Shellfish farming in an era of rapid changes

Fabrice Pernet

Ifremer

LEMAR

VIVALDI

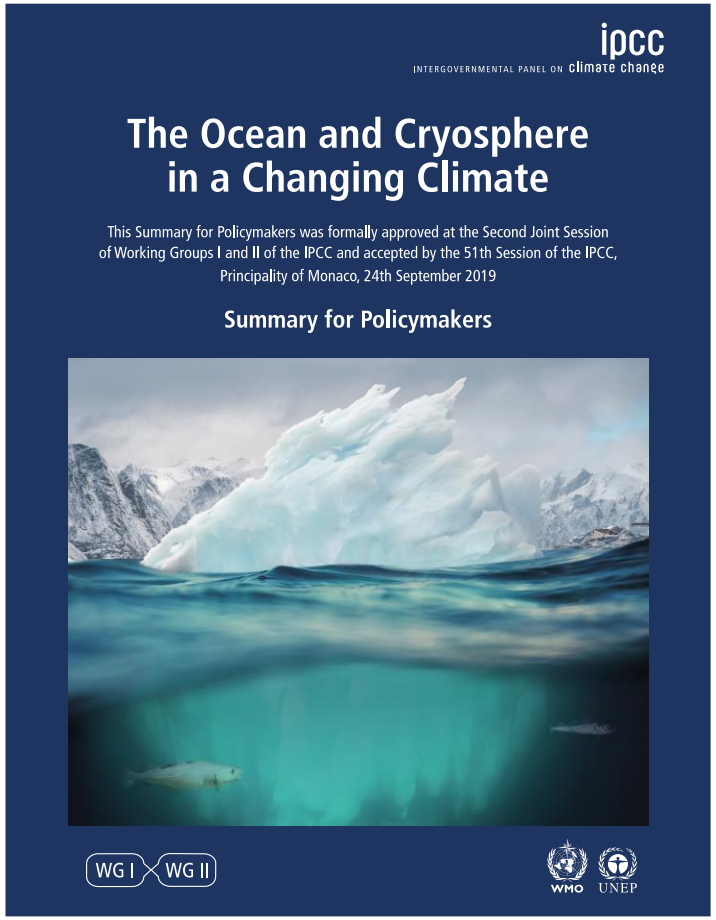
Preventing and mitigating farmed bivalve diseases

For Europe, the annual impact of ocean acidification will be *>1 billion US$*

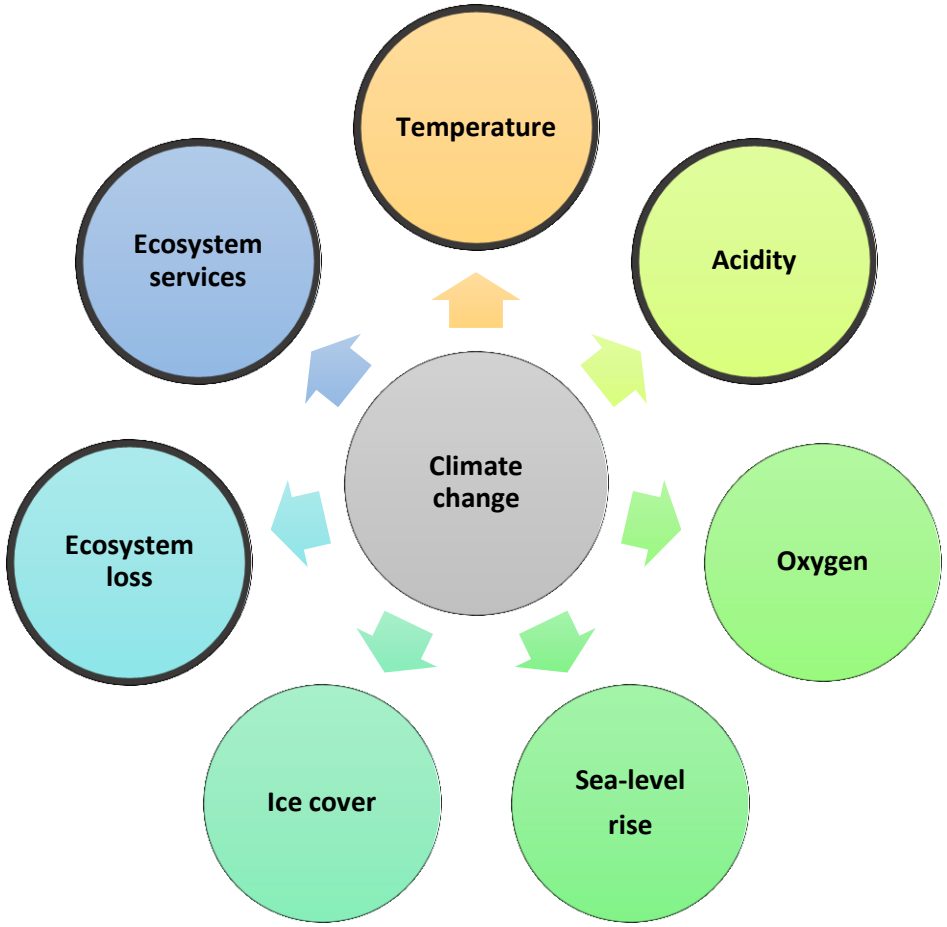
in 2100

Narita, D. and Rehdanz, K. (2017). Economic impact of ocean acidification on shellfish production in Europe. *Journal of Environmental Planning and Management* 60, 500-518.

The CO_2 problems in the ocean



https://report.ipcc.ch/srocc/pdf/SROCC_SPM_Approved.pdf

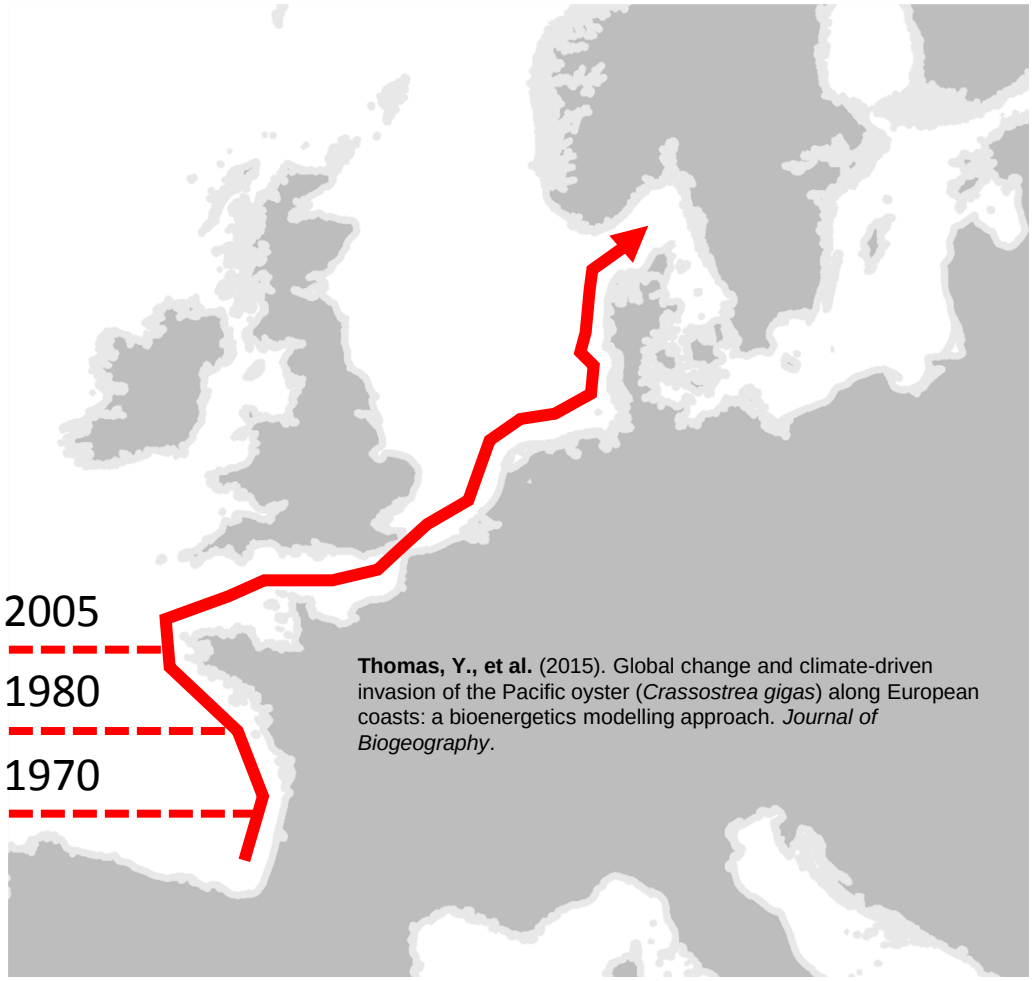


The CO_2 problem

in2100

Temperature +3°C

Impact on biogeographical distribution and cultivation practices



Thomas, Y., et al. (2015). Global change and climate-driven invasion of the Pacific oyster (*Crassostrea gigas*) along European coasts: a bioenergetics modelling approach. *Journal of Biogeography*.

The other CO_2 problem

in2100

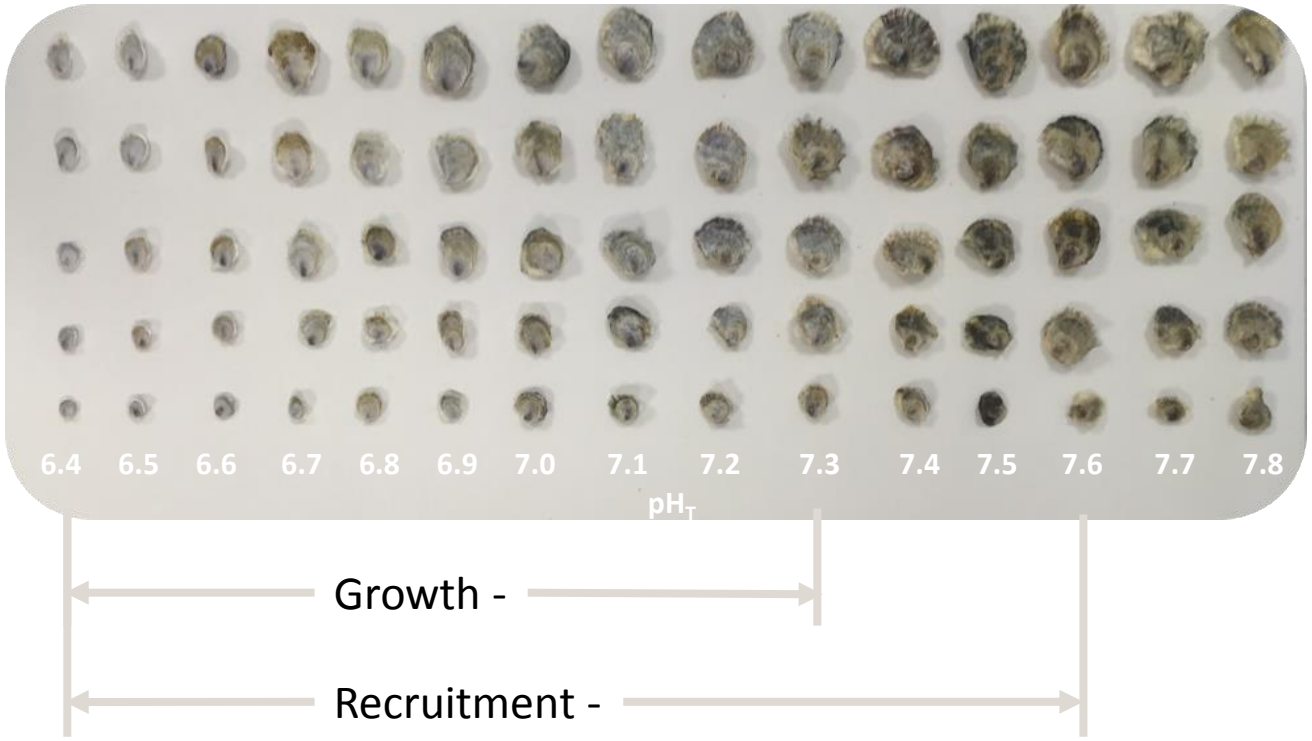
-0.35 pH unit

pH 8.1 → 7.8, ↘carbonates

Coastal zone already at pH 7.6-7.8

Larvae are more susceptible to low pH than juveniles and adults

Recruitment failure ?



And many others

Ecosystem resilience

Decrease in primary productivity and phenological mismatch

Biodiversity loss

Disease emergence

SCIENCE'S COMPASS • REVIEW

REVIEW: MARINE ECOLOGY

Emerging Marine Diseases—Climate Links and Anthropogenic Factors

C. D. Harvell,[1]* K. Kim,[1,2] J. M. Burkholder,[3] R. R. Colwell,[4,5] P. R. Epstein,[6] D. J. Grimes,[7] E. E. Hofmann,[8] E. K. Lipp,[9] A. D. M. E. Osterhaus,[10] R. M. Overstreet,[11] J. W. Porter,[12] G. W. Smith,[13] G. R. Vasta[4]

SCIENCE'S COMPASS • REVIEW

REVIEW: ECOLOGY

Climate Warming and Disease Risks for Terrestrial and Marine Biota

C. Drew Harvell,[1]* Charles E. Mitchell,[1,2] Jessica R. Ward,[1] Sonia Altizer,[3,4] Andrew P. Dobson,[5] Richard S. Ostfeld,[6] Michael D. Samuel[7]

Climate Change Influences on Marine Infectious Diseases: Implications for Management and Society

Colleen A. Burge,[1] C. Mark Eakin, Carolyn S. Friedman, Brett Froelich, Paul K. Hershberger, Eileen E. Hofmann, Laura E. Petes, Katherine C. Prager, Ernesto Weil, Bette L. Willis, Susan E. Ford, and C. Drew Harvell[1]

[1]Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853; email: cab433@cornell.edu, cdh5@cornell.edu*

Infectious Diseases Affect Marine Fisheries and Aquaculture Economics

Kevin D. Lafferty,[1] C. Drew Harvell, Jon M. Conrad, Carolyn S. Friedman, Michael L. Kent, Armand M. Kuris, Eric N. Powell, Daniel Rondeau, and Sonja M. Saksida

[1]Western Ecological Research Center, US Geological Survey, c/o Marine Science Institute, University of California, Santa Barbara, California 93106; email: lafferty@lifesci.ucsb.edu*

ARE DISEASES INCREASING IN THE OCEAN?*

Kevin D. Lafferty,[1] James W. Porter,[2] and Susan E. Ford[3]

[1]U.S. Geological Survey, Western Ecological Research Center, c/o Marine Science Institute, University of California, Santa Barbara, California 93106; email: Lafferty@lifesci.ucsb.edu

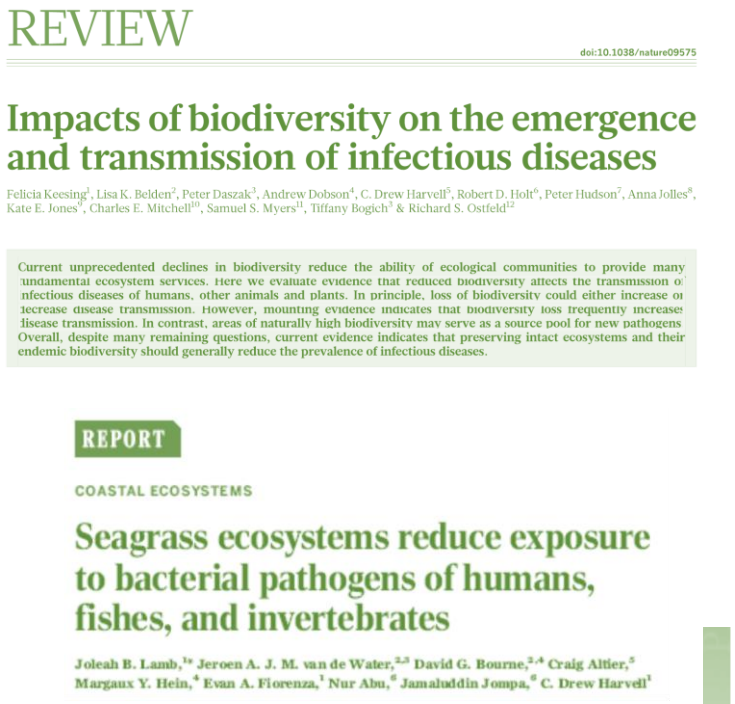
[2]Institute of Ecology, University of Georgia, Athens, Georgia 30602; email: jporter@uga.edu

[3]Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, New Jersey 08349; email: susan@hsrl.rutgers.edu

Focus on biodiversity and disease risk

Ecosystem resilience

- *The dilution effect predicts that disease risk increases for a focal host when host species diversity declines*



REVIEW

doi:10.1038/nature09575

Impacts of biodiversity on the emergence and transmission of infectious diseases

Felicia Keesing[1], Lisa K. Belden[2], Peter Daszak[3], Andrew Dobson[4], C. Drew Harvell[5], Robert D. Holt[6], Peter Hudson[7], Anna Jolles[8], Kate E. Jones[9], Charles E. Mitchell[10], Samuel S. Myers[11], Tiffany Bogich[3] & Richard S. Ostfeld[12]

Current unprecedented declines in biodiversity reduce the ability of ecological communities to provide many fundamental ecosystem services. Here we evaluate evidence that reduced biodiversity affects the transmission of infectious diseases of humans, other animals and plants. In principle, loss of biodiversity could either increase or decrease disease transmission. However, mounting evidence indicates that biodiversity loss frequently increases disease transmission. In contrast, areas of naturally high biodiversity may serve as a source pool for new pathogens. Overall, despite many remaining questions, current evidence indicates that preserving intact ecosystems and their endemic biodiversity should generally reduce the prevalence of infectious diseases.

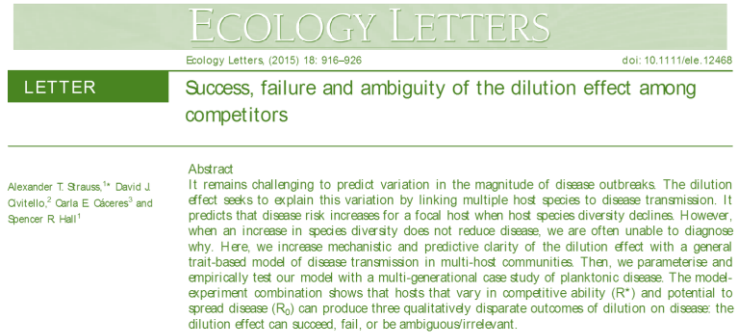
REPORT

COASTAL ECOSYSTEMS

Seagrass ecosystems reduce exposure to bacterial pathogens of humans, fishes, and invertebrates

Joleah B. Lamb,[1]* Jeroen A. J. M. van de Water,[2,3] David G. Bourne,[2,4] Craig Altier,[5] Margaux Y. Hein,[4] Evan A. Fiorenza,[1] Nur Abu,[6] Jamaluddin Jompa,[6] C. Drew Harvell[1]

Lamb *et al.*, *Science* **355**, 731–733 (2017)



ECOLOGY LETTERS

Ecology Letters, (2015) 18: 916–926 doi: 10.1111/ele.12468

LETTER

Success, failure and ambiguity of the dilution effect among competitors

Alexander T. Strauss,[1]* David J. Civitello,[2] Carla E. Cáceres[3] and Spencer R. Hall[1]

Abstract

It remains challenging to predict variation in the magnitude of disease outbreaks. The dilution effect seeks to explain this variation by linking multiple host species to disease transmission. It predicts that disease risk increases for a focal host when host species diversity declines. However, when an increase in species diversity does not reduce disease, we are often unable to diagnose why. Here, we increase mechanistic and predictive clarity of the dilution effect with a general trait-based model of disease transmission in multi-host communities. Then, we parameterise and empirically test our model with a multi-generational case study of planktonic disease. The model-experiment combination shows that hosts that vary in competitive ability (R^*) and potential to spread disease (R_0) can produce three qualitatively disparate outcomes of dilution on disease: the dilution effect can succeed, fail, or be ambiguous/irrelevant.

Biodiversity inhibits parasites: Broad evidence for the dilution effect

David J. Civitello[1], Jeremy Cohen[2], Hiba Fatima[2], Neal T. Halstead[2], Josue Liriano[2], Taegan A. McMahon[2,3], C. Nicole Ortega[2], Erin Louise Sauer[2], Tanya Sehgal[2], Suzanne Young[2], and Jason R. Rohr

Department of Integrative Biology, University of South Florida, Tampa, FL 33620

Edited by Simon A. Levin, Princeton University, Princeton, NJ, and approved May 15, 2015 (received for review March 30, 2015)

Infectious diseases of humans, wildlife, and domesticated species outbreaks, and disease management approaches based on bio-

esa

ECOSPHERE

INNOVATIVE VIEWPOINTS

Is biodiversity bad for your health?

Richard S. Ostfeld[1,†] and Felicia Keesing[2]

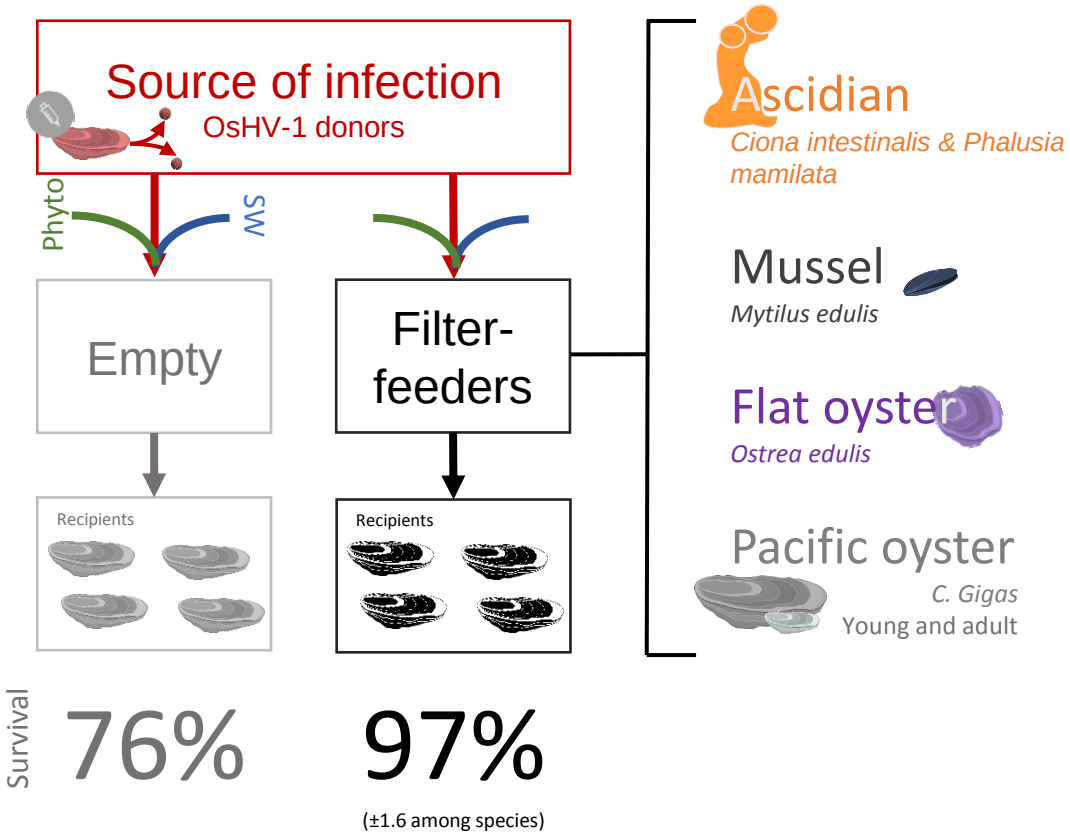
[1]*Cary Institute of Ecosystem Studies, Box AB, Millbrook, New York 12545 USA*
[2]*Bard College, Annandale-on-Hudson, New York 12504 USA*

(…) much of what we know about the transmission of bivalve parasites is based on experimental systems or models in which ***hosts and parasites are considered in an ecological vacuum****. In reality, hosts exist within diverse ecological communities, and ecological interactions undoubtedly influence the transmission and impact of parasites*

T. Ben-Horin et al. Journal of Invertebrate Pathology 131 (2015) 155–176

How filter-feeders influence disease risk in oyster ?

- Reduce food availability, growth and metabolic rate of the host
- Competition with non susceptible host for food resources decreases disease risk



Similar virus load
Differences in food, growth and energy

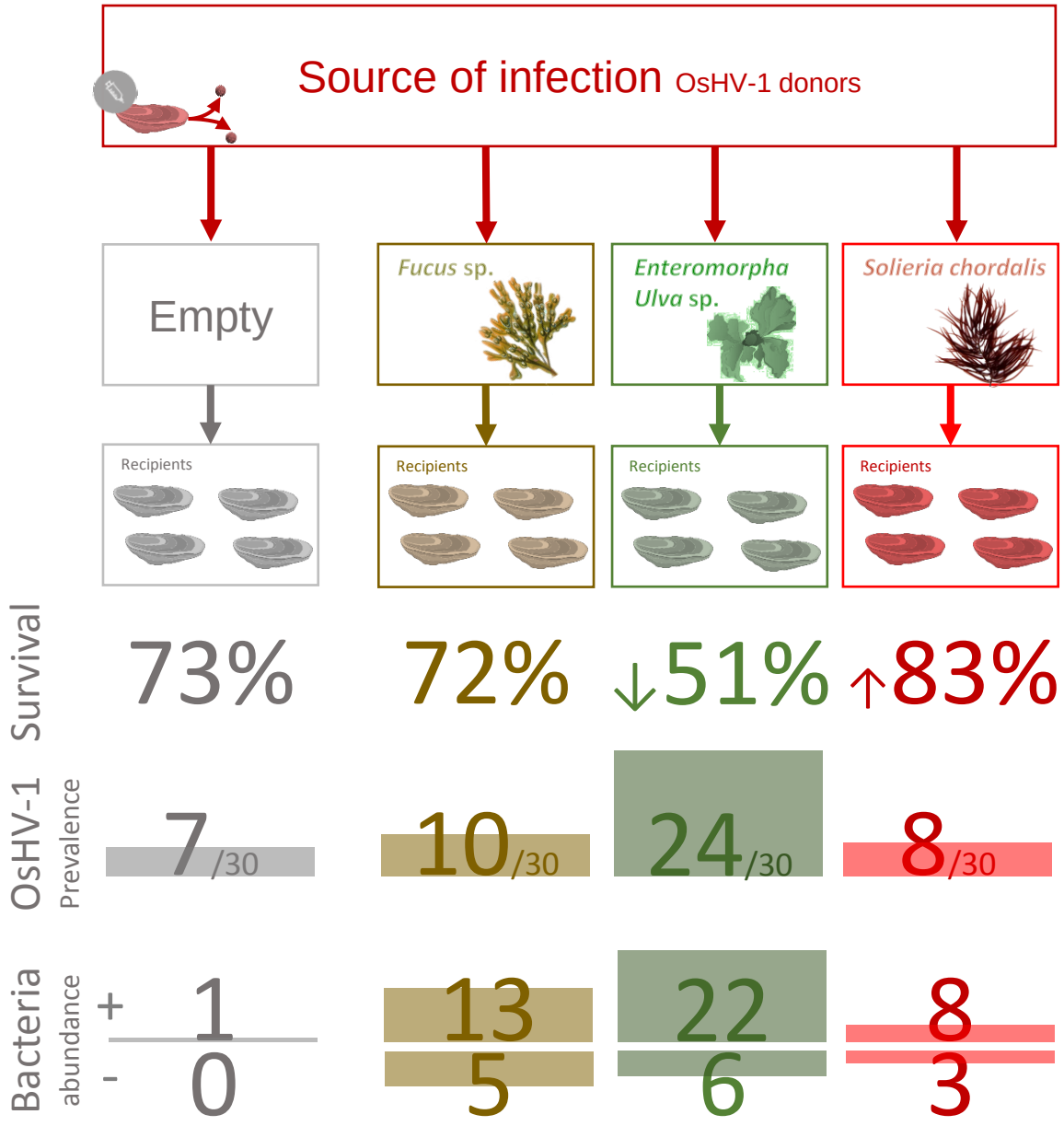
Hosts experiencing stress from the presence of secondary compounds may experience higher transmission success due to the inability to resist pathogen infection

Dallas, T., Hall, R.J. & Drake, J.M. (2016) Competition-mediated feedbacks in experimental multispecies epizootics. Ecology, 97, 661-670.

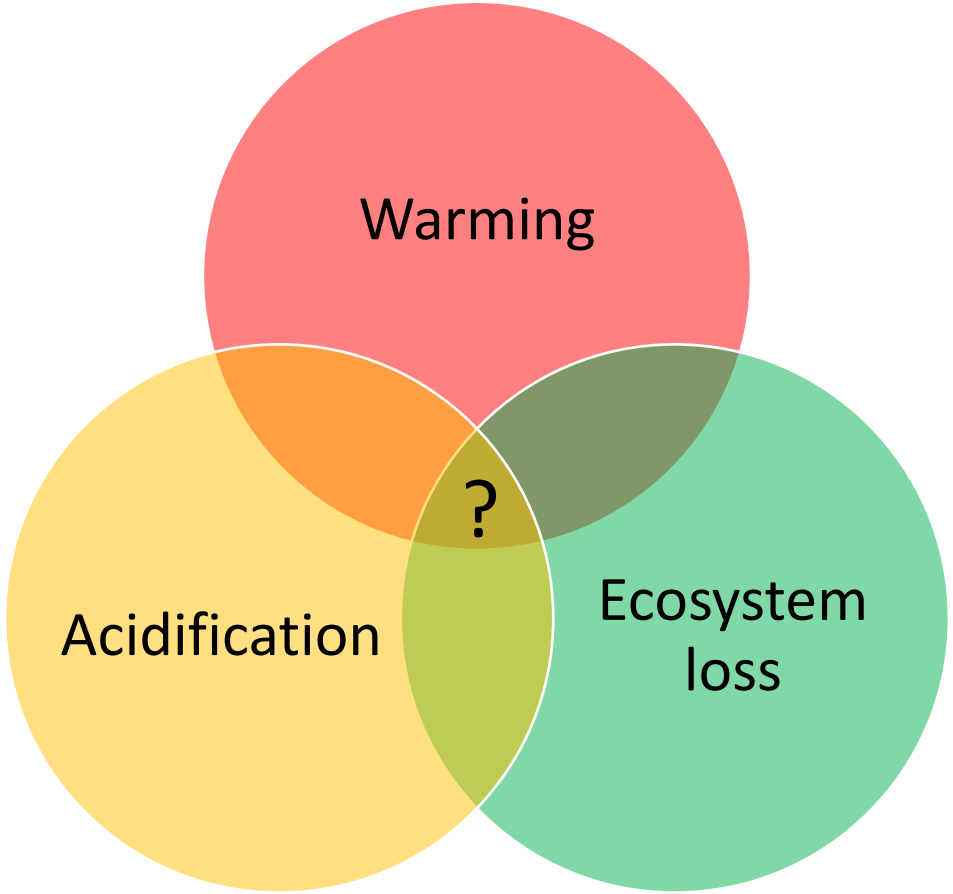
How non filter-feeders influence disease risk in oyster ?

The intricate case of macroalgae

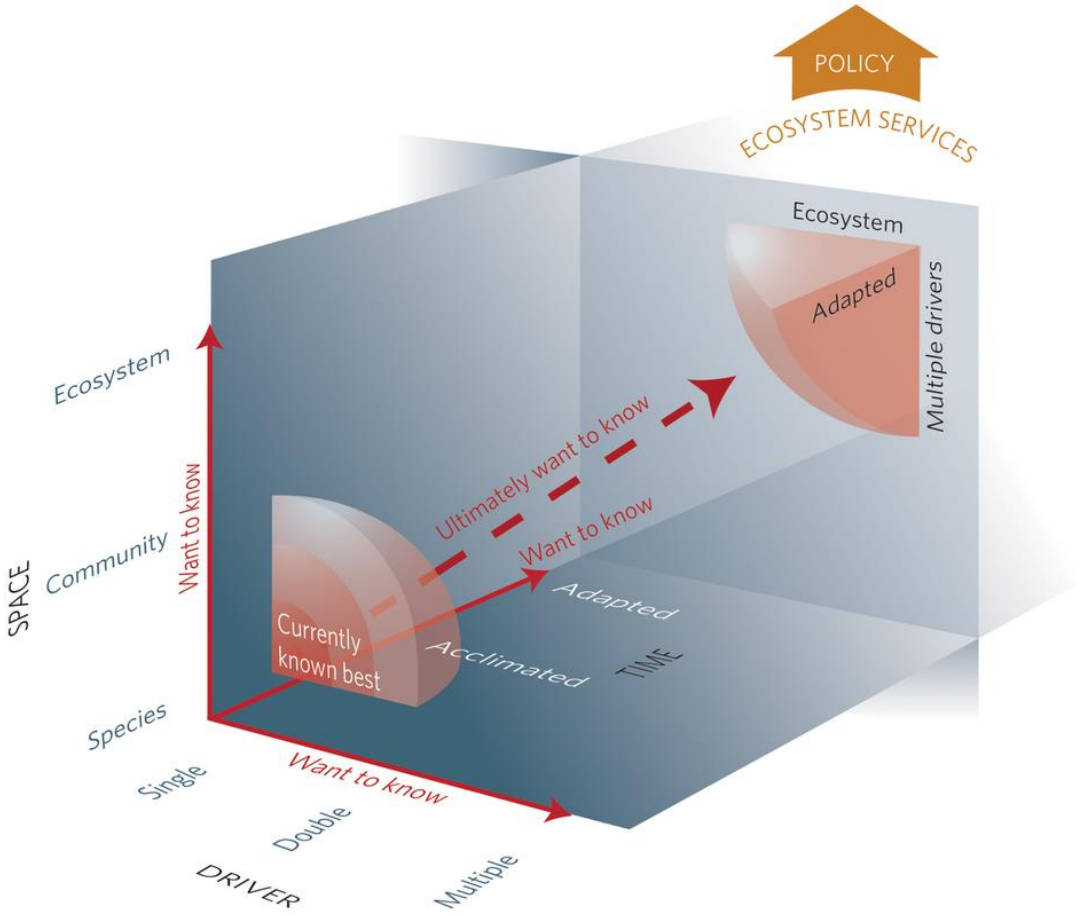
- Influence disease risk and modulate host microbiota
- Change with algal species



The triple CO_2 problem on shellfish farming



How shall we address the problem ?



COMMENTARY:

Lessons learned from ocean acidification research

Ulf Riebesell and Jean-Pierre Gattuso

Reflection on the rapidly growing field of ocean acidification research highlights priorities for future research on the changing ocean.

For Europe, the annual impact of ocean acidification will be *>1 billion US$*

in 2100

Narita, D. and Rehdanz, K. (2017). Economic impact of ocean acidification on shellfish production in Europe. *Journal of Environmental Planning and Management* 60, 500-518.

A triple perspective

Run away A short-term response to biogeographical problems

We get only the best A mid-term response to adaptation problems

The ways of eternal Wisdom A long-term response to most problems

Thank you

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