

Les invasions biologiques : comment ça marche et avec quels impacts ?

19/01/2023

Christophe DIAGNE christophe.diagne@ird.fr







Franck Courchamp (DR CNRS)

# Projet InvaCost : Les coûts économiques des invasions biologiques







Invasive alien species have **huge** and **multidimensional impacts** worldwide...



Invasive alien species have **huge** and **multidimensional impacts** worldwide...



...yet, biological invasions are **little known** as a **major problem** 

# Biological invasions: an intriguing paradox



Science and Policy for People and Nature





**Habitat destruction** 

**Climate change** 

# Biological invasions: an intriguing paradox





Franck Courchamp

Trends in Ecology & Evolution

# **Opinion** Invasion Biology: Specific Problems and Possible Solutions

Franck Courchamp,<sup>1,\*</sup> Alice Fournier,<sup>1</sup> Céline Bellard,<sup>2</sup> Cleo Bertelsmeier,<sup>3</sup> Elsa Bonnaud,<sup>1</sup> Jonathan M. Jeschke,<sup>4,5,6</sup> and James C. Russell<sup>1,7</sup>

Courchamp et al. 2017 TREE

# Biological invasions: an intriguing paradox





Franck Courchamp

Trends in Ecology & Evolution

#### Opinion

# Invasion Biology: Specific Problems and Possible Solutions

Franck Courchamp,  $^{1,\star}$  Alice Fournier,  $^1$  Céline Bellard,  $^2$  Cleo Bertelsmeier,  $^3$  Elsa Bonnaud,  $^1$  Jonathan M. Jeschke,  $^{4,5,6}$  and James C. Russell  $^{1,7}$ 

Courchamp et al. 2017 TREE





One way to quantify impacts, but also to touch nonscientists (including decision makers) is to use a metrics that they are familiar with: **currency** 



# 'Monetizing the impacts' as a lever



*Currency: a common and understandable metrics* 



Economic costs





Damage and losses Management expenditures

Bradshaw et al. 2016 *Nature Comm* Courchamp et al. 2017 *TREE* Diagne et al. 2020 *NeoBiota* 

# 'Monetizing the impacts' as a lever



Currency: a common and understandable metrics



Economic costs



Damage and losses



Management expenditures improve public communication and compel policymakers



support efficient and costeffective decision-making



**increase prioritization** in the **global** environmental **agenda** 

# **Ever-increasing** studies show **huge costs**... ...but are **restricted** to particular **taxa**, **areas** or **sectors**

A peer-reviewed open-access jour

164 | NATURE | VOL 563 | 8 NOVEMBER 2018 © 2018 Springer Nature Limited All rights res

# South Africa's invasive species guzzle water and cost US\$450 million a year

The country's first report on its biological invaders is pioneering in scope, and paints a dire picture for resources and biodiversity.

~ US\$ 450 million per year

Received 13 Feb 2016 | Accepted 18 Aug 2016 | Published 4 Oct 2016

DOI: 10.1038/ncomms12986 OPEN

# Massive yet grossly underestimated global costs of invasive insects

Corey J.A. Bradshaw<sup>1,2</sup>, Boris Leroy<sup>1,3</sup>, Céline Bellard<sup>1,4</sup>, David Roiz<sup>5,\*</sup>, Céline Albert<sup>1,\*</sup>, Alice Fournier<sup>1</sup>, Morgane Barbet-Massin<sup>1</sup>, Jean-Michel Salles<sup>6</sup>, Frédéric Simard<sup>5</sup> & Franck Courchamp<sup>1,7,8</sup>

~ US\$ 76.9 billion per year

NeoBiota 31: 1–18 (2016) doi: 10.3897/neobiota.31.6960

RESEARCH ARTICLE

NeoBiota
NeoBiota
NeoBiota
In Australia

Benjamin D. Hoffmann<sup>1</sup>, Linda M. Broadhurst<sup>2</sup>

~ AU\$ between \$2.31 and \$3.77 billion per year





floating primrose-willow in 14 African countries since 1995

mammals in Australian islands

- different temporal and spatial scales,
- different areas, sectors or taxa,
- different types of costs (damage vs management),
- different methodologies, currencies,...



No common **trends/patterns** No consistent approach No general **reommendations** 



responses at relevant scales



# The InvaCost database





- **13,553** cost entries (US\$ 2017)
- **900+** taxa
- ~180 countries
- ~2200 sources





Collaborative (120+ colleagues from more than 40 countries)



'living' (4 updates since the original version)

# **65** descriptive fields

Reference title, authors, publication year, etc.



Column_name	Definition
Cost_ID	Unique identifier for the cost entry
Repository	Literature engine (Web of Science (WoS), Google Scholar (GS), Google search engine (Go)) or original source (Targeted collection (TC)) from
Reference_ID	Identifier for the reference where the cost entry is reported. As much as possible, this is the original source where the cost was first provid
Reference_title	Title of the reference where the cost entry is reported
Authors	Authors of the reference where the cost entry is reported
Abstract	If existing/accessible, the abstract of the reference where the cost entry is reported
Publication_year	Year of publication of the reference where the cost entry is reported
Language	Main language used in the original reference reporting the cost entry
Type_of_material	Type of reference analyzed (i.e. scientific peer-reviewed article or grey literature); for grey literature, the exact nature of the reference w
Previous_materials	If any, the list of successive materials checked before reaching the original reference providing the cost entry
Availability	The accessibility of the original reference as a searchable document (yes/no)



Kingdom	Taxonomic kingdom of the invasive species associated with the cost entry
Phylum	Taxonomic phylum of the invasive species associated with the cost entry
Class	Taxonomic class of the invasive species associated with the cost entry
Order	Taxonomic order of the invasive species associated with the cost entry
Family	Taxonomic family of the invasive species associated with the cost entry
Genus	Taxonomic genus of the invasive species associated with the cost entry
Species	Taxonomic species of the invasive species associated with the cost entry
Sub-species	Taxonomic sub-species of the invasive species associated with the cost entry
Common_name	Non-scientific (or vernacular) name(s) provided in the original reference, or by t



Probable\_starting\_year\_&\_Probable\_ending\_yearYear range in which the cost is known or assumed to have occurred. When not explicitly provided by the authors, we mentioned unspecificProbable\_starting\_year\_adjusted\_&\_Probable\_ending\_year\_adjustedProbable starting year and Probable ending year columns where the cells with unspecified information are replaced, as much as possibleOccurrenceStatus of the cost estimate as potentially ongoing (if the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost was deemed and the cost can be expected to continue over time) or one-time (if the cost can be expected to continue over time) or one-time (if the cost can be expected to continue over time) or one-time (if the cost can be expected to continue over time) or one-time (if the cost can



Method\_reliability Method reliability refined

Benefit\_values Details

Method\_reliability\_refined\_Explanation Method\_reliability\_refined\_Expert\_Name

Inis states — at the time of the estimation — whether the reported cost was actually observed (i.e., cost actually incurred) or potential (i
Method used to obtain the cost estimate: report/estimation directly obtained or derived (using inference methods) from field-based infor
Sector impacted by the cost estimate in our socio-ecosystems: Agriculture (considered at its broadest sense, food and other useful produce
Damage and losses incurred by an invasion (e.g. damage-loss, damage repair, medical care, crop losses) or means dedicated to understar
Categories of the Type of cost column reassigned into damage (economic losses due to direct and/or indirect impacts of invaders, such as
Pre-invasion management (monetary investments for preventing successful invasions in an area - including quarantine or border inspectic
Assessment of the methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as of (i) high reliability if either provided by officially pre-assessed methodological approach used for cost estimation as officially pre-assessed methodological approach used for cost estimation as officially pre-assessed methodological approach used for cost estimation as officially pre-assessed methodological approach used for cost estimation as officially pre-assessed methodological a
Assessment of the methodological approach used for cost estimation as of high or low reliability based on the evaluation of the estimation
Detailed explanation why a particular methodological approach used for cost estimation was deemed as of high or low reliability based on
Complete name and contact details of the expert had deemed the reliability of the cost entry
Mention (if any) of the benefit value in the analyzed material (yes/no); the figure was not recorded or described as being out of the scope
When necessary, narrative elements deemed important either to understand the cost estimate or to support choices made for completing

1 .1 .1

# The InvaCost workshops

NeoBiota 63: 25–37 (2020) doi: 10.3897/neobiota.63.55260 https://neobiota.pensoft.net



What are the economic costs of biological invasions? A complex topic requiring international and interdisciplinary expertise

SHORT COMMUNICATION

Christophe Diagne<sup>1</sup>, Jane A. Catford<sup>2\*</sup>, Franz Essl<sup>3\*</sup>, Martin A. Nuñez<sup>4\*</sup>, Franck Courchamp<sup>1</sup>





November 12-15, 2019 near Paris (France) 47 attendees from 23 countries



November 7-11, 2022 Marrakesh (Morroco) 44 attendees from 29 countries

### Fruitful - and ongoing - collaborations

- $\rightarrow$  48 published manuscripts / 8 in revision
- $\rightarrow$  > 20 international seminars/conferences
- $\rightarrow$  Reports for different (non-scientist) audiences



### Article

# High and rising economic costs of biological invasions worldwide

https://doi.org/10.1038/s41586-021-03405-6	Christophe Diagne <sup>1⊠</sup> , Boris Leroy², Anne-Charlotte Vaissière <sup>1</sup> , Rodolphe E. Gozlan³, David Roiz⁴, Ivan Jarić <sup>5,6</sup> , Jean-Michel Salles <sup>7</sup> , Corey J. A. Bradshaw <sup>8</sup> & Franck Courchamp <sup>1⊠</sup>
Received: 8 April 2020	
Accepted: 28 February 2021	
Published online: 31 March 2021  Check for updates	Biological invasions are responsible for substantial biodiversity declines as well as high economic losses to society and monetary expenditures associated with the management of these invasions <sup>1,2</sup> . The InvaCost database has enabled the generation

- based on InvaCost v1.0 (original database: 2,419 cost entries)
- using the *invacost* R package
- only the most robust subset (~55%) considered: 'observed' and 'highly reliable' cost data



# A minimum of ~US\$ 1,288 billion between 1970 and 2017

In 2017, costs are estimated to reach US\$ 162.7 billion, more than...





... 20 times higher than the total funds available in 2016–2017

... the **gross domestic product** of **50 out of 54** African countries

# Insight 2: costs are increasing

- Consistent three-fold increase each decade
- Higher **increase** for **damage costs** compared with **management expenditures**



- Consistent three-fold increase each decade
- Higher **increase** for **damage costs** compared with **management expenditures**





→ Invasions increase (no sign of saturation)

- $\rightarrow$  'Anthropisation' increases (more introductions)
- → Climate change increases (more establishments)
- → Cost reporting, awareness and knowledge increase



### (based on InvaCost v4.0)



### Type of cost

1 17

Damage-loss costs Management costs Mixed costs

(based on InvaCost v4.0)



Management is very costly, but still worth, as losses are even more important



### Type of cost

10

1.1

Damage-loss costs Management costs Mixed costs

(based on InvaCost v4.o)



















Not all impacts are known/monetized

geographic and taxonomic biases (knowledge gaps)

# lack of distinction between invasive and native species



Don't judge species on their origins



# hardly accessible cost information(e.g. grey materials, unpublished documents)

methodological and ethical limitations (e.g. value of extinct species?)

Not all impacts are known/monetized hardly accessible cost information (e.g. grey materials, unpublished documents) geographic and taxonomic biases (knowledge gaps) methodological and ethical limitations (e.g. value of extinct species?) lack of distinction between invasive and native species often non-monetized losses (e.g. salaries, ecosystem services)



P Intensify research efforts towards under-reported regions and taxa

→ incentivizing prevention and control efforts at multiple scales



→ fostering partnerships for coordinated, adapted and sustainable management



Evaluate cost-efficiency of past and current management strategies

➔ promoting biosecurity measures and refining local control strategies

# Key Home messages

- Costs are tremendous, increasing, uneven... and largely underestimated
- Springboard for more standardized, concerted and cross-sectoral efforts
- Costs as an (additional) alert item towards the broader impacts of invaders

- Costs are tremendous, increasing, uneven... and largely underestimated
- Springboard for more standardized, concerted and cross-sectoral efforts
- Costs as an (additional) alert item towards the broader impacts of invaders

It's not all about **money**...





...(**non-monetizable**) **biodiversity** and **sanitary issues** are the greatest concerns

### Acknowledgements





Visit our website https://invacost.fr/



Franck Courchamp (CNRS Orsay)



Boris Leroy (MNHN Paris)



Elena Angulo (CSIC, Spain)



Anna Turbelin (GLF, Canada)



Liliana Ballesteros-Mejia (MNHN Paris)



& the InvaCosters!!!