INVESTIGADOR PRINCIPAL: Francisco A. Comín Sebastián

TÍTULO DEL PROYECTO: Conocimiento y gestión de los impactos de especies invasoras en la biodiversidad y los servicios del ecosistema.

ACRÓNIMO DEL PROYECTO: InvasiBES

TITLE OF THE PROJECT: Understanding and managing the impacts of Invasive alien species on Biodiversity and Ecosystem Services.

RESUMEN DE LA PROPUESTA/SUMMARY OF THE PROPOSAL

RESUMEN DE LA PROPUESTA

La invasión por especies exóticas (IAS) constituye una de las causas principales de extinción de especies y degradación de los ecosistemas, causando impactos en los servicios ambientales y el bienestar de la humanidad. Mediante el uso de datos y modelos aplicados a distintas escalas, hábitats y especies, el objetivo de **InvasiBES** es entender y anticipar los impactos multifacéticos de las IAS y proporcionar herramientas para poder manajarlas. Este objetivo se llevará a cabo mediante 5 paquetes de trabajo interelacionados. WP1 diseñará tres escenarios de intervención futuros con foco en la prevención, control y erradicación de IAS en Europa y en EEUU. WP2 adaptará protocolos de análisis de impactos (EICAT y SEICAT) para que considere impactos tanto perjudiciales como beneficiosos de IAS en la biodiversidad y los servicios ambientales. WP3 combinará esta información con mapas de distribución potencial de 100 de las IAS más perjudiciales en Europa tanto en escenarios climáticos presentes como futuros. WP4 replicará las actividades de WP3 en 100 IAS del NE de EEUU. Finalmente, WP5 realizará tres casos de estudio locales en tres hábitats (agua dulce, terrestre y marino) para cuantificar los impactos de las IAS en la biodiversidad y los servicios ambientales, y explorar la recuperación de los ecosistemas después de la eliminación de la especie invasora. Se utilizará la herramienta de planificación espacial InVEST para evaluar los costes y beneficios de distintos escenarios de intervención a escala local. **IPE-CSIC liderará el WP5**, encargándose de un caso de estudio centrado en el río Ebro. IPE-CSIC participará activamente en el resto de paquetes, en especial WP3. La combinación multidisciplinar de métodos y aproximaciones propuesta en **InvasiBES** proporcionará oportunidades únicas para desarrollar escenarios y modelos de biodiversidad y servicios ambientales relevantes para apuntalar la gestión de IAS a distintas escalas.

SUMMARY OF THE PROPOSAL

Invasive Alien Species (IAS) are among the most significant drivers of species extinction and ecosystem degradation, causing impacts on ecosystem services and human well-being. Using data and models across scales, habitats and species, the overall objective of **InvasiBES** is to understand and anticipate the multi-faceted impacts of IAS and to provide tools for their management. This will be achieved through five inter-related work-packages. WP 1 will design three future intervention scenarios focused on prevention, control and eradication of IAS in Europe and the US. WP 2 will adapt current impact assessment protocols (EICAT and SEICAT) to consider both the detrimental and beneficial impacts of IAS on biodiversity and ecosystem services. WP 3 will combine this information with maps of the potential distribution of 100 of the worst IAS in Europe under current and future climate change scenarios. WP 4 will replicate activities in WP 3 for 100 IAS in the NorthEast of US. Finally, WP5 will conduct three local scale studies in three different habiatats (freshwater, terrestrial and marine) to quantify the impacts of IAS on biodiversity and ecosystem services, and explore the recovery of ecosystems after the invader is removed. Spatial planning tools (InVEST) will be used to evaluate the costs and benefits of intervention scenarios at the local scale. **IPE-CSIC will lead WP5**, including a freshwater study in the Ebro River, and will participate in other packages, particularly WP3. The multi-disciplinary combination of methods and approaches proposed in **InvasiBES** provides unique opportunities to

develop scenarios and models of biodiversity and ecosystem services that are relevant to underpin management of IAS at multiple scales.

DOCUMENTO CIENTÍFICO

1. PROPUESTA CIENTÍFICA

Main research questions

Invasive Alien Species (IAS) are considered a direct driver of biodiversity loss and have pronounced negative impacts on supporting, provisioning, regulating and cultural services [1]. Both the numbers and distributions of IAS are increasing in many parts of the world [2], to the extent that the biogeographic distinctiveness of different regions is becoming blurred [3]. The costs of IAS, currently estimated at 12.5 to 20 billion € per year in Europe [4], and 120 billion $ per year in the US [5], are therefore set to increase. These costs mostly arise from economic loss in the agriculture, forestry, energy and health sectors, diminished delivery of ecosystem services, and cost of controlling and eradicating unwanted species. Past research on biological invasions has mainly focused on the ecological factors determining IAS success and distribution, treating ecosystem services only marginally, and focusing on particular species, habitats or ecosystem functions, such as nutrient and water cycling. Moreover, current knowledge on the impacts of IAS on ecosystem services is strongly biased towards terrestrial habitats and services that have marketable values (agriculture yields, forestry production, human health), whereas aquatic habitats and nonmarketable services are largely ignored [1]. **By synthesizing knowledge across habitats (terrestrial, freshwater and marine) and scales (continental to local), InvasiBES aims to provide a comprehensive understanding of the multi-faceted impacts of IAS on biodiversity and ecosystem services.**

The challenges posed by IAS in a global change context have prompted a strong policy response at international and national levels [6]. To support these new regulations, researchers have developed standard protocols to systematically evaluate and prioritize IAS impacts, including the *Environmental Impact Classification of Alien Taxa* (EICAT, [7]) for biodiversity, and the *Socio-Economic Impact Classification of Alien Taxa* (SEICAT, [8]) for human well-being based in the broader concept of Nature's Contributions to People (NCP) [9]. In addition to quantifying potential impacts, researchers and managers are now under growing pressure to evaluate the costs and benefits of plausible intervention scenarios to maintain ecosystem services. This is especially important in cases where IAS are perceived by society as having both positive and negative impacts (e.g. increased forage production but reduced pollination associated to invasive plants), when management options are polemic (e.g. culling introduced animals), and when the economic cost-effectiveness of management actions is unclear (e.g. when the species is already widespread). **InvasiBES aims to evaluate the costs and benefits for society and ecosystems of intervention scenarios focused on prevention, control and eradication of IAS. This knowledge is fundamental for designing pro-active management plans that can effectively address the invasion threat.**

Climate change introduces an additional challenge for IAS management because species' ranges are shifting in response to warming temperatures [10]. Climate change is expected to alter the vectors and pathways of invasion, and to prolong the frequency and duration of climatically suitable conditions for establishment, enabling invasive species to expand into regions where they previously could not survive and reproduce [11]. Unprecedented arrivals of new species, as well as range expansions of established invaders are thus expected. Yet, which species, regions and ecosystem services will be most affected by climate change remains unknown. At the same time, climate change creates a unique opportunity to prevent and eradicate range-shifting IAS before they become widespread and problematic. **InvasiBES aims to consider the interactions between IAS and climate change to ensure the most effective protection of biodiversity and ecosystem services in the context of global change.**

Continental assessments of invasion risk are useful to guide trans-national policy development. However, the impacts caused by IAS on ecosystem services vary markedly between species and habitats [12]. To inform local-scale management, quantifying how ecosystem services vary in invaded *vs.* uninvaded sites across a range of systems is critical. Moreover, local-scale analyses can reveal the direct and indirect interactions and trade-offs between ecosystem services and IAS, and provide a means to evaluate the reversibility of impacts, a key aspect to risk assessment that is difficult to determine. **Focusing on three local-scale studies that cover a range of habitats (freshwater, terrestrial and coastal), invasive species (plants and animals) and ecosystem services (supporting, provisioning, regulating and cultural), InvasiBES aims to use empirical field and experimental data to evaluate the real-world costs and benefits of IAS management.**

General objectives of InvasiBES:

Following, general objectives corresponding to each of the 5 work-packages included in the project, with leaders in brackets.

- **Objective 1**. Develop three intervention scenarios of IAS management in Europe and the US (IGB & FU Berlin; Jonathan Jeschke),
- **Objective 2.** Adapt and test impact assessment protocols to consider the beneficial and detrimental effects of IAS on biodiversity and ecosystem services (U. of Fribourg; Sven Bacher),
- **Objective 3**. Evaluate current and future impacts of IAS on biodiversity and ecosystem services in Europe (EBD-CSIC; Montserrat Vilà),
- **Objective 4.** Evaluate current and future impacts of IAS on biodiversity and ecosystem services in the US (U. of Massachussetts; Bethany Bradley),
- **Objective 5.** Evaluate the effects of IAS on biodiversity and ecosystem services using freshwater, terrestrial and marine local case-studies (**IPE-CSIC; Francisco A. Comín**).

Specific objetives of IPE-CSIC:

IPE-CSIC will specifically be in charge of Objective 5 with the following sub-objetives:

- **Objective 5.1**: to design the freshwater study in terms of focal invasive species and sampling sites.
- **Objective 5.2:** to conduct field and experimental evaluations of biodiversity and ecosystem services in invaded vs. uninvaded reaches.
- **Objective 5.3:** to estimate costs and benefits in terms of ecosystem services of management.
- **Objective 5.4:** to advance the empirical understanding of IAS impacts on biodiversity and ecosystem services and their context-dependency.

Beyond Objective 5, **IPE-CSIC will closely participate in the activities** envisaged in Objective 1 and Objective 3, and to a lower extent, Objective 2 and Objective 4 (see Table 1). Consequently, we will provide a brief overview of these objectives to allow a better understanding of the full range of responsibilities of IPE-CSIC in the project.

Table 1. Estimated working time (in months) per work package. Extracted from full international proposal. Total= 42 person/month.

	WP 1	WP 2	WP 3	WP 4	WP 5
IPE-CSIC	8	4	10	1	18

Fit of the project to the Spanish Programme of R+D

This proposal is related with two of the Societal Challenges contemplated in the Spanish Programme of R&D:

- *Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy*. This project will contribute towards accomplishing two of the priorities of the challenge, to: i) investigate the impact of global change on the expansion of invasive species, pests and diseases, and ii) apply advanced geographic technologies to natural resources management. This will be achieved through the application of advanced modelling techniques to anticipate the expansion of "IAS of interest in Europe", most of which are also priority invaders in Spain (Obj. 3), and also developing a new InVEST module to specifically address the impacts of IAS on human well-being at the local scale (Obj. 5).

- *Climate Action, Environment, Resource Efficiency and Raw Materials*. Some of the priorities that are covered in this project include i) modelling regional climate-related scenarios for Spain; ii) applied research to evaluate the impact, vulnerability and adaptation to climate change of high-diversity regions; and iii) R&D in biodiversity oriented towards the conservation and sustainable use of natural resources. Spatial models in InvasiBES cover the European continent (Obj. 3) as well as the Ebro River (Obj. 5) and open the opportunity to zoom in and analyse the situation at national scale.

Added value of the project for Spain

At the cross-roads of ecology, geography, socio-economics and spatial planning, **InvasiBES** constitutes a multidisciplinary synthesis. For the first time, this project aims to compare trends in IAS impacts across continents (Europe and North America), scales (continental and local) and habitats (terrestrial, freshwater and marine), with the ultimate goal of generating scenarios that are relevant for IAS management and conservation of nature's contribution to people. As such, this project brings an exceptional opportunity for Spain to lead a major international initiative, foster collaboration with outstanding international experts, and ultimately advance the state-of-the-art in the ecosystem services-IAS research field. The IPE-CSIC team has only briefly collaborated in international projects with some of the partners (M. Vilà, S. Bacher and J. Jeschke through the COST Action Alien Challenge), and provides expertise in fields such as ecosystem services valuation (F.A. Comín) and soil fauna (J.J. Jimenez) new to the consortium, so the potential of synergies between partners is very high. Ultimately, **InvasiBES** provides an exceptional opportunity to increase the visibility of Spain's best science and the synergy between teams, through a number of joint activities

1.1. PLAN DE TRABAJO Y RESULTADOS PREVISTOS

1.2. METODOLOGÍA

To achieve the objectives of the project, **InvasiBES** builds on previous investigations conducted by seven research teams across five different countries, benefiting from the extensive network of researchers and stakeholders they have developed over the last years. The exceptional combination of methods and approaches envisaged by **InvasiBES** and described below provides unique opportunities to underpin management at multiple scales.

Milestones and deliverables from each Objective are listed in the "CRONOGRAMA" section below.

Objective 1. Participatory planning and evaluation of scenarios of invasive species and ecosystem services.

Scale: Continental (Europe) and national (United States).

Methodological approach: participatory scenario planning.

Intervention scenarios will be co-developed with other scientists and stakeholders. There are two extreme possible intervention scenarios (Fig. 1): under a worst-case scenario, IAS are not

managed, so that by 2050 species are able to fill-in their potential climate range modelled in Objs. 3 and 4, fostered by increasing globalization. Under a best-case scenario, international coordinated action prevents the arrival of new IAS –through, for instance, border control and trade regulation— and existing IAS are managed combining eradication techniques with ecological restoration of biodiversity and ecosystem services. In between, a number of scenarios can be drawn, ideally through a participatory process involving stakeholders with practical experience in environmental management and ecosystem restoration. In all cases, intervention scenarios should consider all stages of the invasion process, and the cost-effectiveness, practicality and acceptability of alternative management options [13].

Role of IPE-CSIC: The team will participate in joint activities to design plausible future scenarios of IAS management, particularly the following:

> **Task 1.** Workshop 1 in Germany with participation of all project partners, invited stakeholders and other scientists.

> **Task 2.** Selection of 70-100 "IAS of Interest in Europe". Species will cover various habitats (freshwater, terrestrial, marine), stages of invasion (initial through to wide-spread) and impacts (Minimal to Massive). In particular, **IPE-CSIC will advise on the selection of freshwater and soil invasive species** (fields of expertise of team members).

> **Task 3.** Workshop 4 in Spain. Organized and coordinated by EBD-CSIC, the specific objectives of the workshop are to (i) integrate information generated in the project across spatial (continental to local) and temporal (current and 2050 future scenarios) scales, (ii) communicate results from the project to stakeholders and other scientists, and (iii) establish future needs.

Contingency plans: If there is disagreement between researchers and stakeholders during scenario building, we will prioritize IPBES (International Panel on Biodiversity and Ecosystem Services) recommendations to mediate conflict.

> **Objective 2. Evaluating the positive and negative impacts of invasive species on biodiversity and ecosystem services.**

Scale: Impact assessments will be applied to different spatial scales, habitats and species.

Methodological approach: expert evaluation of IAS.

The impact assessment protocols EICAT [7] and its adaptation to include socio-economic impacts SEICAT [8] will be used to score impacts on biodiversity and ecosystem services of species selected in **Task 2** in five levels: from "Minimal Concern" to "Massive". EICAT has the advantage that it has been officially adopted by the IUCN, and thus, our implementation at the continental scale can be used as a proof-of-concept for international adoption of the protocol. These protocols currently consider only detrimental impacts, and we aim to adapt them to also quantify beneficial impacts (e.g. pollination, social value) that are important to resolve conflicting situations.

Role of IPE-CSIC: As experts in freshwater (F.A. Comín) and soil (J.J. Jimenez) biodiversity, IPE-CSIC will participate in the evaluation of the impacts of invasive species. In particular:

> **Task 4.** Workshop 3 in Switzerland to provide training on how to use the adapted protocol. IPE-CSIC will **send a postdoc** to this workshop to receive training, which substantially reduces uncertainty in scoring among assessors and is an essential part of an expert elicitation process.

Contingency plans: If there are doubts regarding the implementation of S/EICAT, they will be solved during the training course or by e-mail to reduce uncertainty and bias among assessors.

> **Objective 3. Assessing and mapping the impacts of invasive species on biodiversity and ecosystem services in Europe.**

Scale: Continental (Europe).

Methodological approach: Species Distribution Modeling (SDM).

State-of-the-art modelling techniques will be used to correlate the presence of each "IAS of Interest" selected in Europe (**Task 2**) with the environmental conditions of their native and introduced range. Models allow anticipating the potential expansion of species under current and future 2050 scenarios, identifying regions of maximum concern because of their susceptibility towards invasion. SDMs will account for uncertainty in data availability (bias-analyses), modelling approach (ensemble models) and climate change forecasts (multiple IPCC scenarios).

Role of IPE-CSIC: In 2017, IPE-CSIC's former team member B. Gallardo led a study that modelled the potential distribution of 100 of the worst IAS in Europe under current and future climate change scenarios [14]. These maps are indicative of the full potential distribution of some of Europe's worst invasive species if they are not managed, thereby representing the "worst scenario" (Fig. 1). In parallel, the European project VOLANTE generated maps of ecosystem services supply including cultural (leisure), provisioning (food/fibre and raw materials provision), and regulating (climate, water, extreme events, biological control, pollination, genetic diversity) services. By crossing maps indicative of IAS potential range with maps of ecosystem services supply, InvasiBES will be able to go beyond species distributions and assess potential impacts under a range of climate and management scenarios. We expect that the majority of "IAS of Interest" in Europe selected in **Task 2** have been already modelled in this previous investigation, and will **follow the same methodology** to model any further species. For this reason, B. Gallardo, soon to be appointed postdoc at Cambridge University (UK), will be invited to collaborate in this activity. In particular:

> **Task 5.** Model the potential distribution of "IAS of Interest in Europe" selected in **Task 2** under current and 2050 climate change scenarios, weight them by their impacts on ecosystem services (**Task 4**), and overlap them with maps of ecosystem service supply in Europe. **IPE-CSIC will closely collaborate with EBD-CSIC** (leaders of this work-package) **providing the following: models and maps from** [14], **advise on the best methodology to achieve the goals of Objective 3, and a high-performance computer** (20 CPU, 60-GB RAM, 8-TB storage) **to run and storage models using the R-server platform**.

Contingency plans: In case our dedicated computer server has not enough power to run the models, we will take advantage of CSIC's cluster "Trueno".

Objective 4. Evaluate current and future impacts of IAS on biodiversity and ecosystem services in the US.

Scale: National (USA).

Similar to Objective 3, here we will use state-of-the-art modelling techniques to prioritize range-shifting invasive plants and marine organisms that have not yet been reported in parts of the US but are projected to expand with climate change, and to anticipate the threat posed by IAS to biodiversity and ecosystem services under three alternative intervention scenarios.

Role of IPE-CSIC: Since the participation of the IPE-CSIC team in the development of this objective is limited, we haven't described the associated tasks, which can be found in the full InvasiBES international proposal.

Objective 5. Evaluate the effects of IAS on biodiversity and ecosystem services using freshwater, terrestrial and marine local case-studies.

Scale: Local, several locations in Europe and the US.

Methodological approach: combining field, experimental and modelling techniques.

At the local scale, a number of invaded and uninvaded sites across freshwater, terrestrial and marine habitats will be selected to measure differences in the field in biodiversity and ecosystem services. In addition, managed sites and/or removal experiments will be used to follow the recovery of ecosystem services, assessing the reversibility of impacts. Using the data generated, we will use the software InVEST to model spatially the provision of ecosystem services, biodiversity and trade-

offs at the local/regional scale [15]. In contrast to the continental evaluations of Objectives 3 and 4, case studies will provide real on-the-ground information to test the accuracy of impact assessments like S/EICAT and quantify the real costs and benefits of alternative management decisions.

Role of IPE-CSIC: As leader of this work-package, **IPE-CSIC will ensure coordination among the three local-scale studies**, and the appropiate selection of ecosystem services to be modelled with the spatial planning software InVEST to evaluate the costs and benefits of alternative intervention scenarios. This Objective can be divided into the following sub-objectives:

Objective 5.1: to design the study in terms of focal invasive species and sampling sites.

Task 6. Identify freswater IAS of interest in the Ebro River. Potentially: the apple snail (*Pomacea canaliculata*), present in the Ebro delta since 2009, and the blue crab (*Callinectes sapidus*) present since 2012.

Task 7. Identify sampling sites that are invaded, uninvaded and that have been recently managed by local authorities (N=15 of each, total= 45 sampling sites per species). To accomplish this task, and after the recommendation of local authorities (CHE), we will subcontract the services of "Paleoymas", a company that has been commanded the erradication o *P. canaliculata* over the last 5 years, and the sampling of *C. sapidus* since 2018. The extensive field experience of this company in the area of study and precise knowledge of the river stretches that have been managed justifies this contract.

Objective 5.2: **to conduct field and experimental evaluations of biodiversity and ecosystem services in invaded vs. uninvaded reaches.**

Task 8. Field work to be conducted over the first and second years of the project (2019 and 2020), subcontracting part of the work to Paleoymas. Water, sediment and biological samples will be processed in IPE-CSIC's main laboratory. We will consider complementing field work with *in situ* or *ex situ* inclusin/exclusion studies to better understand the impacts of IAS presence/absence on ecosystems.

Objective 5.3: **to estimate costs and benefits in terms of ecosystem services of management.**

Task 9. Use statistical analyses and spatial planning software (InVEST) to evaluate the costs and benefits of the alternative intervention scenarios of IAS management at the local scale.

Task 10. Taking the module for land-use change as reference, use field and experimental information together with additional land-cover information available at InVEST to parametrize a new module that allows evaluating the consequences of alternative IAS management decisions.

Objective 5.4: to advance the empirical understanding of IAS impacts on biodiversity and ecosystem services and their context-dependency.

Task 11. Statistically compare results from the three case studies envisaged in InvasiBES (freshwater in Spain, terrestrial in France and marine in California). We will agree on common methodological standars at the beginning of the project to ensure that data from local studies is comparable.

Task 12. Write a scientific review of the local impacts of IAS on ecosystem services across freshwater, terrestrial and marine ecosystems and the costs and benefits of management.

Contingency plans: If we find difficulties locating invaded/uninvaded/managed sites in the Ebro River, we will change species (e.g. *Corbicula fluminea* and *Dreissena polymorpha*) and/or look for other river stretches and tributaries. If any of the field campaigns programmed in 2019 and 2020, fails, we will conduct and additional one the last year of the project, 2021. If we are unable to create a new InVEST package devoted to invasive species, we will apply the existing Habitat Risk Assessment module, treating invasive species as a "stressor".
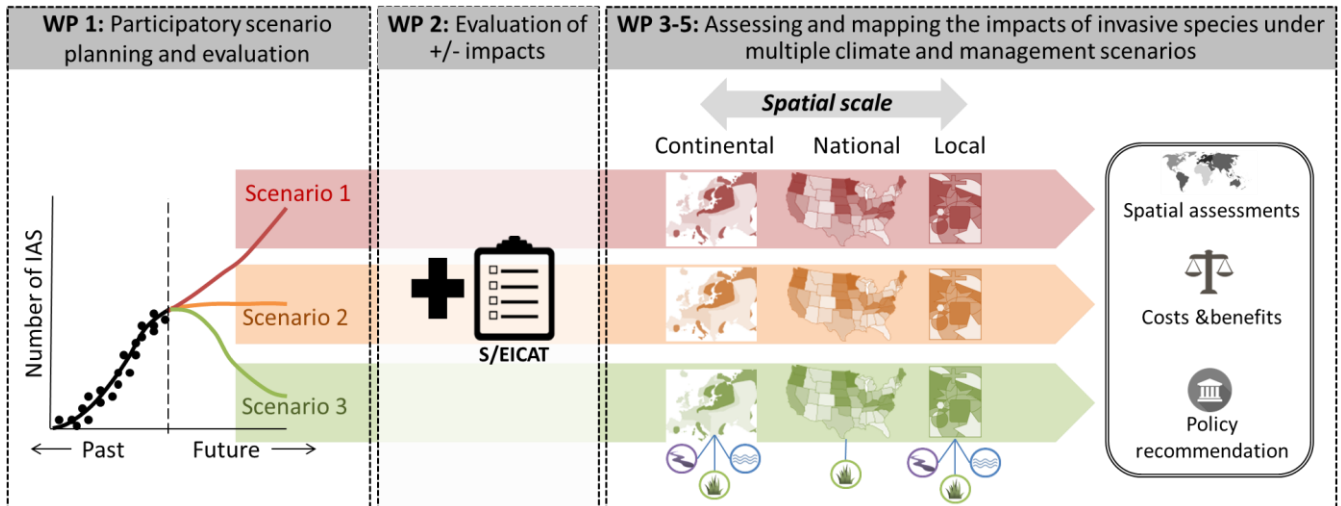
Figure 1. InvasiBES aims to use scenarios and models to understand and manage the impacts of Invasive Alien Species (IAS) on biodiversity and ecosystem services. First, intervention scenarios will be co-developed with other scientists and stakeholders based on past trends in IAS and current policies (WP 1). Second, standard protocols such as EICAT and SEICAT (S/EICAT) will be used to test and evaluate the impacts of IAS on biodiversity and ecosystem services (WP 2). This information will be then used to generate spatially-explicit assessments of the threat posed by IAS to biodiversity and ecosystem services across habitats (freshwater, terrestrial, marine) and scales (continental-WP 3, national-WP 4 and local-WP 5), under a range of climate change and intervention scenarios. Deliverables of the project include spatially-explicit assessments, evaluation of the costs and benefits in terms of ecosystem services, and policy recommendations associated to each intervention scenario.

Explanations concerning the budget

InvasiBES is ambitious but realistic within the timelines of the call (3 years) because it: 1) builds upon substantial scientific progress developed by project partners, 2) makes use of established regional and international networks of stakeholders, and 3) counts with a Principal Investigator (coordinator of the full project M. Vilà, from EBD-CSIC) with strong leadership and coordination capacities, and abundant experience managing large research projects. Consequently, the project counts with a solid knowledge and experience base, not only in evaluating the consequences of biological invasions for ecosystem services, but also organizing large workshops in the cross-road between research and management.

The advanced field and experimental sampling and ecological modelling planned in this proposal **require an experienced researcher** that can fulfil the activities on time. Consequently, a large part of the requested funding is for **personnel**. In IPE-CSIC, we have anticipated hiring one postdoc (2 years, full time), and have also budgeted visits of the postdoc to all workshops and to EBD-CSIC, Germany and Switzerland for joint work, as well as participation to national and international conferences. To optimize travelling costs, we will carefully plan Workshops together with Consortium Meetings and other major national or international scientific events.

Field work costs are distributed in "Viajes y dietas" (to and from field-work), "Fungibles y similares" (laboratory analyses) and "Otros gastos" (related to field and laboratory analyses). Part of "Otros gastos" will be used to subcontract the company Paleoymas, currently in charge of prospections and eradication of aquatic invasive species in the Ebro River, experience that is fundamental to achieve the objectives of our project (see work-plan of Objective 5).

Other costs are mainly for computer material, bibliographic material and open access fees.

Facilities, equipment and other singular means available for the project

Most of the equipment needed to conduct field and experimental work, as well as a high-performance dedicated server for modelling is provided by the group.

1.3. CRONOGRAMA

With indication of objectives, milestones (H), deliverables (E) and periods of work by trimesters (T).

Obj 1: **Participatory planning and evaluation of scenarios of invasive species and ecosystem services.**

Responsable: J. Jeschke (IGB & FU Berlin, Germany) & B. Bradley (U. Massachussetts, USA)

Participantes (from IPE-CSIC): F.A. Comín, J.Jiménez and requested postdoc.

Período de ejecución (en trimestres): T1 – T11

H1 – "IAS of Interest" in Europe and the US identified. T2

H2 – Three intervention scenarios of IAS management in Europe and the US co-designed. T4

E1 – Reports describing and comparing the three intervention scenarios of IAS management for EU and the US, respectively. T5

E2 – Policy briefing including results from the different Objectives, future research needs, and recommendations for policy development and implementation. T11

Obj 2: **Evaluating the positive and negative impacts of invasive species on biodiversity and ecosystem services.**

Responsable: S. Bacher (U. Fribourg, Switzerland).

Participantes (from IPE-CSIC): requested postdoc.

Período de ejecución (en trimestres): T3 – T8

Obj 3: **Assessing and mapping the impacts of invasive species on biodiversity and ecosystem services in Europe.**

Responsable: M. Vilà (EBD-CSIC, Spain)

Participantes (from IPE-CSIC): F.A. Comín, J.Jiménez and requested postdoc. Considering her previous experience modelling species, IPE-CSIC will invite B. Gallardo (**University of Cambridge**, UK) to participate in workshops envisaged in this work-package. According to Art.7.5, this researcher cannot be included as part of the research team but their activities can be funded as long as they are included in this work-plan.

Período de ejecución (en trimestres): T1 – T12

H3 – Spatially-explicit assessment of the threat posed by IAS to biodiversity and ecosystem services in Europe and its potential evolution under a range of climate and management scenarios. T10.

E3 – European maps of the potential distribution of "IAS of Interest" under current and 2050 climate scenarios, and identification of hotspots of invasion. T3.

E4 – European maps of the potential impacts on ecosystem services of "IAS of Interest" under current and 2050 climate scenarios, and identification of the most vulnerable areas. T6.

Obj 5.1: **To design the study in terms of focal invasive species and sampling sites.**

Responsable: F.A. Comín (**IPE-CSIC**, Spain)

Participantes: F.A. Comín, J.J. Jiménez and requested postdoc (**IPE-CSIC**).

NOTE: Considering her previous experience sampling invasive species in the Ebro River, we

will invite Belinda Gallardo (**University of Cambridge**, UK) to participate in the field work activities envisaged in this work-package. According to Art.7.5, this researcher cannot be included as part of the research team but their activities can be funded as long as they are included in this work-plan.

Período de ejecución (en trimestres): T1

H4 – Field and experimental study design. T1

Obj 5.2: **to conduct a field and experimental evaluation of biodiversity and ecosystem services in invaded vs. uninvaded reaches.**

Responsable: F.A. Comín (**IPE-CSIC**, Spain)

Participantes: F.A. Comín, J.J. Jiménez and requested postdoc (**IPE-CSIC**).

NOTE: Considering her previous experience sampling invasive species in the Ebro River, we will invite Belinda Gallardo (**University of Cambridge**, UK) to participate in the field work activities envisaged in this work-package. According to Art.7.5, this researcher cannot be included as part of the research team but their activities can be funded as long as they are included in this work-plan.

Período de ejecución (en trimestres): T2 – T3, and T6 – T7.

H5 – Empiric evaluation of IAS impacts on ecosystem services across freshwater habitats. T7.

Obj 5.3: **To estimate costs and benefits in terms of ecosystem services of management.**

Responsable: F.A. Comín (**IPE-CSIC**, Spain)

Participantes: Requested postdoc and J.J. JIménez (**IPE-CSIC**), .

Período de ejecución (en trimestres): T1 – T8

H6 – Empiric evaluation of IAS impacts on ecosystem services across freshwater habitats. T8.

E5 –Publication describing the impacts of IAS on biodiversity and ecosystem services in freshwater habitats. T8

E6 – InVEST module to evaluate the effects of IAS management decisions on the local provision of ecosystem services. T8

Obj 5.4: **To advance the empirical understanding of IAS impacts on biodiversity and ecosystem services and their context-dependency.**

Responsable: F.A. Comín (**IPE-CSIC**, Spain)

Participantes: F.A. Comín, requested postdoc and J.J. JIménez (**IPE-CSIC**), .

Período de ejecución (en trimestres): T8

H7 – Comparison of IAS impacts on ecosystem services across different type of habitats. T8

E7 –Review publication about the impacts of IAS on biodiversity and ecosystem services across a range of habitats. T8

Other Milestones and Deliverables

As part of the international consortium IPE-CSIC team will participate in the following genereal Milestones and Deliverables (also included in the Cronograma below):

H8 – Recruitment of postdoctoral fellows. T1.

H9 – Coordination Committee and work-package leaders appoint Scientific Officer, Engagement Officer and Data Manager. T1.

H10 – Consortium meetings. T1, T6 and T11.
E8 – Consortium Memorandum of Agreement. T2.
E9 – Mid-term report monitoring the progress of the project. T6.
E10 – Final report of the project. T12.

1.4. CRONOGRAMA (GRÁFICO)

IPE-CSIC project starts: 31/12/2018.   Duration: 2 years.

Objetivo	Año1(trimestres)				Año2(trimestres)				Año3(trimestres)			
	1	2	3	4	5	6	7	8	9	10	11	12
1	X	H1	X	H2, E1	X	X	X	X	X	X	E2	
2					X	X	X	X				
3	X	X	E3	X	X	E4	X	X	X	H3	X	X
4												
5.1	H4											
5.2		X	X			X	H5					
5.3							X	H6, E5, E6				
5.4								H7, E7				
General	H8, H9, H10	E8				H10, E9					H10	E10

2. DIFUSIÓN Y TRANSFERENCIA DE LOS RESULTADOS

Because IAS are recognized as important, albeit underestimated, drivers underlying biodiversity loss, **InvasiBES** has exceptional potential to inform future assessments of IPBES. Specifically, **InvasiBES** contributes towards reducing the barriers identified by IPBES as impeding the widespread use of scenarios and models by (i) considering the views and needs of stakeholders from the beginning and all along the duration of the project (WP 1); (ii) measuring multiple sources of uncertainty (e.g. in expert assessment of IAS, modelling distributions, climate change scenarios, and field measurements as mentioned in WPs 2-5); (iii) using state-of-the-art models to translate scenarios of drivers and policy interventions into projected consequences for nature (modelling techniques envisaged in WPs 3-5); (iv) linking scenarios and models across scales (continental-WP 3, national-WP 4, local-WP 5) and timeframes (current, 2050), and (v) using models and scenarios to inform policy implementation in Europe and the US (as described in WP 1).

End users and stakeholder engagements

Reasons to undertake stakeholder engagement in **InvasiBES** are multiple, including to (a) provide clearer understanding of the benefits of research for the management and conservation of nature's contribution to people; (b) raise awareness about the impacts of IAS on biodiversity and ecosystem services; (c) create networks of organizations with common interests, sharing knowledge and data; (d) promote science-based decision making and implementation; (e) create channels of communication and dissemination of project results; (f) promote open-access to scientific knowledge; (g) identify knowledge gaps and information needs; and (h) anticipate and manage impacts to improve contingency plans.

IPE-CSIC has well established research-stakeholder networks including several organizations with the capacity to influence the success of InvasiBES. Based on this experience Table 2 identifies a preliminary list of stakeholders, including contact persons to evidence support, and categorizes them depending on the expected level of engagement in the project.

Table 2. Summary of strategic stakeholders for InvasiBES. Contact persons within each organization are included in brackets. See abbreviations at the foot of the table.

	Level of involvement in the project			
	Collaborate	**Involve**	**Consult**	**Inform**
Public administrations	EU-Commission (S. Leiner) Northeast RISCC (C. Brown-Lima)	National authorities: MAPAMA in Spain (I. Lorenzo), BfN in Germany (S. Nehring), Umweltbundesamt in Austria (W. Rabitsch), NY ISRI in the US		Water Authorities (CHE, J. San Román) Regional Authorities (DGA, J. Guerrero; AMAYA, E. Dana)
International organizations and NGO	IUCN-ISSG (P. Genovesi & K. Smith) BirdLife Int. (D. Heptinstall)	CABI-ISC (P. González-Moreno, R. Shaw) RSPB (C. Carboneras) WWF	AEMS-Rios con vida	GEIB (L. Capdevila)
Research networks or associations	AISECO (F.Comín) Neobiota (M. Vilà) TrIAS (T. Adriaens)	SER (F.A. Comín) Aquainvad-ED (E. Tricarico) INVASIVESNET (F. Lucy)	InDyNet (J. Jeschke) NNSS (O. Booy)	CCI (E. Allen) ICHN (J. Pino) AEET (F. LLoret) LandLife
Private organizations		Land trusts (TTOR, Mass Audubon) Land owners	CEC (D.C. Aldridge) Paleoymas (C. Rubio)	Ramboll Environment, GoCOnsult
General public	Artists Researchers from same discipline	Researchers from same discipline	Researchers from different disciplines	Educators, students, local and national media. Local communities. Natural history museums

AEET: Spanish Society for Terrestrial Ecology. **AISECO**: Spanish Society for the Integration of Ecosystem Services. **Aquainvad-ED**: Innovative Training Netowrk on Aquatic IAS. **BfN**: Bundesamt für Naturschutz. **CCI**: Cambridge Conservation Initiative. CEC: Cambridge Environmental Consulting. **GEIB**: Specialist Group on Biological Invasions. **ICHN**: Catalan Institute of Natural History. **InDyNet**: Invasion Dynamics Network. **ISSG**: IUCN's Invasive Species Specialist Group. **LandLife**: Life project promoting land stewardship. **MAPAMA**: Spanish Ministry of Agriculture, Fisheries, and the Environment. **Mass Audubon**: Massacusetts Audubon wildlife sanctuaries. **NEOBIOTA**: European Group on Biological Invasions. **NNSS**: UK's Non-Native Species Secretariat. **NY ISRI**: New York Invasive Species Research Institute. **RISCC**: Northeast Regional Invasive Species and Climate Change. **SER**: Society for Ecological Restoration. **TrIAS**: Tracking Invasive Alien Species. **TTOR**: The trustees of reservations.

We will invite stakeholders presented in Table 2 to provide feedback at several stages of the project. Stakeholders in the Collaborate category will be invited to attend Workshops 1 and 4 programmed in Obj. 1 and contribute with their views and experience to the development of scenarios. Workshops among the scientific community and stakeholders will foster transdisciplinary discussions and address complex issues at the borders of different disciplines. US partners will organize a working group of invasive pest council representatives from RISCC to support the regulatory listing of high priority species identified in the project. Stakeholders in the Involve category will be informed about the objectives of the project, encouraged to share data and knowledge useful to the project, and to provide feedback on those aspects most relevant for them. Stakeholders in the Consult and Inform categories will be updated on the progress of the project

and the target of outreach activities directed to raise awareness about the impacts of IAS on biodiversity and key ecosystem services such as food and water security, climate adaptation and supply of biological materials, among others. This will be done in collaboration with relevant stakeholders (e.g. public administrations, NGOs, local associations).

2.1. PLAN DE DIFUSIÓN

2.2. PLAN DE TRANSFERENCIA Y EXPLOTACIÓN

Communication Plan

The results of InvasiBES are of high interest for policy stakeholders and practitioners who aim to invest IAS management resources efficiently and solve potential conflicts using science-based analyses of costs and benefits for ecosystems and society. Furthermore, knowledge and data produced in the framework of this proposal will support the implementation of European and US policies, strategies and actions to improve management of IAS, mitigate potential negative effects and, ultimately, promote sustainability.

Table 3. What: Major deliverables of the project; Who: target group of stakeholders (see more details in Table 2); Why: reasons for engagement.

What	Who	Why
Presentations outlining the project	Collaborate	Ensure an early visibility of the project and initiate the relationship with stakeholders Ensure timely dialog with stakeholders
Report describing three intervention scenarios	Collaborate, Involve	Co-design project with stakeholders Understand stakeholder views and develop more realistic scenarios Share experiences in IAS management across borders
Artistic expressions (e.g. drawings, comics, or short movies)	Consult, Inform	Increase the visibility of project activities and results Improved dissemination of research results Promote links between science and society
Report + training material about S/EICAT	Collaborate	Improve learning and comparability of assessments Sense of inclusion and involvement
Spatial analysis of IAS patterns and impacts on biodiversity and ecosystem services	Collaborate, Involve, Consult, Inform	Anticipate negative outcomes if IAS are not managed Potential to improve modelling methods Better knowledge applied in policy and practice
Scientific publications and press releases	Collaborate, Involve, Consult, Inform	Opportunity to influence future research Transfer knowledge with researchers in the discipline Enhanced impact of research
Databases including evidence of IAS impacts on biodiversity and ecosystem services	Collaborate, Involve	Provide findings that can be used in feedback loop with stakeholders Enhanced impact of research
Policy briefing	Collaborate, Involve, Consult, Inform	Strengthen science-policy interface Ensure relevance of research outputs at national and international levels
Online dissemination of results	Collaborate, Involve, Consult, Inform	Increase the visibility of project activities and results Promote links between science and society Create communication channels to improve knowledge transfer and feedback with workshop participants

Results will be presented as oral and poster communications in **national and international scientific meetings** (e.g. NEOBIOTA, EMAPI, ESA) every year. Scientific publications will be

13

submitted to major journals in ecology and environment, including those with a socio-economics, management and/or policy focus. The project has a high potential to generate high-impact publications due to its Novelty and potential to advance state-of-the-art, and the exceptional track-record of project partners, including two Highly Cited Researchers (M. Vilà and S. Bacher), a total of 28 "Highly Cited Papers" in the top 1% of Ecology/Environment, and publications in high-profile journals such as *Science*, *Trends in Ecology & Evolution*, and *Ecology Letters*. Whenever possible, results from the project will be published as Open Access, otherwise stored in digital repositories and available upon request. Publications along with a statement of relevance for policy making will be sent to *Science for Environment Policy*, the news and information service of the EU Commission that have featured 7 of the partners' publications in recent years. Press releases directed at news media across 5 countries in two continents and active participation in social networks – using artist expression to better visualize models and scenarios – will help disseminate the results of the project. Data, reports and publications will be made openly available through the project's webpage and digital repositories.

Publication Working Groups (WGs)

For each scientific publication arising from data and models generated by **InvasiBES**, the project partners will decide on Publication WGs that will collaborate in collating and analysing data, writing the publications and mobilising the full potential of the consortium towards high-impact, interdisciplinary, collaborative publications. The leader of each individual WG will be in charge of the writing with collaboration of other co-authors, submitting to the target journal, and coordinating activities to maximize the impact of the publication by, for instance, issuing a press-release, sharing the publication through social media and specialized blogs, and presenting the work in national and international conferences. The Publication WGs will update the Coordination Committee on their progress via the website and e-mail list.

3. RELACIÓN DE LAS PERSONAS QUE COMPONEN EL PLAN DE TRABAJO

1. Prof. Francisco A. Comín. D-C-I
2. Dr Juan José Jiménez. D-C-I
3. Postdoc 1. D-C-T

NOTE: As described in the "Cronograma", we will invite B. Gallardo (**University of Cambridge**, UK) to participate in some of the activities envisaged in this project: attendance to meetings (Obj. 3 and 5) and participation in field-work (Obj. 5). As a researcher with foreign affiliation, she cannot be included as part of the research team but her activities (basically consisting on "Viajes y dietas") can be funded as long as they are mentioned in this work-plan (BOE 178: 38912, Art.7.5).

4. PRESUPUESTO DE LA AYUDA SOLICITADA
NA

5. IMPLICACIONES ÉTICAS Y/O DE BIOSEGURIDAD DE LA INVESTIGACIÓN PROPUESTA
NA.

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