>6</sup> | Fernando O. Mardones<sup>7</sup>



# Surveillance 12-point checklist

**14** *Piscirickettsiosis (Piscirickettsia salmonis)*

PEDRO A. SMITH<sup>1\*</sup> AND FERNANDO O. MARDONES<sup>2</sup>

<sup>1</sup>University of Chile, Santiago, Chile; <sup>2</sup>Pontifical Catholic University of Chile, Santiago, Chile

Aquaculture 507 (2019) 402–410

Contents lists available at ScienceDirect

Aquaculture

journal homepage: [www.elsevier.com/locate/aquaculture](http://www.elsevier.com/locate/aquaculture)

Eliciting expert judgements to estimate risk and protective factors for *Piscirickettsiosis* in Chilean salmon farming

Rodrigo A. Estévez<sup>\*,1</sup>, Fernando O. Mardones<sup>2</sup>, Felipe Álamos<sup>3</sup>, Gabriel Arriagada<sup>4</sup>, Jan Carey<sup>5</sup>, Christian Correa<sup>6</sup>, Joaquín Escobar-Dodero<sup>7</sup>, Álvaro Gaete<sup>8</sup>, Alicia Gallardo<sup>9</sup>, Rolando Ibarra<sup>10</sup>, Christian Ortiz<sup>11</sup>, Marco Rozas-Serri<sup>12</sup>, Osvaldo Sandoval<sup>13</sup>, Jaime Santana<sup>14</sup>, Stefan Gelwick<sup>15</sup>



### Data collection and management

- Consistency and quality of data
- Communication and motivation
- Detection of missing, inconsistent or inaccurate records
- Resolution of data
- Minimization transcription errors

### Case and outbreak definition



OIE Aquatic animal health code

**6**

**Preventive medicine of aquatic animals**

Fernando O. Mardones

School of Veterinary Medicine, Pontifical Catholic University, Santiago, Chile



### Diagnostic testing

- Test used (procedures, interpretation of results, Se/Sp)
- Laboratories included

Aquaculture

Volume 529, 15 December 2020, 735739

Effect of sampling time and surveillance strategy on the time to onset and magnitude of *piscirickettsiosis* (*Piscirickettsia salmonis*) outbreaks in Chilean farmed Atlantic salmon

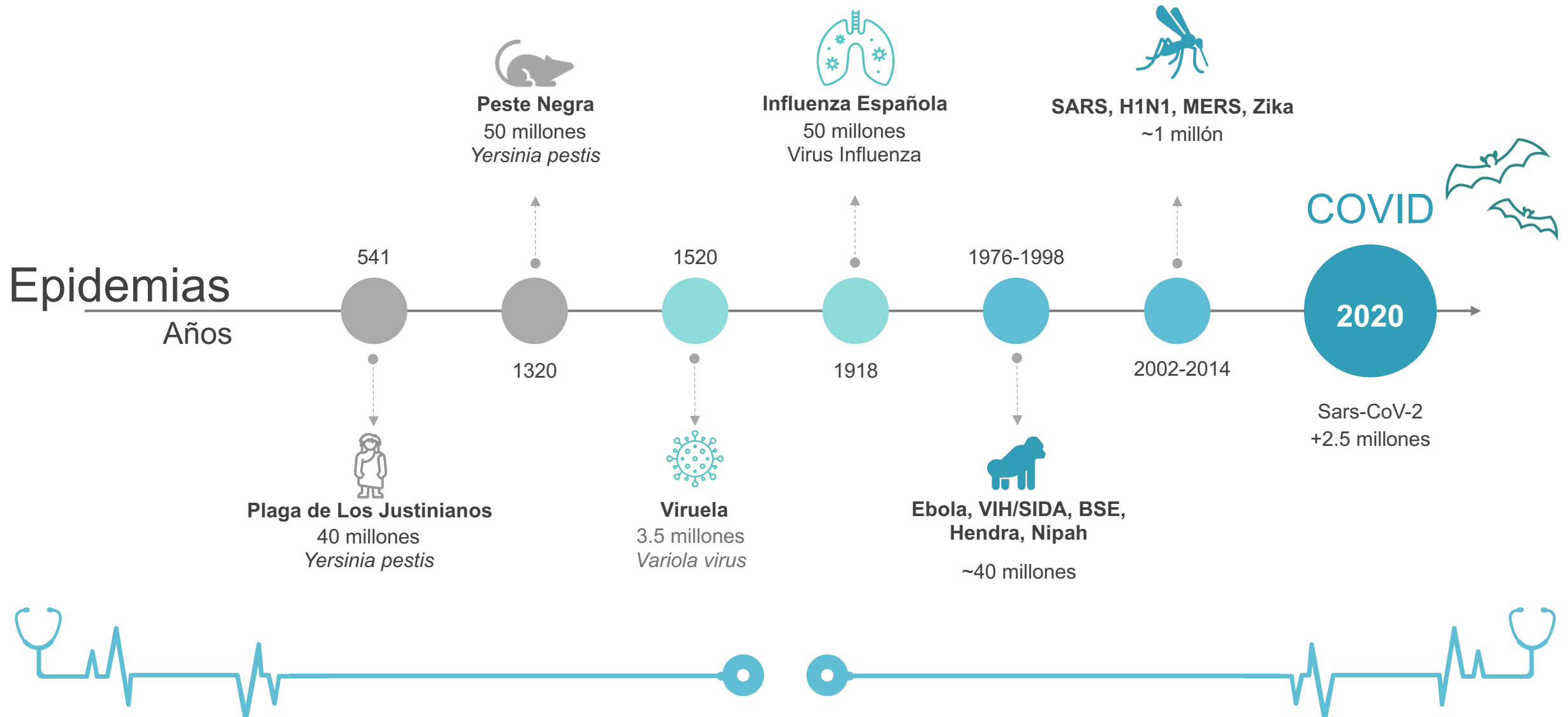
Derek Price<sup>\*,1</sup>, A.R. Emilie Laurin<sup>2</sup>, Fernando O. Mardones<sup>3</sup>, Daniel Jimenez<sup>4</sup>, Marcela Lara<sup>5</sup>, Ian Gardner<sup>6</sup>



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# Era de Epidemias y Pandemias



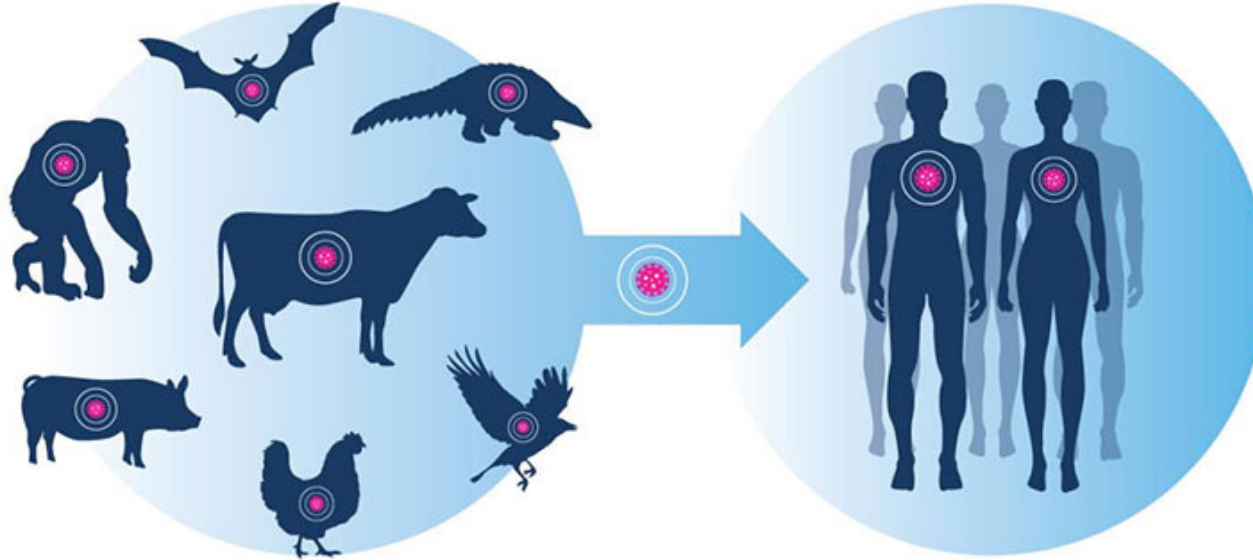


# ENFERMEDADES ZONOTICAS

se diseminan ENTRE  
animales y personas



Las **zoonosis** como COVID-19 son enfermedades que son transmitidas de animales a personas



**75%** de las nuevas enfermedades emergentes son zoonosis

**60%** de las enfermedades infecciosas en humanos son diseminadas por animales

Las zoonosis son responsables de aprox. **2.5 billones de enfermos** y **2.7 millones de muertes** en todo el mundo, cada año.



World  
Organisation  
for Animal  
Health



Taking a Multisectoral, One Health Approach:  
**A Tripartite Guide to Addressing  
Zoonotic Diseases in Countries**



**World Health  
Organization**



**Food and Agriculture  
Organization of the  
United Nations**

# Concepto de “Una Salud”

“Aproximación colaborativa, multisectorial y transdisciplinaria, que trabaja tanto a nivel local, regional, nacional y global, con la meta de alcanzar indicadores óptimos de salud reconociendo la interconexión entre personas, animales, plantas y el ambiente compartido”.

# Relevancia Acuicultura

## Article

# The future of food from the sea

<https://doi.org/10.1038/s41586-020-2616-y>

Received: 19 December 2019

Accepted: 29 June 2020

Published online: 19 August 2020



Check for updates

Christopher Costello<sup>1,2,23</sup>✉, Ling Cao<sup>3,23</sup>✉, Stefan Gelcich<sup>4,5,23</sup>✉, Miguel Á. Cisneros-Mata<sup>6</sup>, Christopher M. Free<sup>1,2</sup>, Halley E. Froehlich<sup>7,8</sup>, Christopher D. Golden<sup>9,10</sup>, Gakushi Ishimura<sup>11,12</sup>, Jason Maier<sup>1</sup>, Ilan Macadam-Somer<sup>1,2</sup>, Tracey Mangin<sup>1,2</sup>, Michael C. Melnychuk<sup>13</sup>, Masanori Miyahara<sup>14</sup>, Carryn L. de Moor<sup>15</sup>, Rosamond Naylor<sup>16,17</sup>, Linda Nøstbakken<sup>18</sup>, Elena Ojea<sup>19</sup>, Erin O'Reilly<sup>1,2</sup>, Ana M. Parma<sup>20</sup>, Andrew J. Plantinga<sup>1,2</sup>, Shakuntala H. Thilsted<sup>21</sup> & Jane Lubchenco<sup>22</sup>

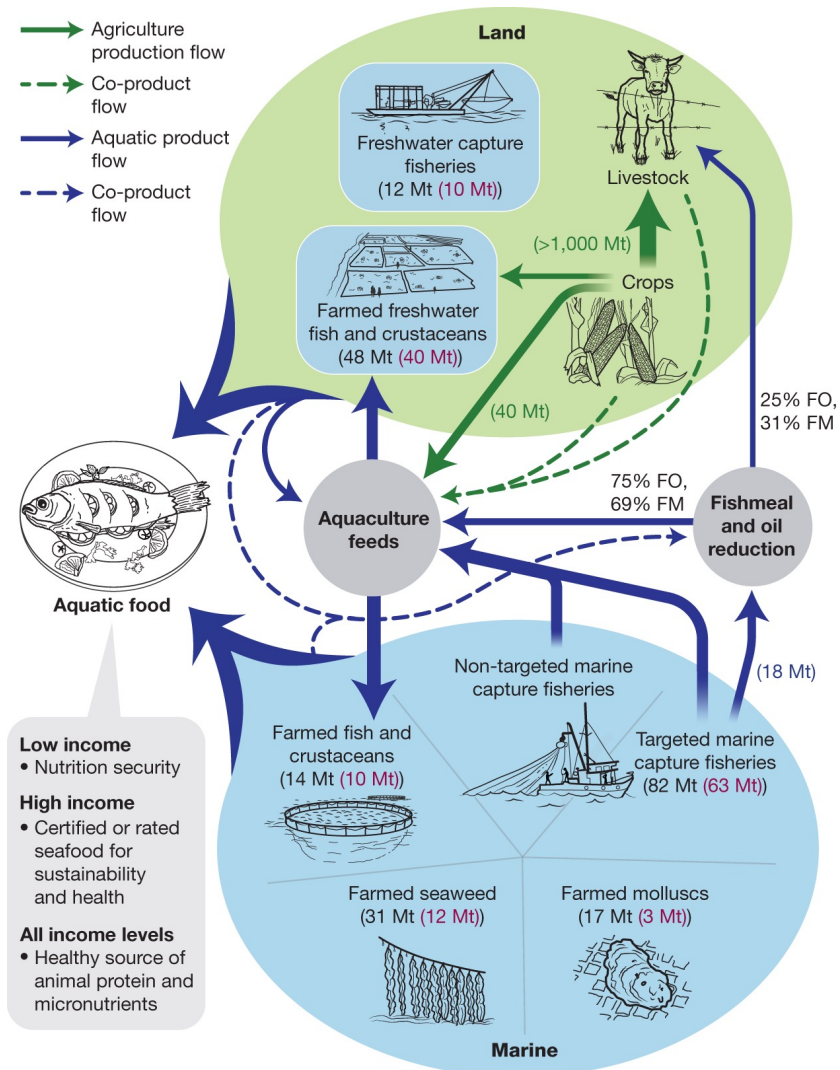


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# Acuicultura Global



- Low income**
- Nutrition security
- High income**
- Certified or rated seafood for sustainability and health
- All income levels**
- Healthy source of animal protein and micronutrients

- Key areas for governance**
- Spillovers between and within sectors**
- Technology transfer from agriculture and livestock farming to aquaculture
- Negative externalities**
- **Land:** Land-use change, biodiversity loss, GHG emissions, nutrient and chemical wastes and/or effluent (pollution), and antibiotic and antimicrobial resistance
  - **Oceans:** Habitat change, biodiversity loss, GHG emissions, nutrient and chemical wastes and/or effluent (pollution), and antibiotic and antimicrobial resistance
- Positive externalities**
- **Oceans:** Ecosystem services (for example, nutrient uptake and habitat from mollusc and seaweed farming)
- Persistent stressors to aquatic food systems**
- Pathogens, parasites and pests
  - Climate change and ocean acidification
  - Harmful algal blooms
  - Pollution

Review Article | Published: 24 March 2021

## A 20-year retrospective review of global aquaculture

Rosamond L. Naylor ✉, Ronald W. Hardy, Alejandro H. Buschmann, Simon R. Bush, Ling Cao, Dane H. Klinger, David C. Little, Jane Lubchenco, Sandra E. Shumway & Max Troell

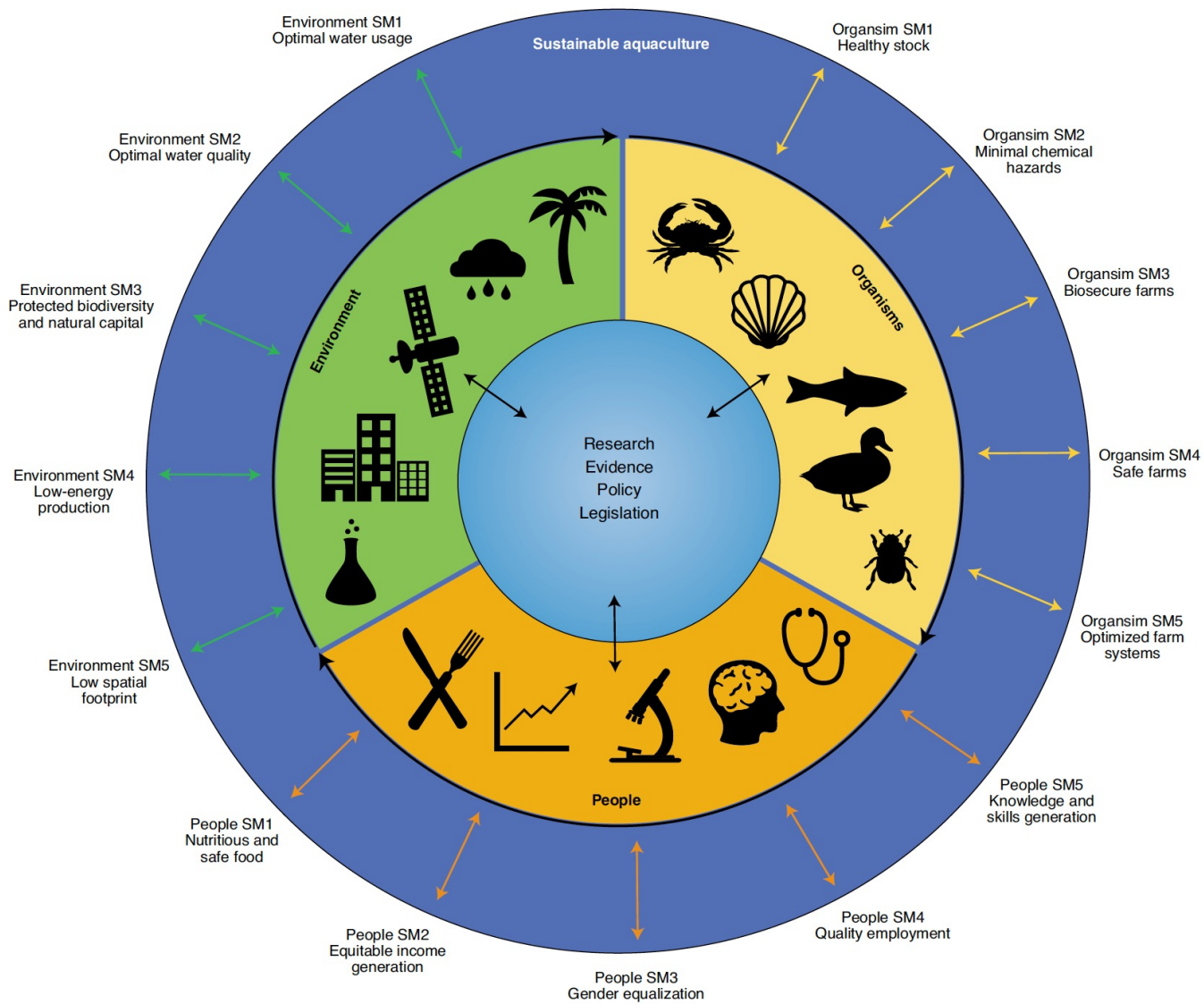
*Nature* 591, 551–563(2021) | [Cite this article](#)



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Stentiford et al., 2020 Sustainable aquaculture through the One Health lens.



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# Temas de **Una Salud** incluyen

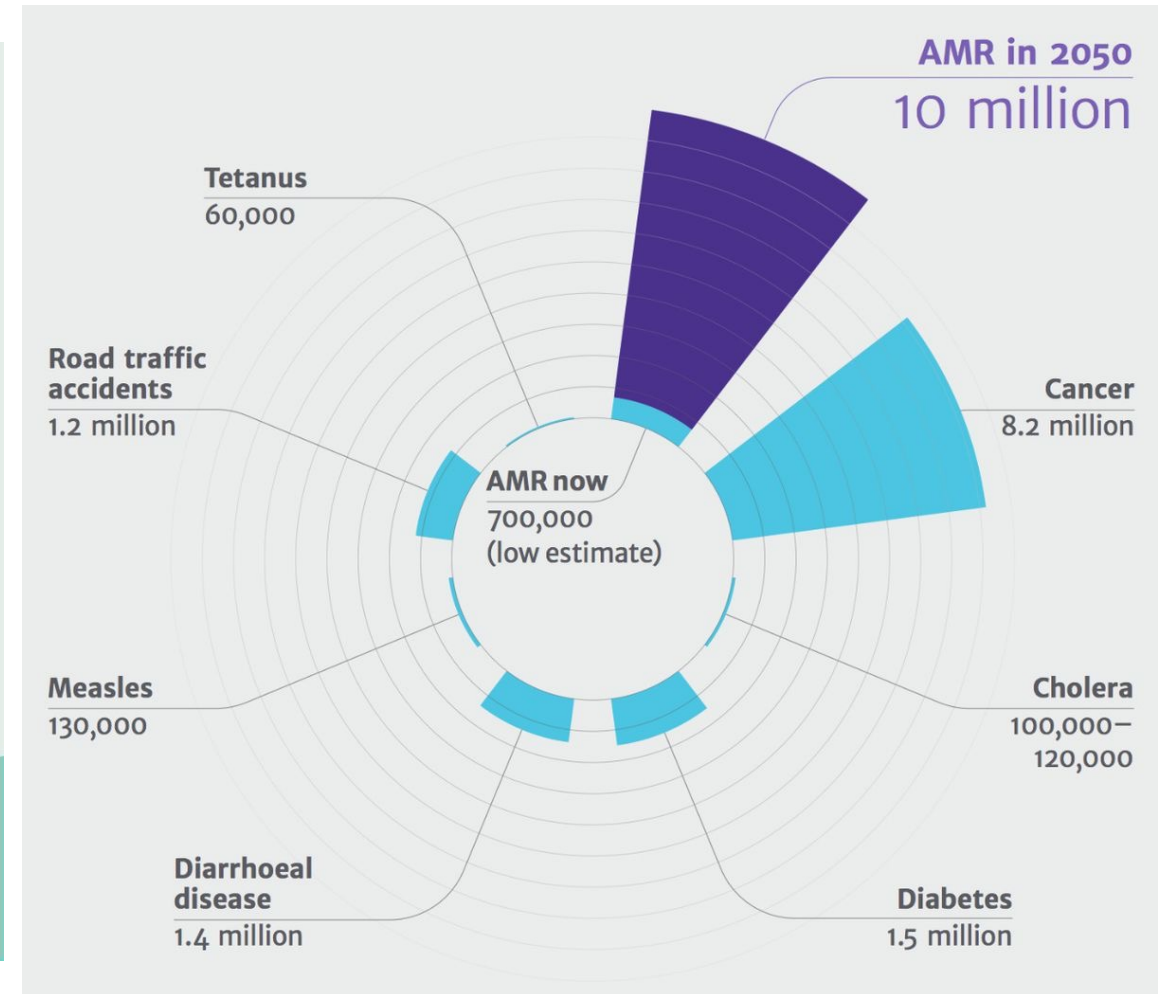
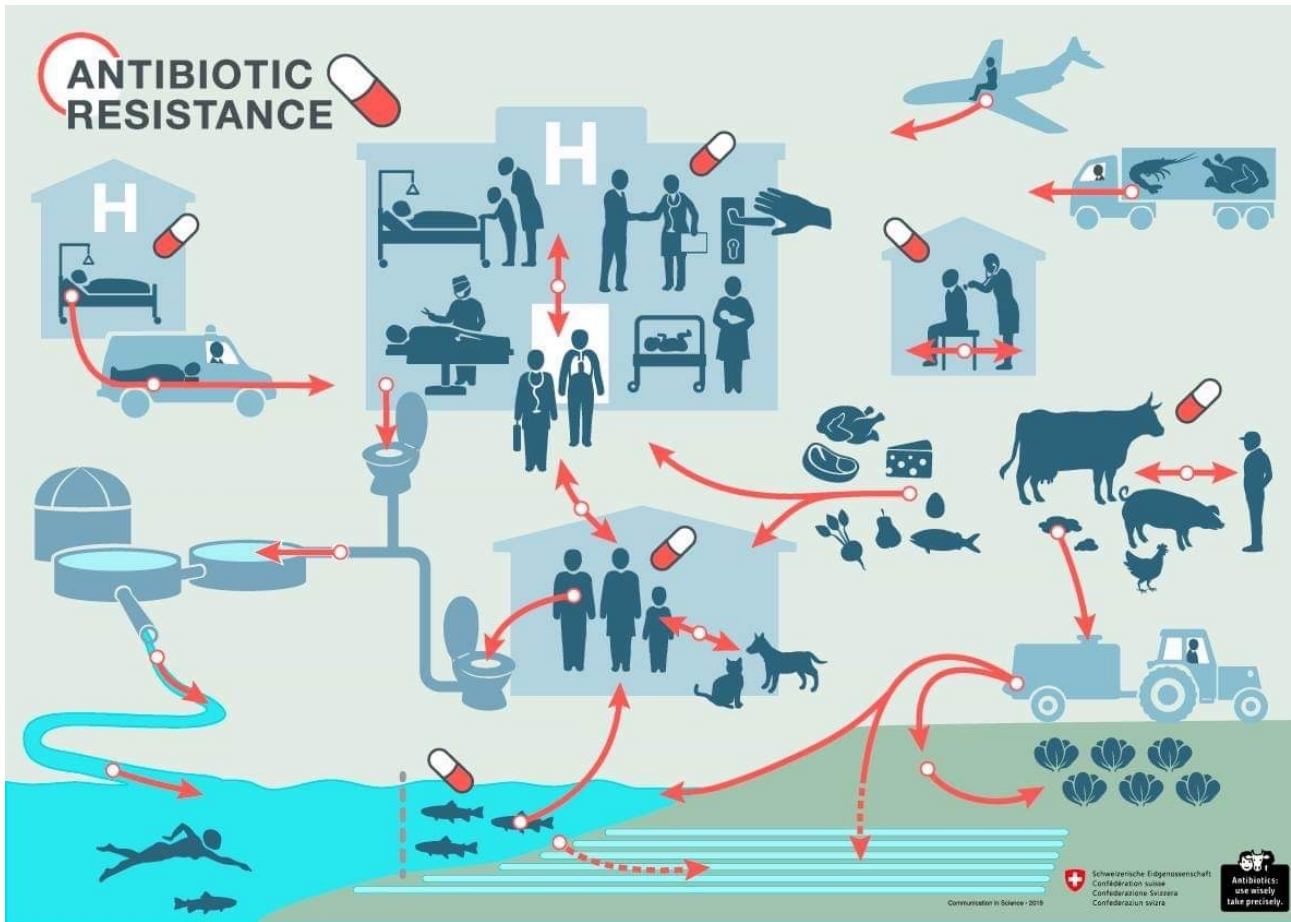
- Enfermedades zoonóticas
  - Resistencia antimicrobiana
  - Inocuidad y seguridad de los alimentos
  - Enfermedades transmitidas por vectores
  - Salud medioambiental
  - Enfermedades crónicas
  - Salud mental
  - Salud ocupacional
- Y muchas más!



Adaptado de CDC



# Resistencia Antimicrobiana



O'Neill 2014

# Metas y Objetivos de Desarrollo Sostenible



Organización de las Naciones Unidas para la Alimentación y la Agricultura



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# Metas y Objetivos de Desarrollo Sostenible



Organización de las Naciones Unidas para la Alimentación y la Agricultura



Instituto Colombiano Agropecuario

Próximo 30 de Marzo, 2021



**FSE** Center on Food Security and the Environment

Institute of Aquaculture  
UNIVERSITY of STIRLING

The Big Fish Series

Is Aquaculture Breaking Into the Global Food System?

Tuesday 30th March 13:00-14:00 (BST)



Organización de las Naciones Unidas para la Alimentación y la Agricultura



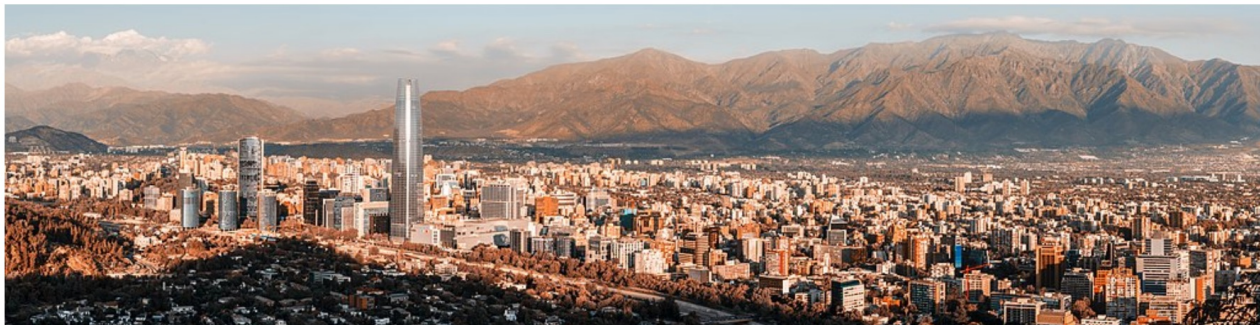
Instituto Colombiano Agropecuario

## ISAAH

Every four years, the Fish Health Section of the American Fisheries Society (FHS) expands its annual meeting by inviting international participation in the form of The **International Symposium on Aquatic Animal Health (ISAAH)**.

The symposium is broad in scientific scope, geographic range, and impact to the aquatic animal health community worldwide. Previous meetings have drawn aquatic animal health professional from across the globe. The inaugural ISAAH took place in 1988 on the west coast of North America in Vancouver, Canada. Subsequent meetings have all taken place in the US until the meeting in 2018 which was held on the east coast of Canada in Prince Edward Island.

### 2022 ISAAH, SEPTEMBER 4–8, SANTIAGO, CHILE



<https://units.fisheries.org/fhs/isaah/>



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