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Emerging trends and research needs in aquaculture

JRC - IPSC - Maritime Affairs Unit

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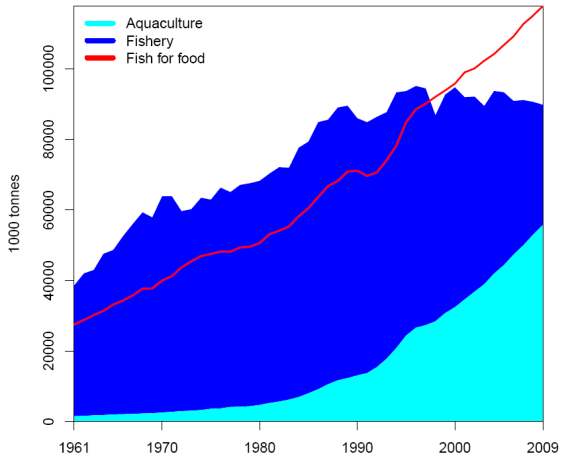
http://fishreg.jrc.ec.europa.eu/

Summary

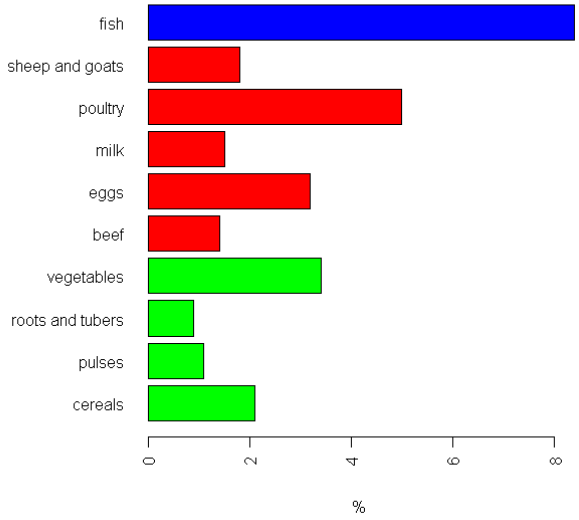
- Achievements and challenges for research on aquaculture
- EU funded research on aquaculture
- A bibliometric study of aquaculture literature

The “blue revolution”

- Limited margin of growth for fishery
- 46% of fish for food from aquaculture



- 8.5% growth rate



Genetics

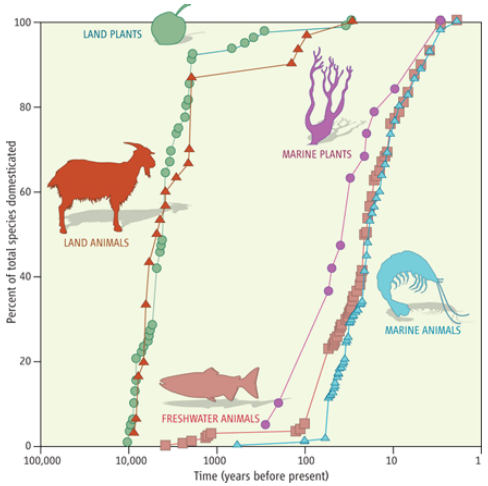
- Higher response to selection for growth than in livestock
  - Higher genetic variance
  - High fecundity
  - Short generation time

Species	Mean weight	No. of generations	Gain per generation (%)	Reference
Coho salmon, *Oncorhynchus kisutch*	250 g	4	10.1	Hershberger et al. (1990)
Rainbow trout, *Oncorhynchus mykiss*	4.0 kg	2	13.0	Gjerde (1986)
Atlantic salmon, *Salmo salar*	4.5 kg	1	14.4	Gjerde (1986)
Atlantic salmon	5.7 kg	6	14 *	Gjerde and Korsvoll (1999)
Channel catfish, *Ictalurus punctatus*	-	1	12-18	Dunham (1986)
Channel catfish	67 g	1	20	Bondari (1983)
Nile tilapia, *Oreochromis niloticus*	ca. 80 g	5	12-17	Eknath et al. (1998)
Rohu carp, *Labeo rohita*	400 g	1	13-15	Gjerde (pers. comm.)
Whiteleg shrimps, *Penaeus vannamei*	18 g	1	4.4	Fjalestad et al. (1997)
Golden shiner, *Notemigonus crysoleucas*	-	1	5.3	Tave (1994)

*Estimated from realized selection differentials.

Olesen et al., 2003

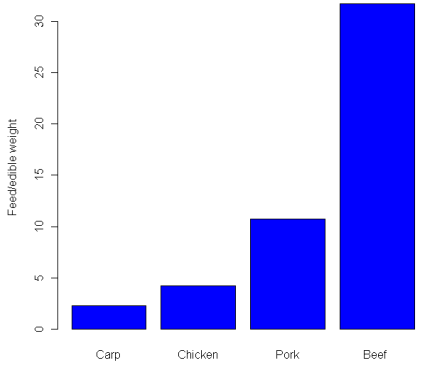
- Domestication and selection at an early stage
  - Less than 5% of production from breeding programs
  - Most aquaculture stocks in developing countries genetically similar or inferior to wild

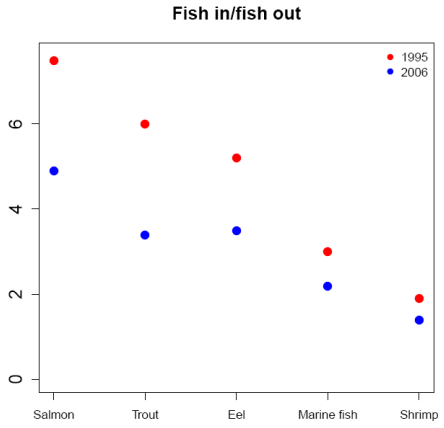


Duarte et al., 2007

Nutrition

- Starting at higher feed efficiency
- Decreasing fish-in fish-out ratios and replacement in fish oil fish meal

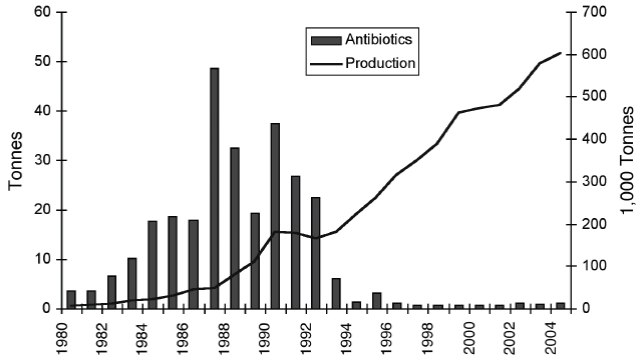




Hall et al., 2011

Health

- Vaccines for bacterial diseases in high value species
  - Reduction of mortality Scottish salmon industry 38% (1990) to 12% (1997)
  - Reduction of use of antibiotics in Norwegian salmon industry

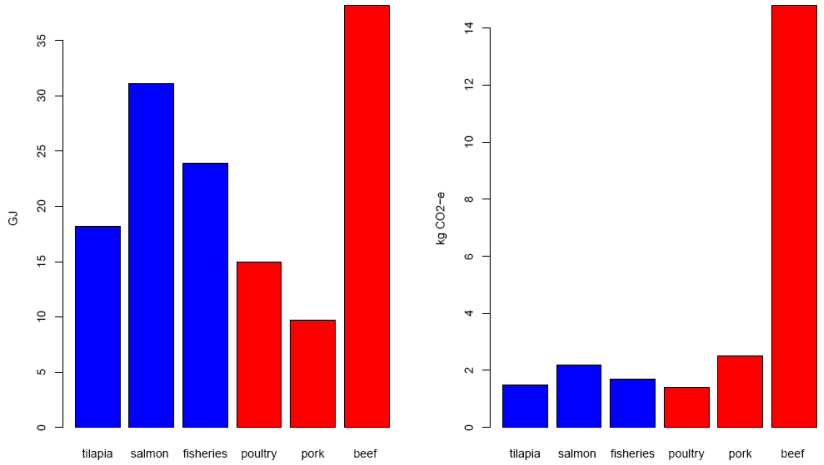


Asche, 2008

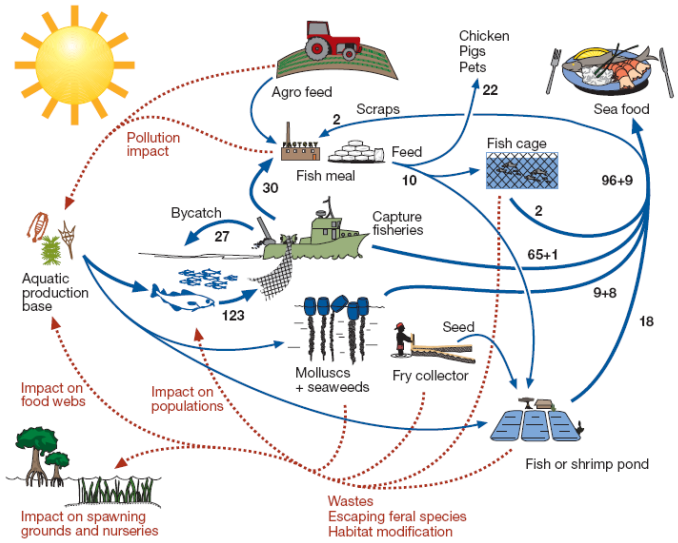
- Recombinant vaccines, direct DNA vaccination
- A solution for Sea lice in salmon
- High cost of development and authorisation of antibiotics and vaccines

Sustainability

- Particular attention needed since intensification is happening quickly and at times of high environmental concerns
- In many respects a more sustainable system of production in comparison to terrestrial systems
- Trade offs between different production strategies (fishery-livestock-aquaculture), feed uses, management practices and species



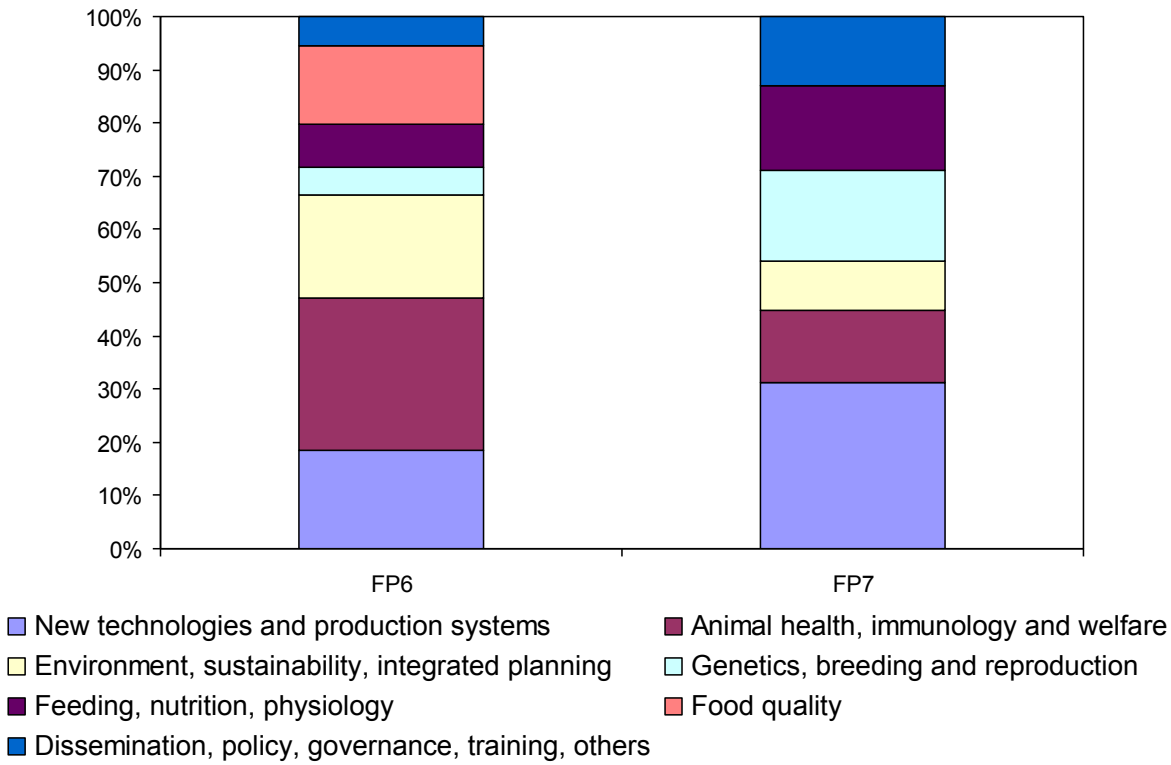
Pelletier and Tyedmers, 2010



Naylor et al., 2000

Funding by topic

Topics	FP6 2002 2006	FP7 2007 2013
Total nr	98	51
Total funding (million Euro)	150	75



Bibliometric analysis

Data

- 14,308 scientific articles (2000-2011) from Scopus

Journal	Nr (%)	Country	Nr (%)
Aquaculture	1823 (12.3)	United States	2950 (16.5)
Aquaculture Research	760 (5.1)	China	1124 (6.3)
Journal of the World Aquaculture Society	583 (3.9)	United Kingdom	995 (5.6)
Diseases of Aquatic Organisms	398 (2.7)	Canada	988 (5.5)
Aquacultural Engineering	366 (2.5)	Australia	940 (5.3)
Aquaculture International	279 (1.9)	Spain	894 (5.0)
Journal of Fish Diseases	201 (1.4)	Norway	697 (3.9)
Hydrobiologia	185 (1.2)	France	690 (3.9)
Journal of Shellfish Research	170 (1.1)	India	688 (3.8)
Fish and Shellfish Immunology	163 (1.1)	Japan	678 (3.8)

Methods

- Latent semantic analysis
- Probabilistic topic model
- Co-citation analysis

Latent Semantic Analysis

Term frequencies

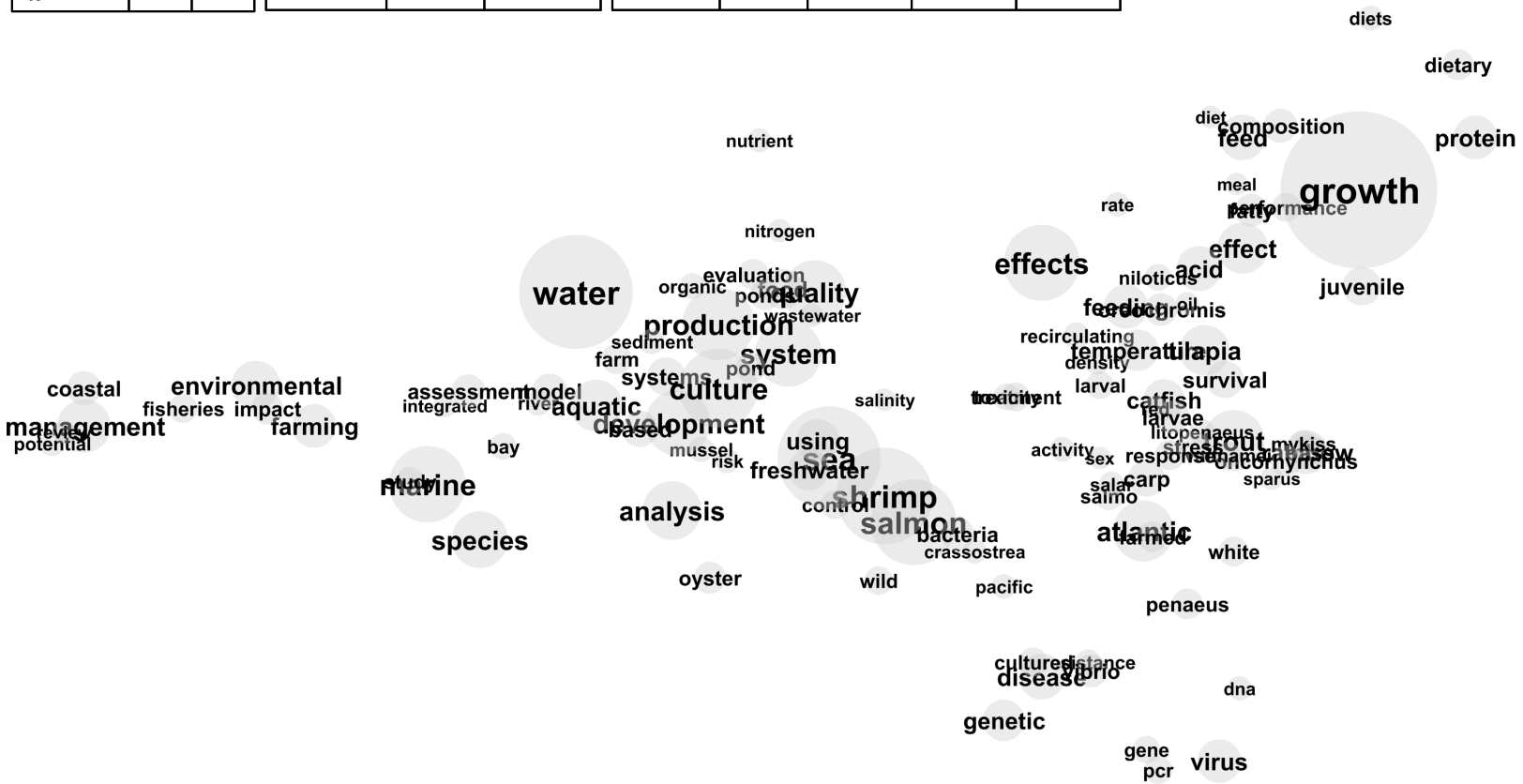
	D1	D2
term1	1	1
term2	1	1
term3	1	
term4		1

Dimensionality reduction

	D1	D2
term1	1	1
term2	1	1
term3	1	1e-16
term4	1e-16	1

Term similarity

	term1	term2	term3	4erm4
term1	1	1	0.7	0.7
term2	1	1	0.7	0.7
term3	0.7	0.7	1	1.3 e-16
term4	0.7	0.7	1.3 e-16	1



Probabilistic Topic Model

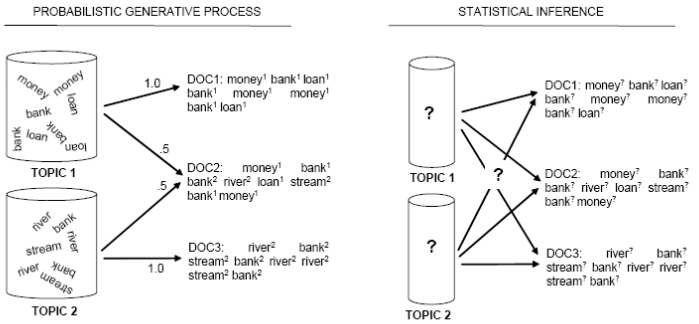


Figure 2. Illustration of the generative process and the problem of statistical inference underlying topic models

Steyvers, 2007

Genetics and reproduction

genet popul egg femal wild develop spawn male reproduct sea hatch sperm sex select matur stage group growth rate individu

Growth and physiology

growth cultur feed product rate densiti pond surviv day temperatur system stock larva increas salin tank treatment juvenil rear size

Farming systems environment

farm develop product model manag system area environment fisheri marin industri impact data base coastal includ sea risk econom increas

Nutrition

diet feed protein fed acid level growth lipid dietari meal increas fatti weight content oil group composit digest higher day

Water quality

sediment organ system pond farm nutrient toxic remov nitrogen sampl aquat total treatment effluent qualiti high effect rate increas level

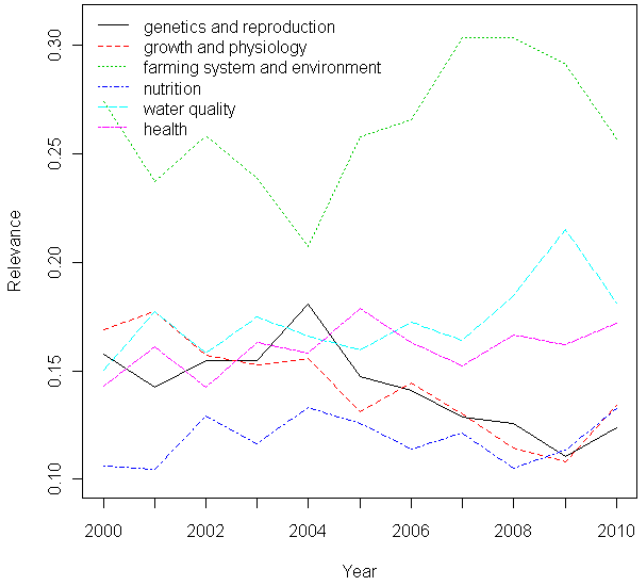
Health

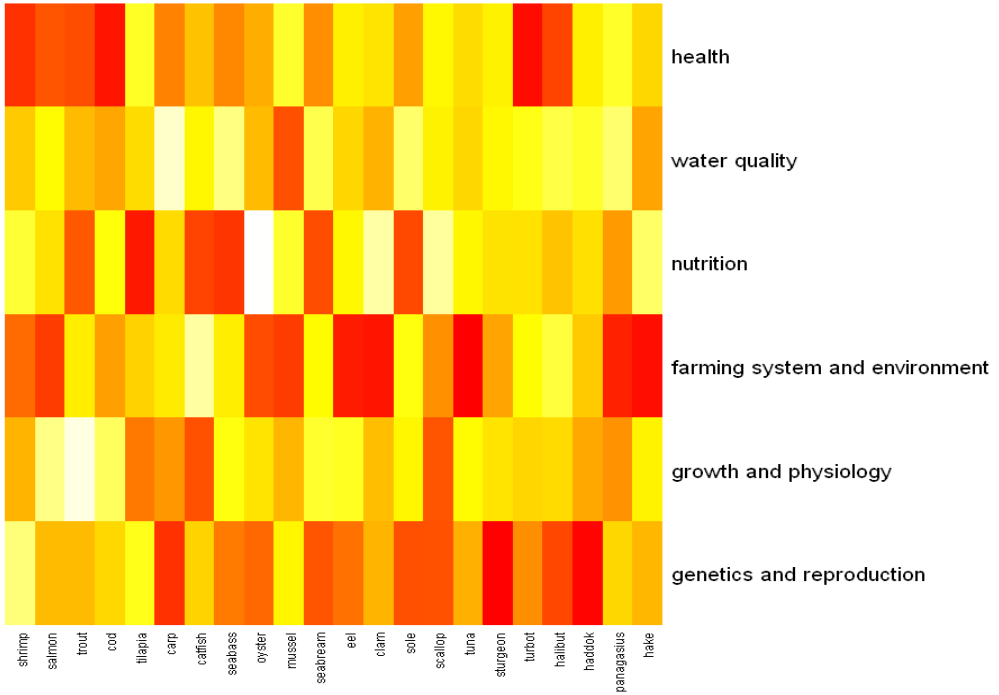
infect diseas gene isol cell virus pathogen sequenc strain detect express resist pcr bacteria immun bacteri activ vibrio vaccin protein

Example of topic assignments

Extract from the abstract	Genetics and reproduction	Growth and physiology	Farming systems and environment	Nutrition	Water quality	Health
Molecular tools to assist breeding programs in the gilthead sea bream (Sparus aurata L.) are scarce. A new multiplex PCR technique (OVIDORPLEX), which amplifies nine known microsatellite markers, was developed in this work...	0.9	0.0	0.0	0.0	0.0	0.1
The sapphire devil, Chrysiptera cyanea, were reared for 45. days during the non-reproductive season (September) under LD14:10 at four different wavelengths produced by light emitting diodes (LEDs): red (peak at 627. nm), green (530. nm), blue (455. nm) and white (5000. K). Ovarian maturation occurre...	0.6	0.4	0.0	0.0	0.0	0.0
Limited information is available on vaccine performance in parasitized fish. The objective of this study was to determine if parasitism of fish affected vaccine efficacy. Antibody level, hematology and survival of Nile tilapia vaccinated...	0.0	0.0	0.0	0.1	0.0	0.9
The concentrations of 16 PAHs in surface sediments collected from four Italian lagoons, exploited for aquaculture and fishing activities, during the period 2004-2007, were analysed...	0.0	0.0	0.2	0.0	0.8	0.0

Relevance of research topics





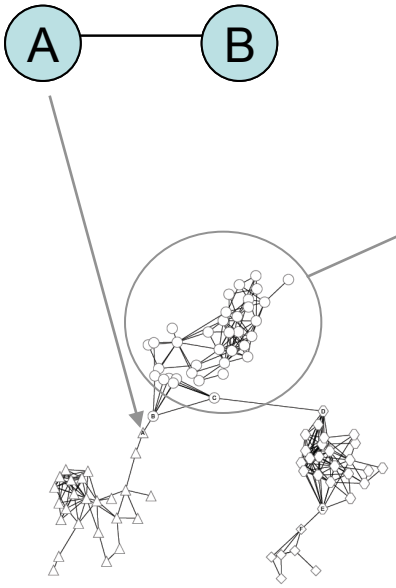
Co-citation analysis

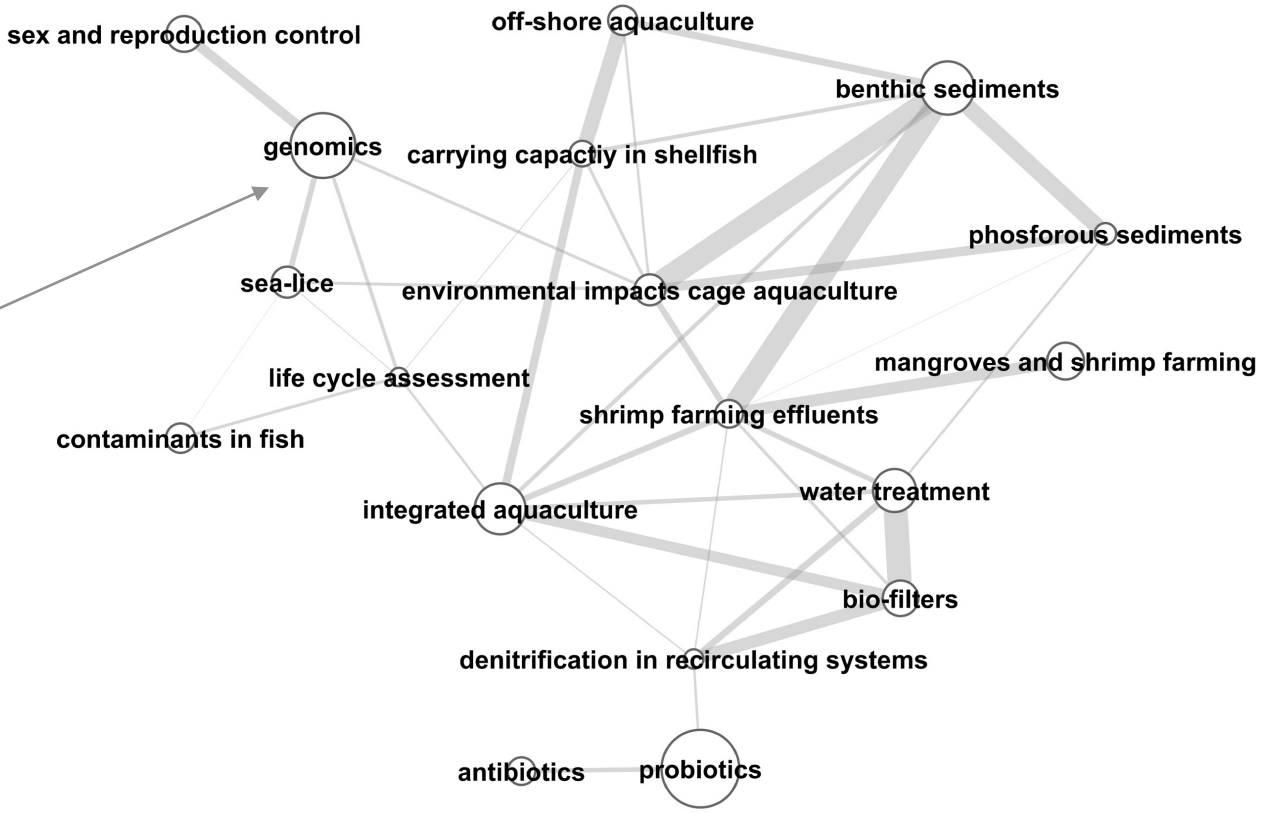
Article X

References:
A, B, C,…

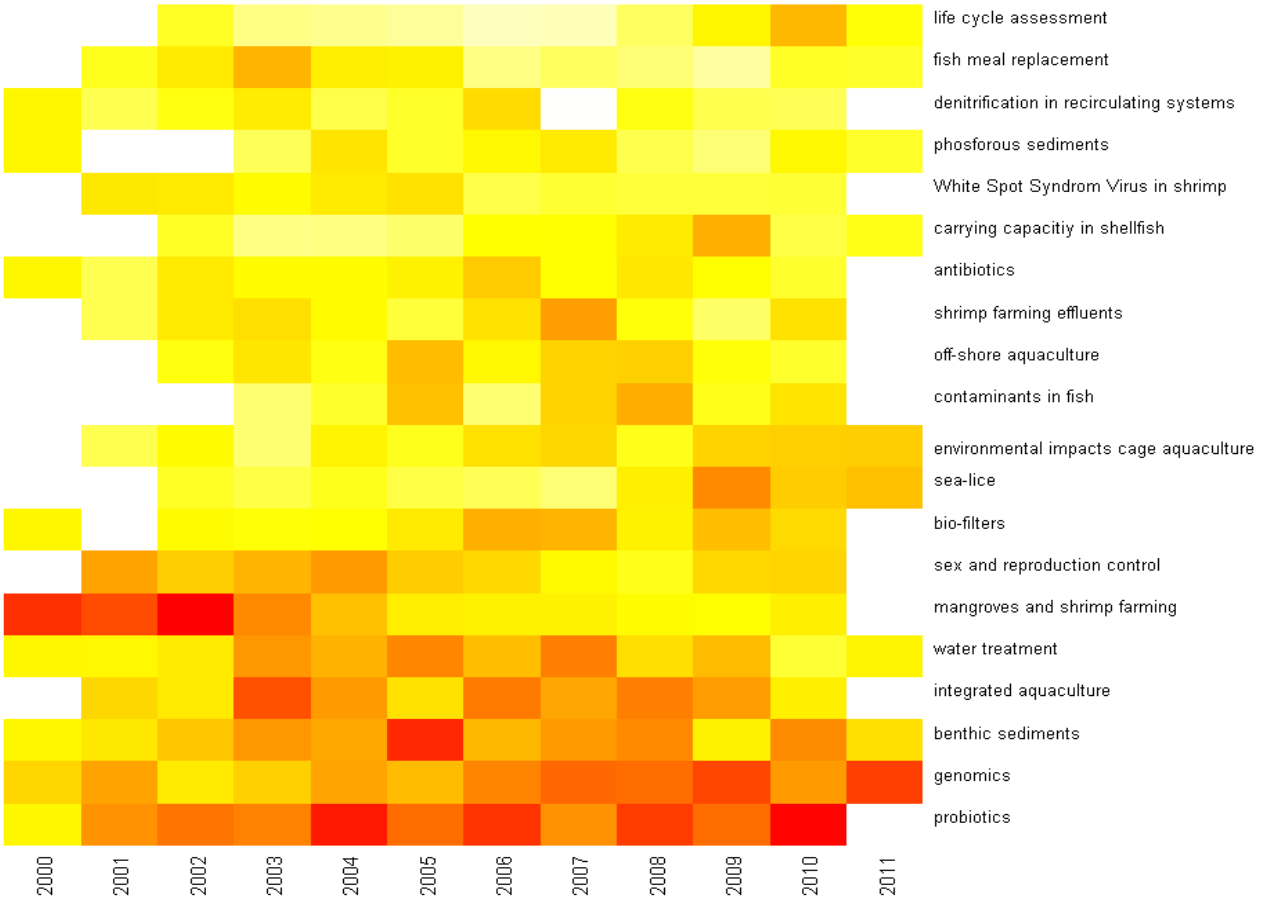
Article Y

References:
A, B, D,…





Research fronts by year



Conclusions

- Research contributing to exceptional growth of aquaculture with many opportunities ahead
- EU funded research in FP7 targeting productivity
- Bibliometric methods allowing quantitative assessment of relevance 6 main themes and showing connections between emerging research fronts (e.g. genomics, probiotics)

References of figures

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Thank you!