

From immuno-ecology to conservation: how deciphering physiological mechanisms can help conservation

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WSC3, symposium on Conservation physiology in seabirds



Seabirds are threatened

Invasive species, bycatch and climate change are the top threats to seabirds globally

Dias et al. 2019 *Biological Conservation*

But infectious diseases are another (neglected) threat



Seabirds are threatened

Invasive species, bycatch and climate change are the top threats to seabirds globally

Dias et al. 2019 *Biological Conservation*

But infectious diseases are another (neglected) threat

And against infectious diseases, understanding physiological / immunological mechanisms may be important



Sometime, strong, exceptionnal negative effects



New Island, Falkland Islands, January 2016:
Massive mortalities of Gentoo penguin and black-browed albatross chicks

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New Island, Falkland Islands, January 2016:
Massive mortalities of Gentoo penguin and black



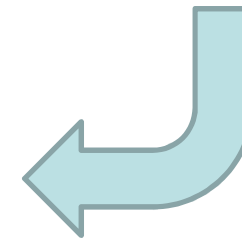
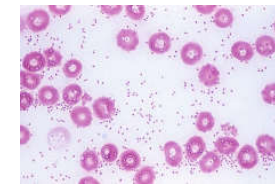
Sometime, strong, massive negative effects

There are some well documented cases

Avian cholera (bacteria *Pasteurella multocida*)

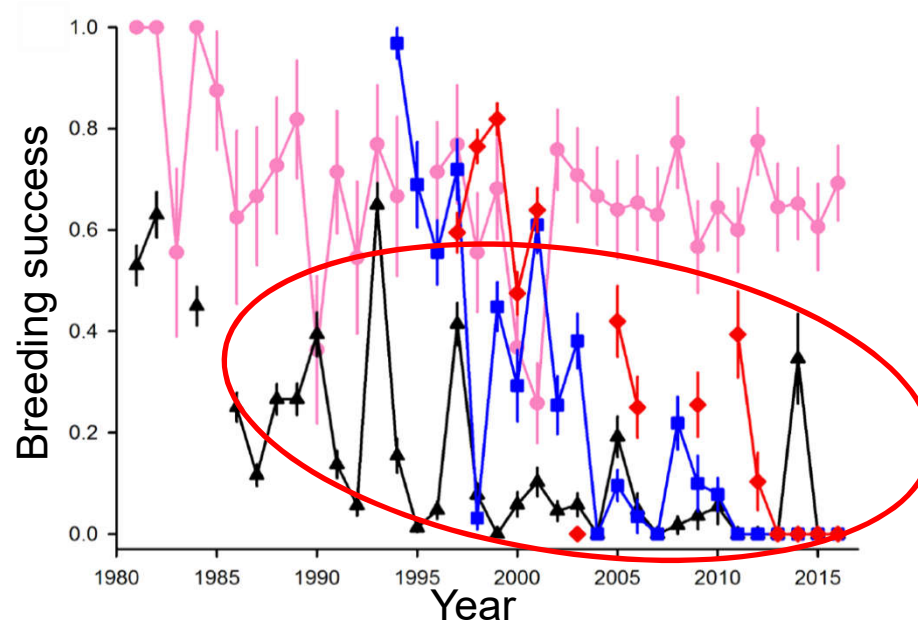


**Yellow-nosed albatrosses
on Amsterdam Island**



Weimerskirch 2004
Polar Biology
Jaeger et al 2018
Plos One

Avian cholera (*Pasteuralla multocida*) on Amsterdam Island



Risk



- Amsterdam albatross
- Indian yellow-nosed albatross
- Sooty albatross
- Northern rockhopper penguin



Jaeger et al. 2018, *PLOS One*

Amsterdam island, Southern Indian Ocean



What to do in terms of conservation ?

Limit transmission

Biosecurity measures



Surveillance

What to do in terms of conservation ?

Limit transmission

Limit pathogenic effects

Biosecurity measures

Vaccine ?



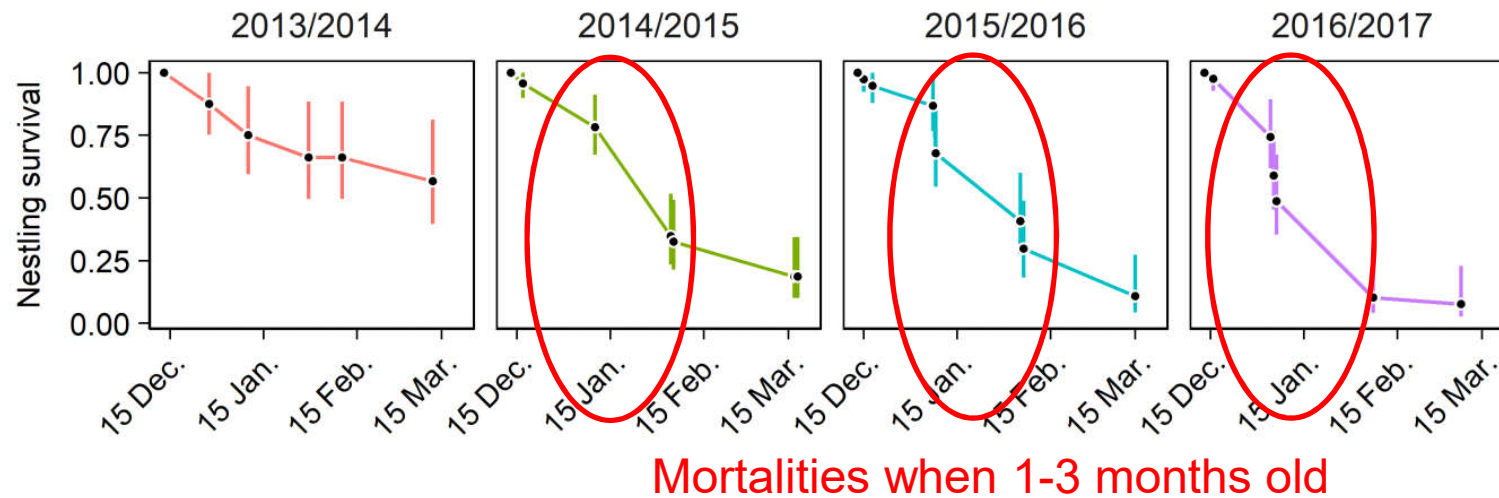
Surveillance

- **Protect individuals**
- **Limit transmission**
- (- **Eradicate**)

(notably if infectious agents introduced via poultry)

Protecting young nestlings via a vaccine ?

- Epidemics inducing mortalities of nestlings

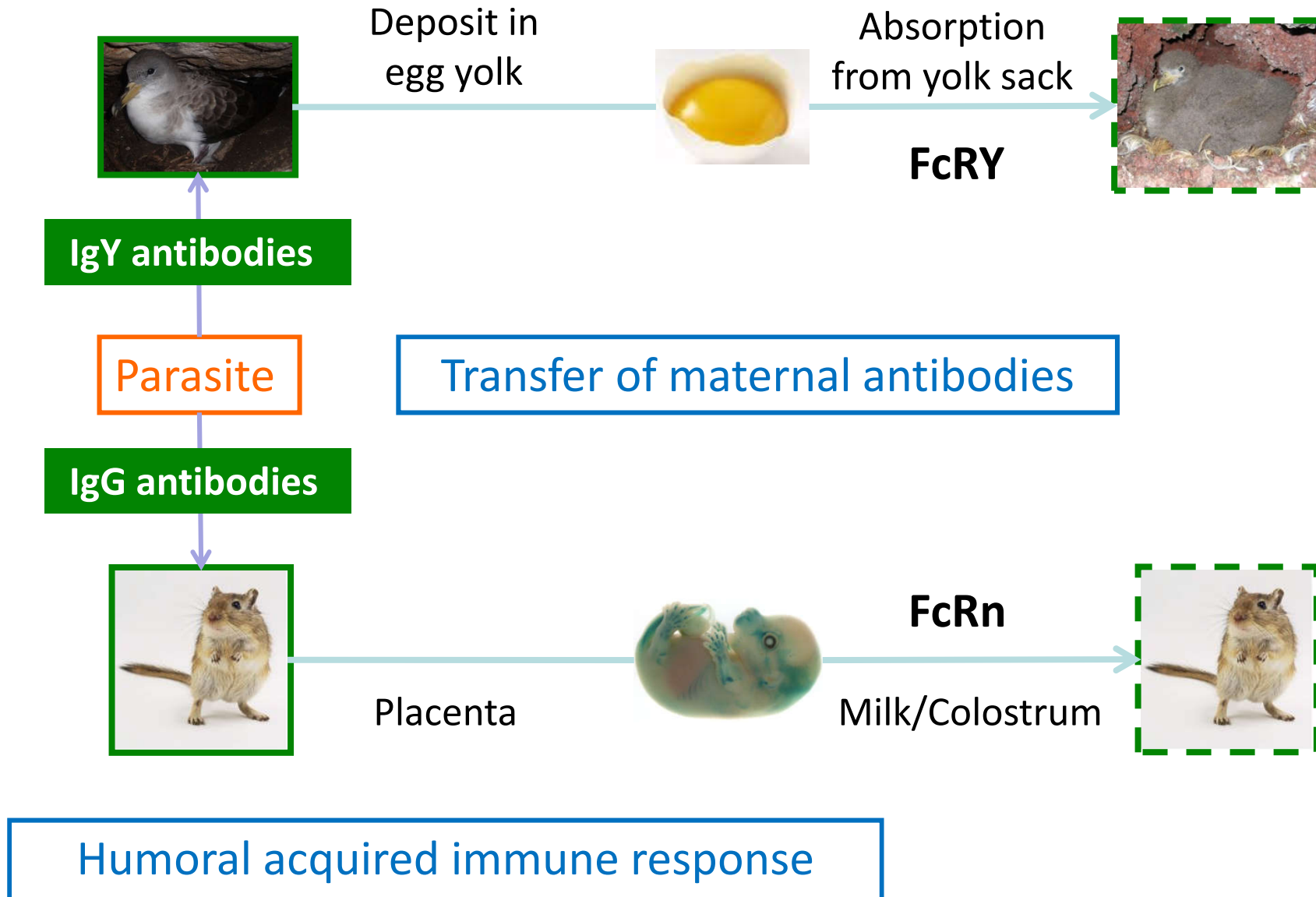


Jaeger, Gamble et al. 2018 *Ecohealth*

What about vaccinating females so that they would transmit maternal antibodies ?

Garnier et al. 2013 *Proc Roy Soc B*

What is the transfer of maternal antibodies ?



Role of the maternal transfer of antibodies ?

Well known in domesticated animals and humans

- Protect the juvenile

Vaccination
of hens



IgY transfer via
egg yolk

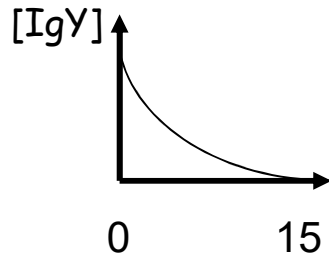
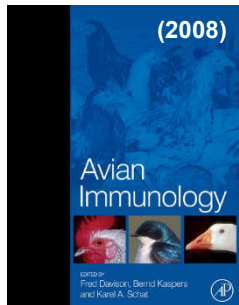


Polyclonal
antibodies
IgY

Role of the maternal transfer of antibodies ?

Well known in domesticated animals and humans

- Protect the juvenile
- Temporary
(approx. 15 days in chickens)



Vaccination
of hens



IgY transfer via
egg yolk

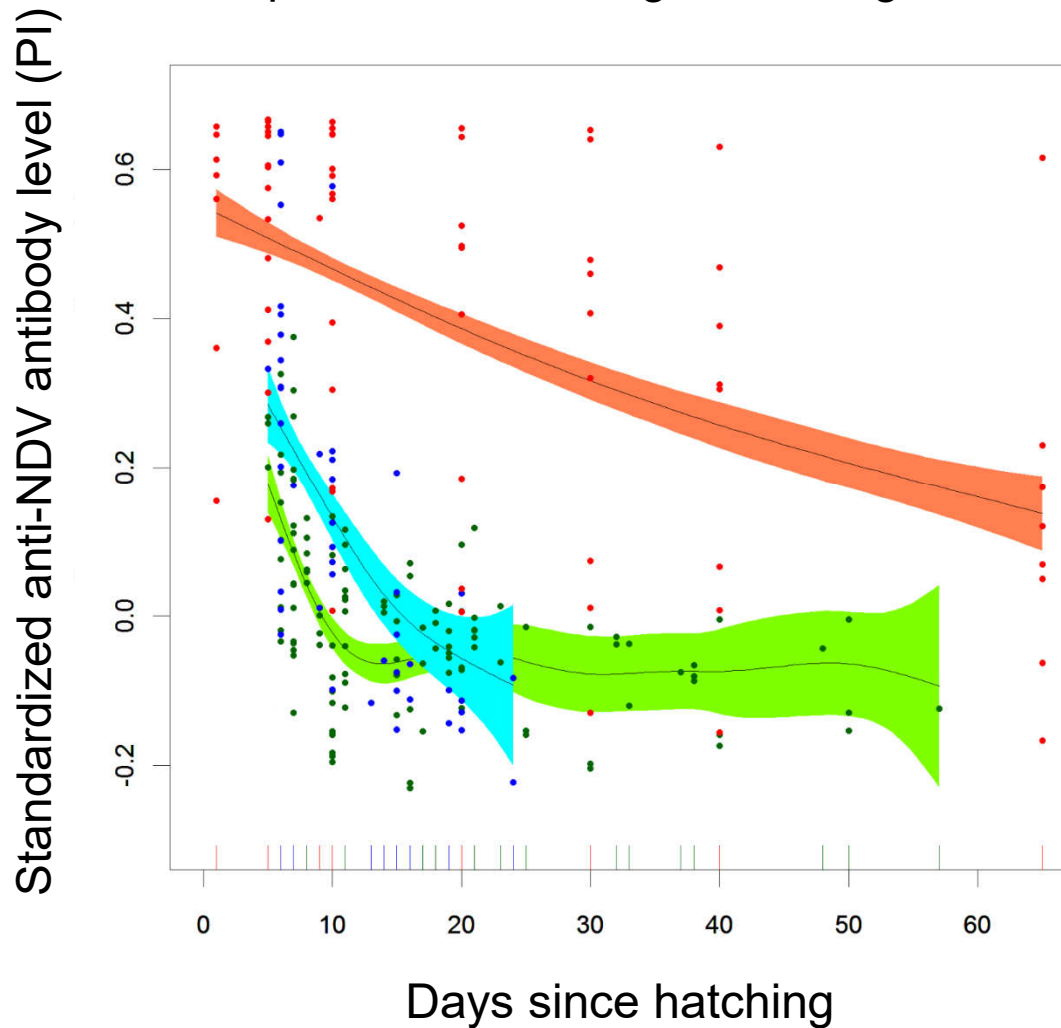


Polyclonal
antibodies
IgY



Long persistence of maternal antibodies in the Cory's shearwater

Experimental investigation using NDV vaccine



Garnier et al. 2012 *Proc Roy Soc London B*



Cory's shearwater



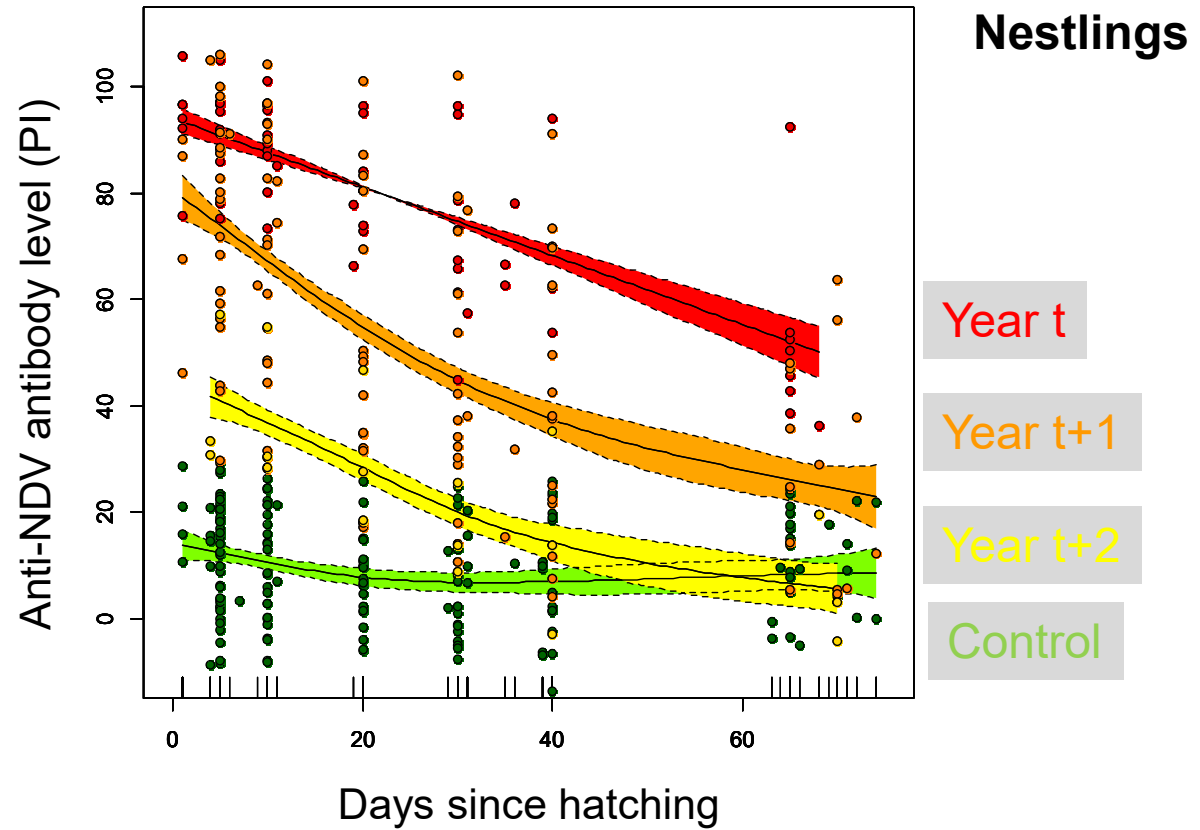
Kittiwake
(Staszewski et al. 2007
J Anim Ecol)



Quail
(Staszewski & Siitari 2010
Functional Ecol)

Long persistence at an inter-annual scale

Experimental investigation using NDV vaccine



Ramos, Garnier, Gonzalez-Solis & Boulinier 2014

American Naturalist

In other species seabird ?

COMPARATIVE APPROACH



European shag
Isle of May, Scotland



Francis Daunt Sarah Burthe
CEH Edinburgh, Scotland



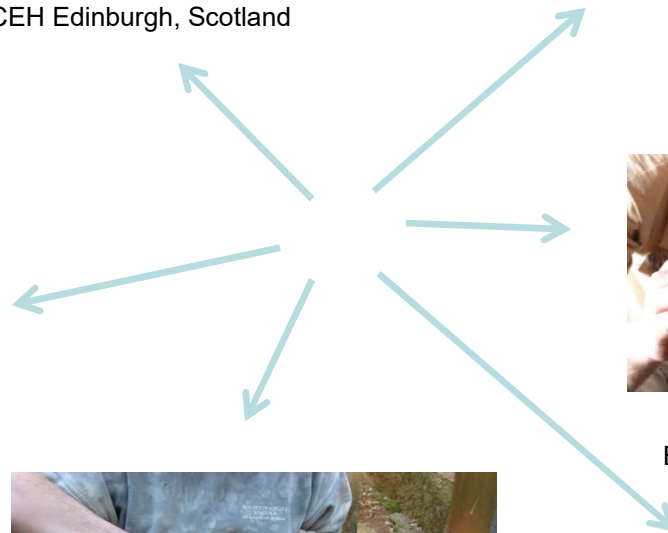
Rockhopper penguin
Falklands



Maud Poisbleau,
Univ. Antwerp, Belgium



Yellow-nosed albatross
Amsterdam island, French
sub-antarctic territories



Storm petrel
Benidorm island, Spain



Ana Sanz-Aguilar
Spain



Raptors, Rocher des aigles

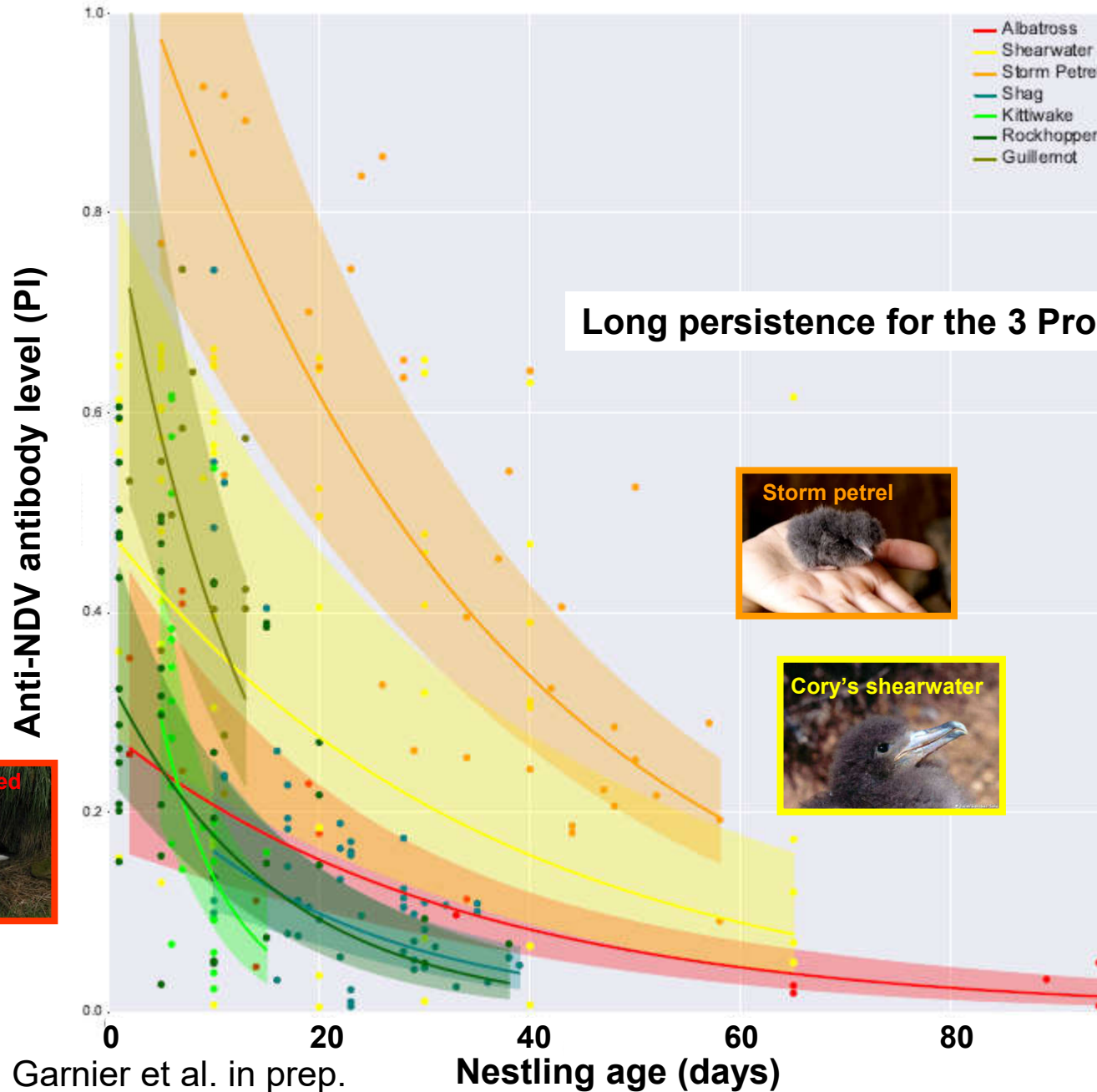


Common guillemot
Hornøya, Norway



Jérémy Tornos

Temporal persistence of maternal antibody levels



Assessing the potential use of vaccination against avian cholera

Field trial of the vaccine

Amsterdam Island, since 2013

n = 30 pairs + chick / year (n = 30 control pairs + chick)



Yellow-nosed albatross

Assessing the potential use of vaccination against avian cholera

Production of an autogenous vaccine



Pasteurella multocida strain from Amsterdam Island, isolated by Audrey Jaeger and Pablo Tortosa, PIMIT, Réunion Island

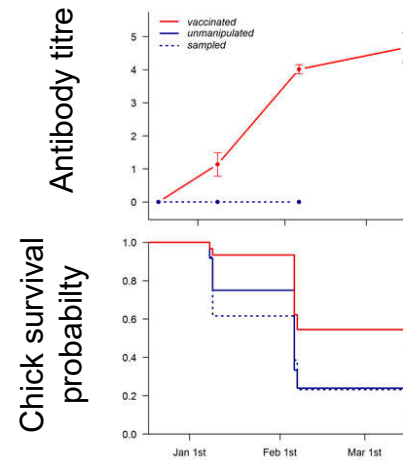


Subcutaneous injection of 0.5 ml

Bourret, Gamble, Tornos [...] Garnier, Boulinier 2018 *Conservation Letters*

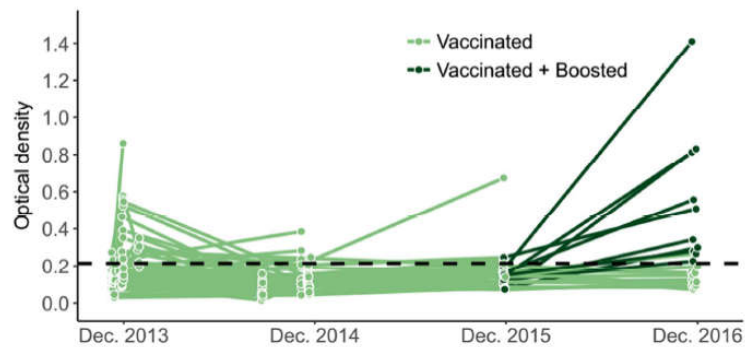
Assessing the potential use of vaccination against avian cholera

Protective effect by vaccinating nestlings



Bouret et al 2018 *Conservation Letters*

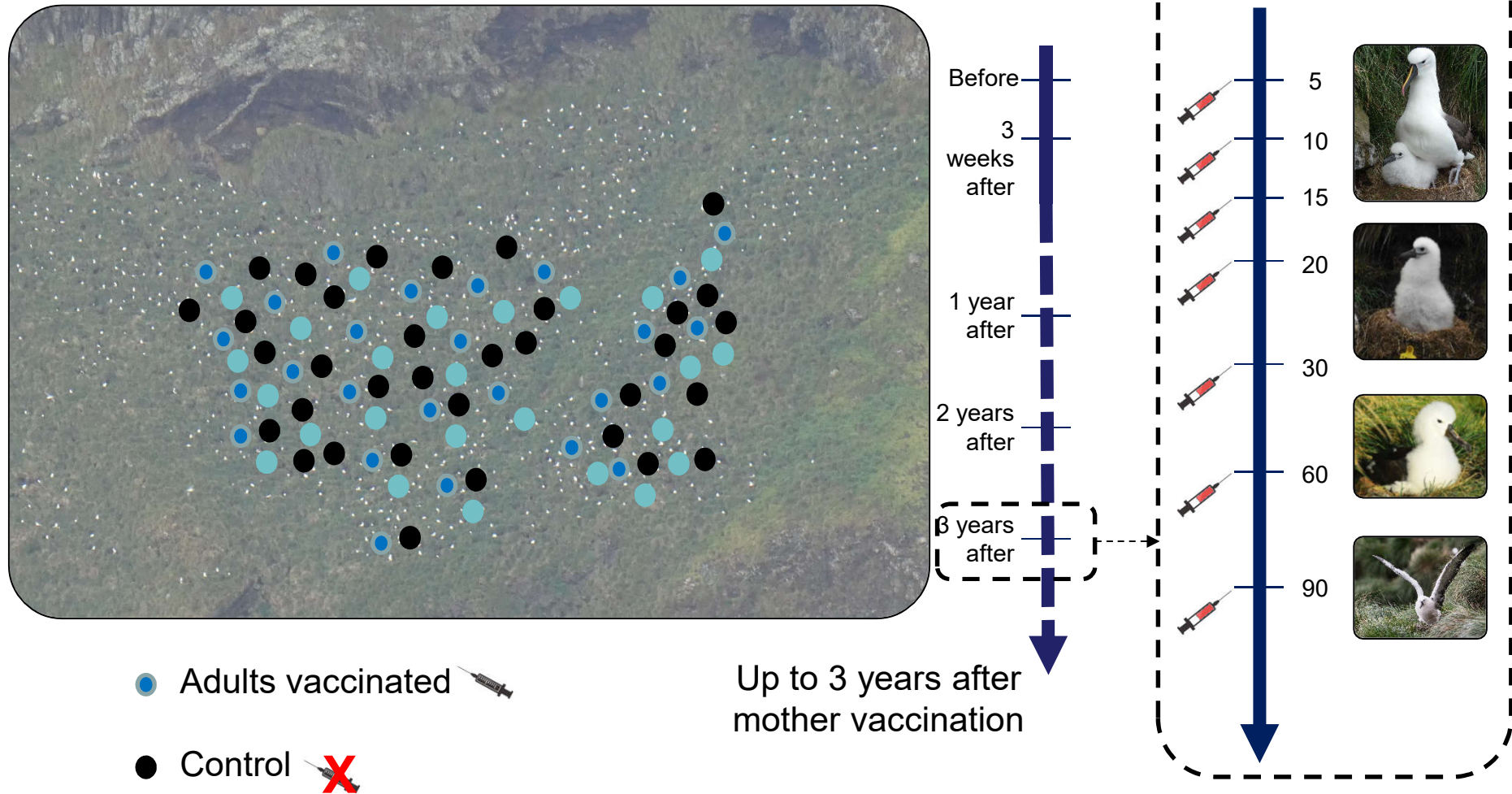
But relatively short inter-annual temporal persistence in adults



Gamble et al. 2019 *Oecologia*

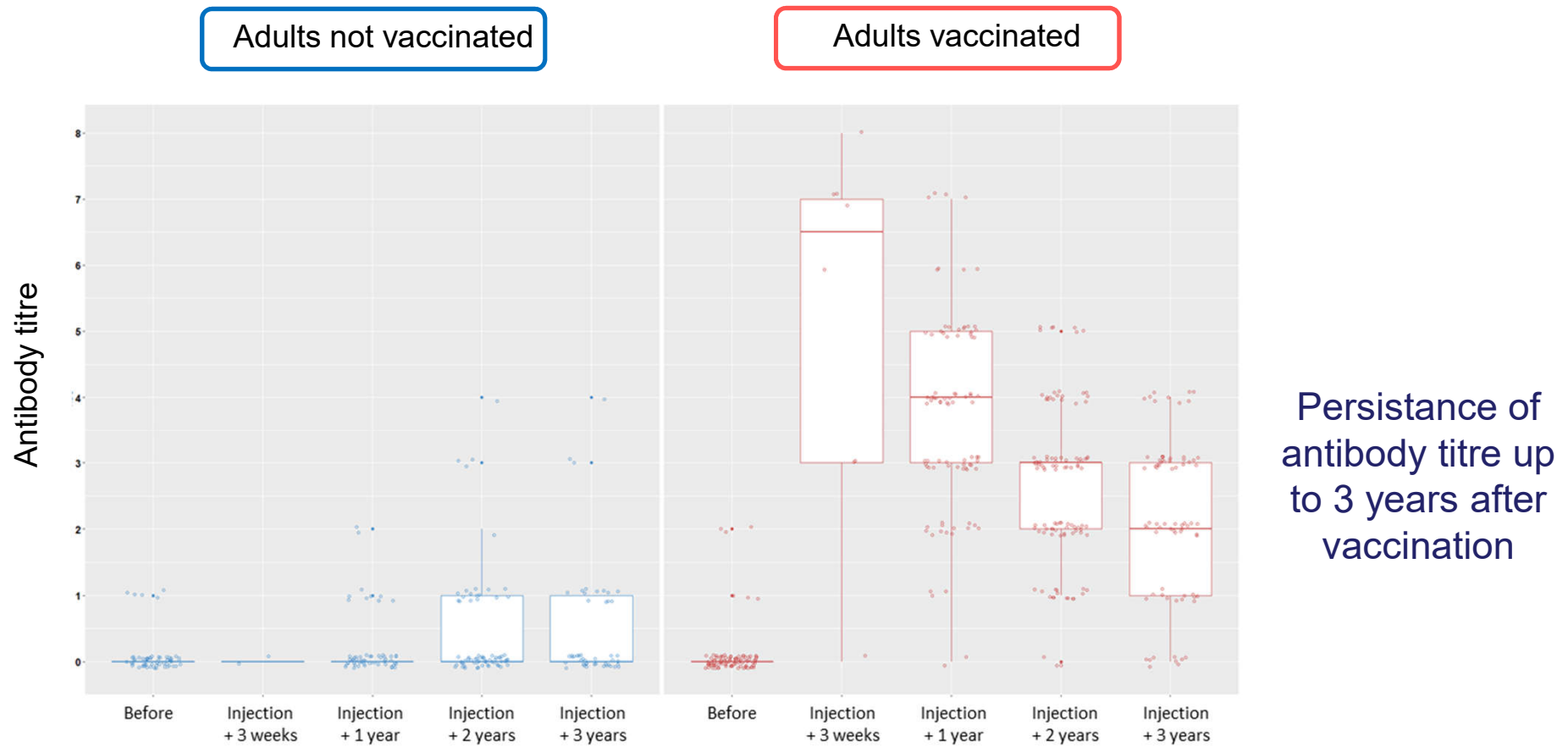
Assessing the potential use of vaccination: recent results

2017: New adult cohort with **new formulation** of the vaccine



Assessing the potential use of vaccination: recent results

- Inter-annual persistence of antibodies with the new formulation of the vaccine

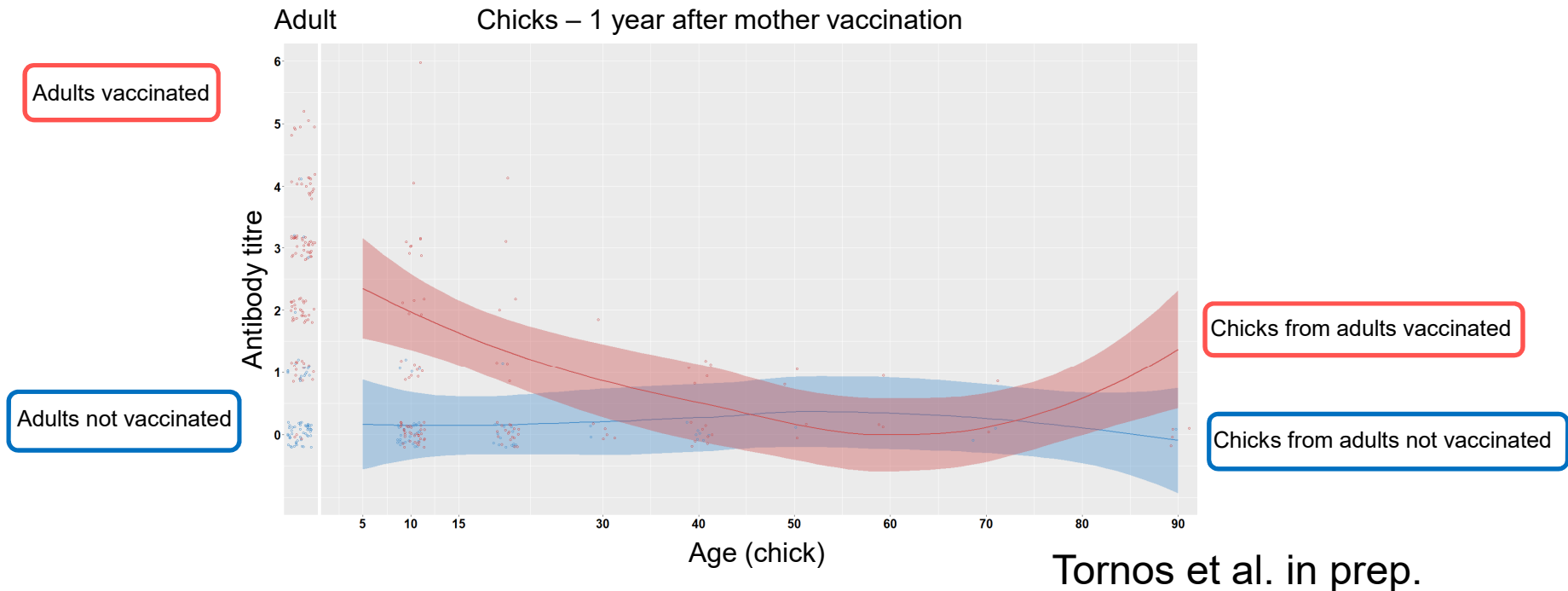


Persistence of antibody titre up to 3 years after vaccination

Tornos et al. in prep.

Assessing the potential use of vaccination: recent results

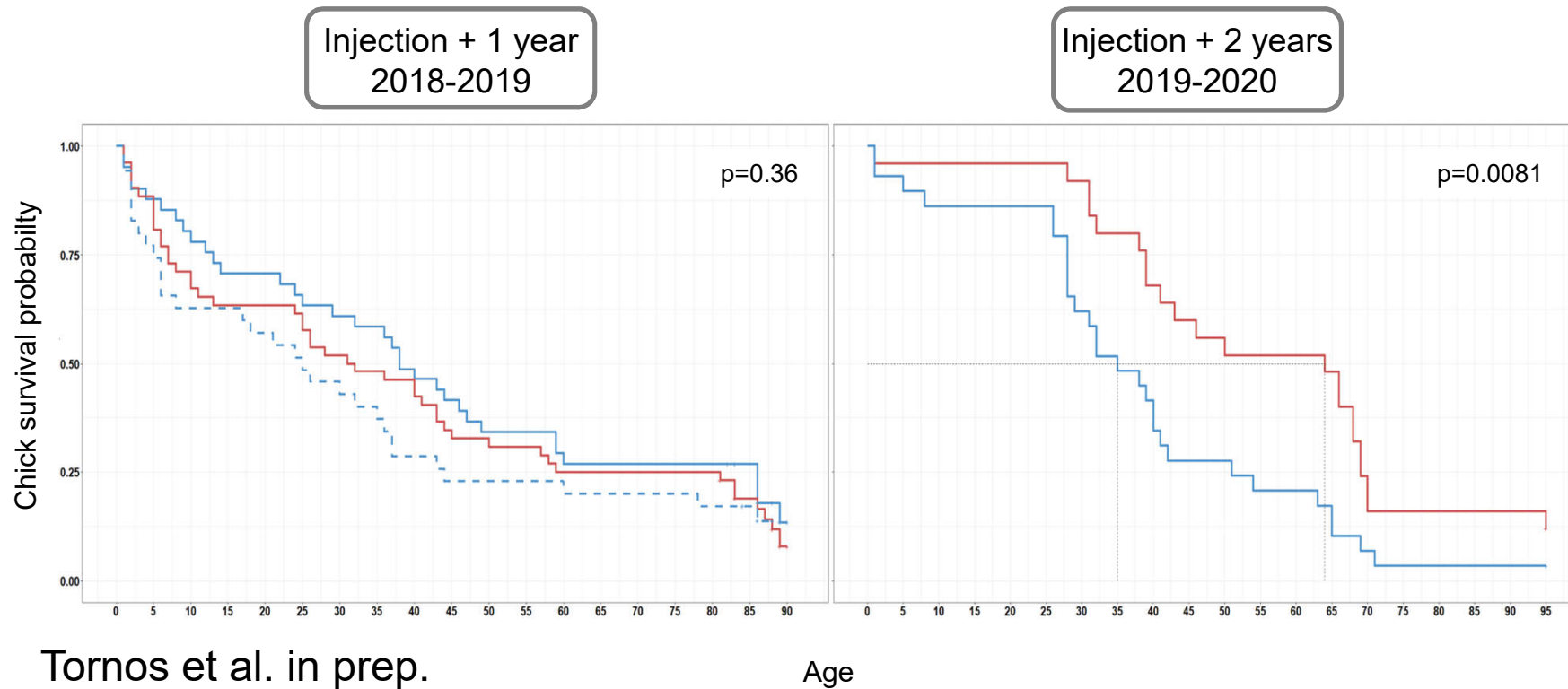
Maternal antibody transfer ?



- Strong correlation between mother and chick titres 5 days after hatching ($r = 0.92, p < 0.01$)
- Evidence of temporal persistence

Assessing the potential use of vaccination: recent results

Protective effects of maternal antibodies ?

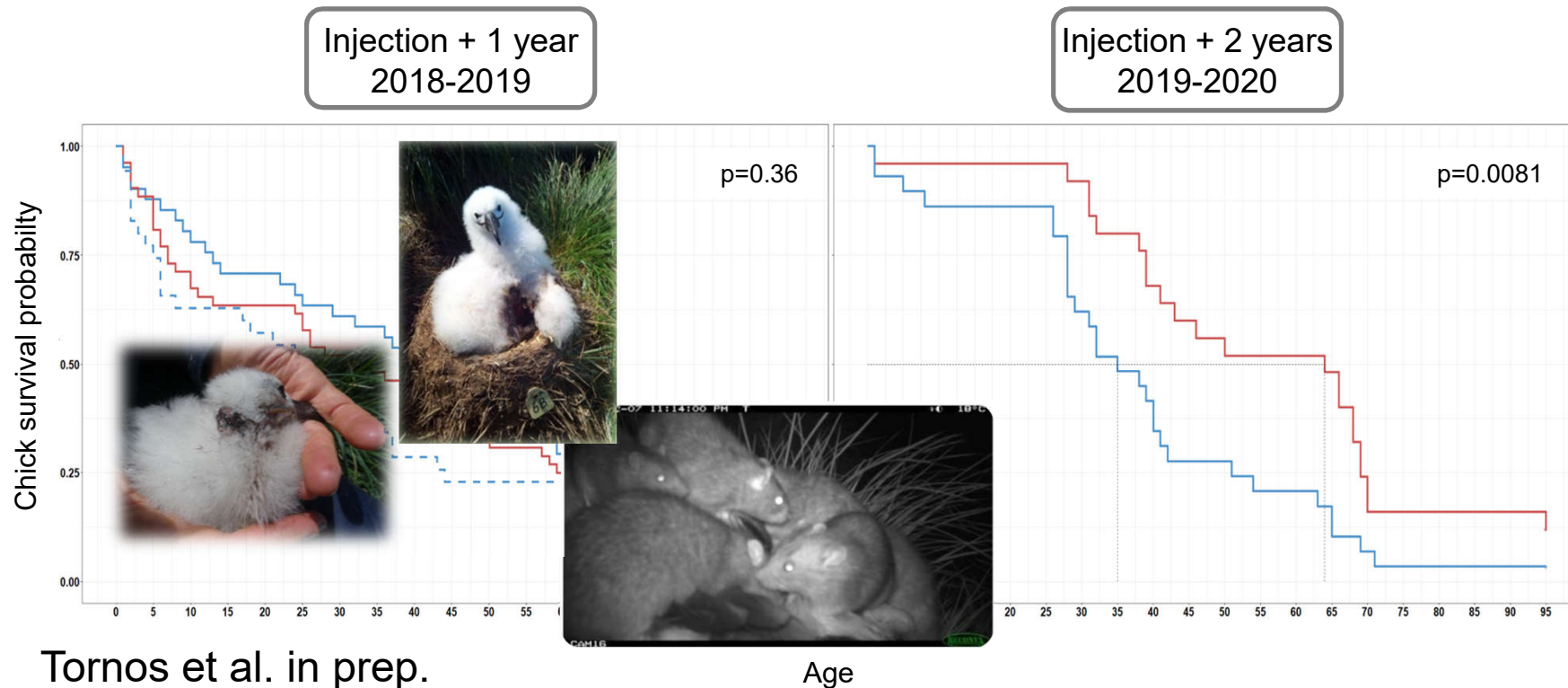


Tornos et al. in prep.

- Detection of a protective effect 2 years after vaccination, but not 1 year after vaccination, but high rat activity early

Assessing the potential use of vaccination: recent results

Protective effects of maternal antibodies ?



Tornos et al. in prep.

- Detection of a protective effect 2 years after vaccination, but not 1 year after vaccination, but high rat activity early
- Low breeding success all years, likely due to interactions with rats

Conclusion

- In the current context of global change and increasing threats to seabirds, benefits of **understanding processes** when considering **management opportunities for biodiversity conservation**
(basic science is needed)
- **Need to combine approaches**, from ecophysiology, comparative immunology to population and disease ecology
- **Vaccination** in the case of avian cholera in albatrosses is a **potentially useful tool**, but requires to deal with introduced rats



Perspectives

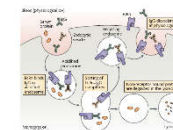
- Ongoing **introduced mammal eradication project** on Amsterdam Island should enable exploring :

- effects on the epidemiological dynamics ?
- effect on the benefits of vaccination ?



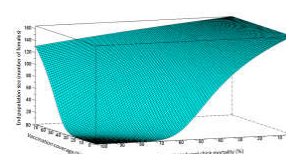
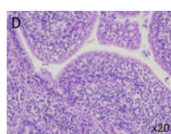
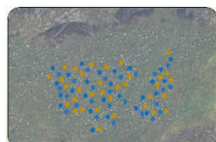
- Physiological/immunological **mechanisms** involved in maternal antibody persistence ?

Clear predictions to explore (*FcRγ-IgY interactions*)



Garnier et al. 2012 *Proc Roy Soc B*

- More broadly, need to further develop the **integration of approaches, within ecology and beyond**



Thank you for your attention and thanks to:



And several other collaborators



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