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### **Appendix 1. Supplementary information**

This document contains supplementary text and graphics to complement the indicated sections of the parent article on the AS-ISK decision support tool (Figure 1S). References, figures and table cited in this document and not preceded by ‘S’ refer back to those of the parent article. Whereas, Figures S2–S5 and Tables S1 and S2 are contained within this document, with references in Table S2 cited using a numerical system to enhance conciseness.

#### **Protocols**

Within the *Biogeography/Historical* section, the three question (Q) categories *Domestication/Cultivation*, *Climate, distribution and introduction risk* (previously, *Climate and distribution*) and *Invasive elsewhere* all retain the same number of questions (Qs) as in FISK (i.e. three, five and five, respectively). However, in the *Domestication/Cultivation* category, Q1 now includes a ‘20 generations’ constraint for domestication/cultivation, Q2 differs by referring to the taxon’s harvesting rather than the establishment of self-sustaining populations, and Q3 on invasive taxonomic sub-entities remains virtually unchanged. Domestication is important because of the potential for enhanced fitness of domestic strains when cultivated (e.g. growth rate, mating success and/or fecundity), which can contribute to increased invasiveness (e.g. see Copp et al. 2005). In the *Climate, distribution and introduction risk* category, Q4 has been generalised to encompass the climate matching between the RA area and the taxon’s native range, and Q5 on climate matching quality data is unchanged; whereas Qs 6–8 have been modified to eliminate repetitions of (overlaps in) FISK Qs so that the first two Qs address the taxon’s presence in the RA area and the possible introduction pathways thereof, and the latter Q evaluates the likelihood of un/intentional introductions. In the *Invasive elsewhere* category, Qs 9–11 remain near-identical save for slight re-wording, Q12 combines the former ‘rivers, lakes or amenity values’ under the more generic term ‘ecosystem services’, and Q13 queries the occurrence of adverse socio-economic impacts (thereby eliminating the previously redundant Q in FISK on invasive congeners).

Within the *Biology/Ecology* section, only the *Undesirable (or persistence) traits* (previously, *Undesirable traits*) and *Reproduction* categories retain the same number of Qs as for FISK (twelve and seven, respectively). Amongst the other categories, *Resource exploitation* (previously, *Feeding guild*) now includes only two Qs instead of four: *Dispersal mechanisms* has eight instead of nine Qs, and *Tolerance attributes* (previously, *Persistence attributes*) has six instead of five Qs.

In the *Undesirable (or persistence) traits* category, Qs 14, 23 and 25 on danger to human health, tolerance to water velocity, and minimum population size viability remain near-identical. Whereas, Qs 15, 16, 22 and 24 on smothering, parasitism, ultimate body size and behaviours, respectively, have been re-worded to reduce ambiguous terminology and/or uncertainty in interpretation of Qs. The remaining Qs differ from those of FISK and address issues of adaptability (Q17), food-web disruption (Q18), adverse impacts (Q19), and hosting/vectoring for pests (Qs 20 and 21). In *Resource exploitation*, the somewhat convoluted arrangement of related questions in FISK has been resolved into consumption (Q26) and sequestering (Q27) of food resources. In the *Reproduction* category, re-wording of Qs 28–32 was minor, whereas the wording of Qs 33 and 34 on propagule/offspring production and age at first reproduction, respectively, was considerably improved.

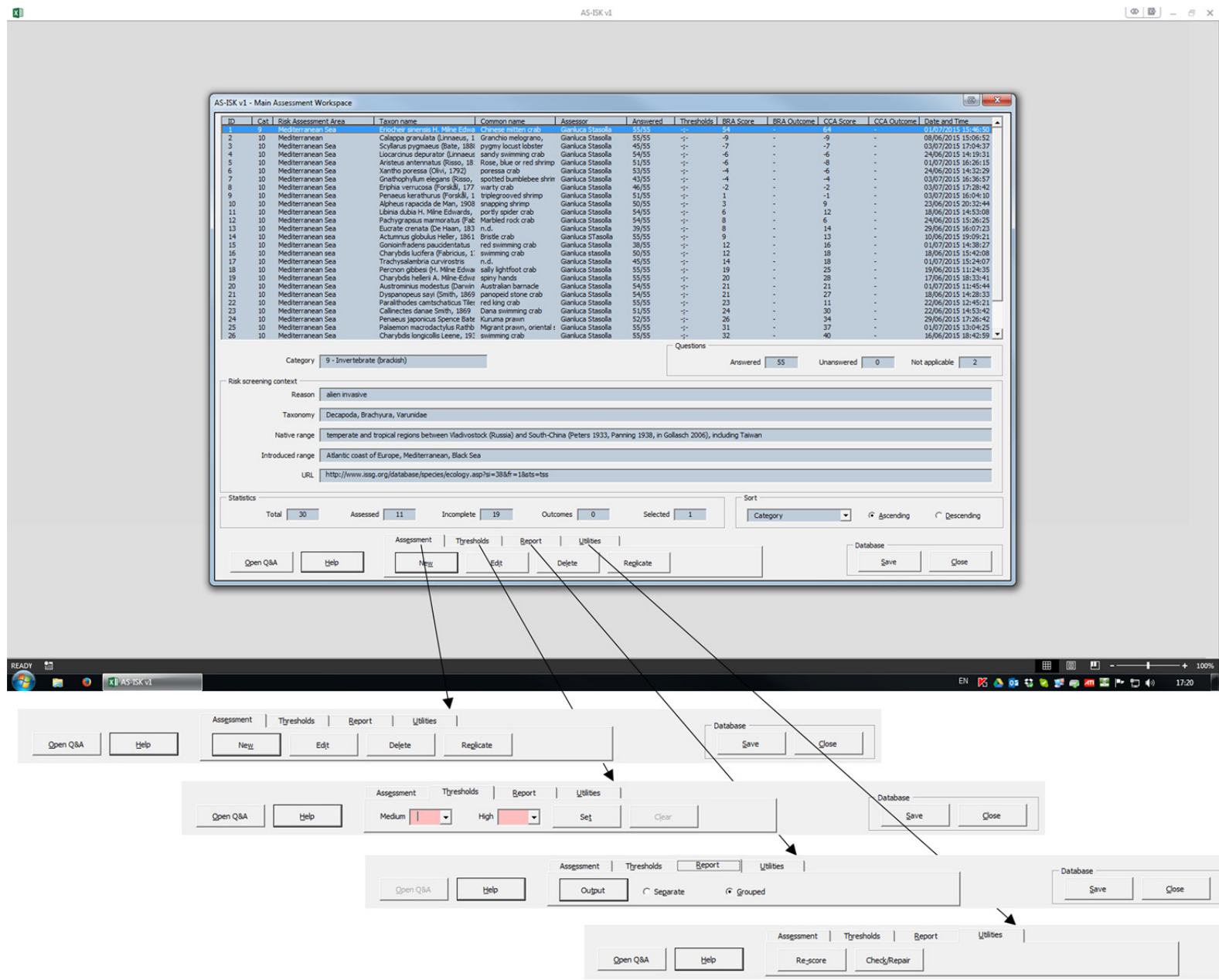


Figure S1. AS-ISK Main Assessment Workspace with indication of the four tabs of controls.

In the *Dispersal mechanisms* category, Qs 38, 39, 41 and 43 on dispersal of eggs or propagules, dispersal of larvae/juveniles or fragments/seedlings, dispersal by other animals, and density-dependence of dispersal, respectively, were re-worded, as was Q40 on migration to be more generally on 'older life stages'. Whereas, Qs 35–37 and 42 differ from those of FISK by addressing potential internal pathways, the likelihood of pathways into protected areas, the ability of the taxon to attach itself to substrata, and the relative speed of the dispersal process, respectively. Finally, in *Tolerance attributes*, all Qs (44–49) were re-worded, but note that Qs 44 and 48 on desiccation and salinity tolerance were moved to this category from the *Undesirable traits* category, their location in FISK.

## **Electronic toolkit**

### *Pre-loading*

Before AS-ISK can load into its own session, a check is performed for Excel<sup>®</sup> version compatibility. Owing to some VBA code-related features, AS-ISK (which is deployed as a Microsoft Excel<sup>®</sup> Macro Enabled Worksheet: extension “.xism”) runs under Excel 2007 or higher in Windows<sup>®</sup> 7 (under which it was developed) and Windows<sup>®</sup> 8 and, backwardly, in Windows XP<sup>®</sup> and Vista<sup>®</sup>. Notably, owing to its 'dictator' features, AS-ISK takes over the entire Excel user interface (whose original settings, however, are restored upon exiting the program), but still allows the opening of other Excel<sup>®</sup>-based sessions (processes) independent of the one where AS-ISK is running.

### *Start*

As a stand-alone, dialog-driven application AS-ISK requires a spreadsheet (either located on the user's local computer or remotely accessible from the network) to be opened as the assessment database source file (Figure S2a). Two main options are available, namely: (i) *Open* either an *Existing* or a *New* assessment worksheet (database) (Figure S2b), or (ii) *Import* a previous assessment worksheet originally created from one of the FISK family of toolkits for re-assessment under AS-ISK (Figure S2c).

When initiating a species assessment with AS-ISK, the user currently has five language options to choose from (i.e. English, French, Italian, Spanish, Turkish) and, depending on the local computer's Excel<sup>®</sup> language settings, AS-ISK will default to the local language (if available, otherwise to English). Notably, as many languages as desired can be added to the toolkit GUI, depending on users' demand. To this end, the supporting language templates (i.e. including question text and related guidance plus all text for the GUI controls) can be provided by the developer (LV) for translation by any interested users. Finally, the AS-ISK interface is available in ten colour schemes for the user to select, even during a session (unlike the language, which can only be chosen for the entire session).

### *Main Assessment Workspace*

The core user interface component of AS-ISK is the *Main Assessment Workspace* from which all assessment-related data manipulations can be performed (Figure 1S). This dialog includes an assessment list organised into (sort-able) columns that provide information on the *Category* within which the aquatic organism is being assessed. In total, 16 categories are included, encompassing the full range of aquatic organisms: mammal, reptile, bird, amphibian, fish (fresh water), fish (brackish), fish (marine), invertebrate (fresh water), invertebrate (brackish), invertebrate (marine), plant (fresh water), plant (brackish), plant (marine), algae (fresh water), algae (brackish), algae (marine) (each indicated by a corresponding category identification number ranging from 1 to 16).

Additional information is provided on the *Risk Assessment (RA) Area*, *Taxon name*, *Common name*, *Assessor*, number of *Answered* questions, *Thresholds* (set following calibration), *BRA Score* and *CCA Score* and their corresponding (threshold-dependent) *BRA Outcome* and *CCA Outcome*, as well as *Date and Time* (i.e. when the assessment was last modified). Also in this dialog, for each assessment in the list, detailed information is provided about the corresponding *Category* and *Risk Screening Context* (including *Reason*, *Taxonomy*, *Native range*, *Introduced range*, and *URL*), overall *Statistics* are given (indicating the *Total* number of assessments in the list, the number of these that have been *Assessed* or left *Incomplete*, the number of *Outcomes* and of *Selected* assessments in the list), and a *Sort* option (either *Ascending* or *Descending*) is available for all columns (except ID).

Data manipulation is facilitated by the logical arrangement of the options available into four separate sections (tabs) (Figure S2): (i) in the *Assessment* section, the user can either create a *New* assessment or *Edit* an existing one (including *Batch edit* multiple assessments according to one of the following and required fields: *RA Area*, *Taxon name*, *Common name*, *Assessor*), *Delete* one or more assessments, or *Replicate* an assessment (see below); (ii) in the *Thresholds* section, the user can *Set* (or

*Re-set*) or *Clear* the *Medium* and *High* thresholds set following calibration either for individual or multiple assessments (taxa); (iii) in the *Report* section, the user can *Output* one or more reports, with the option of producing either *Separate* reports or a *Grouped* one in the latter case; and (iv) in the *Utilities* section, the user can *Re-score* individual or multiple assessments and *Check/Repair* the entire database for any errors.

From the present dialog, the *Open Q&A* button launches the assessment dialog proper (see below), and the user can *Save* the local changes to the assessment list into the source spreadsheet database from which the assessment data were retrieved for the current AS-ISK session. Notably, all GUI features in this dialog are 'smart' meaning that their behaviour changes dynamically based on the user's selections.

#### *New/Edit*

In this dialog, the user provides all details of the taxon being assessed, either by creating a new assessment (Figure S3a), editing an extant assessment (Figure S3b), or batch editing multiple assessments (Figure S3c). There are ten fields in total grouped into two main sections, namely: (i) *Taxon and Assessor Details*, including the aquatic organism *Category*, *Taxon name*, *Common name* and *Assessor* (all are required fields), and (ii) *Risk Screening Context*, including the *Reason* for carrying out the assessment, the *RA Area* (required), the *Taxonomy*, *Native range* and *Introduced range* of the taxon, plus the optional inclusion of a *URL* for reference to a web page providing additional resources.

In line with AS-ISK's smart GUI philosophy, the behaviour of all fields in this dialog is context-dependent, with their colour changing depending on whether or not information has been provided and if they were in edit mode. Also, error checking for text-related constraints (i.e. length of text and typing of unsupported characters for certain required fields, trimming of extra spaces) is implemented automatically by the program through real-time detection of the user's input.

#### *Replicate*

This dialog (Figure S4) allows replication of an assessment selected from the *Main Assessment Workspace*. This option is useful when, for example, starting a series of assessments for multiple taxa relative to a certain *RA Area* and/or carried out by the same *Assessor*. Nine fields in total can be replicated, namely all those available in the *New/Edit* dialog except for *Category*. The maximum number of replicates is currently limited to 10 000 (i.e. the maximum number of taxa that an AS-ISK database spreadsheet can include) minus the number of assessments already present in the Assessment list (even though support for up to 1 048 572 assessments would be theoretically possible but subject to computer memory availability).

#### *Q&A*

In the Q&A (Questions & Answers) dialog (Figure S5), the user carries out the assessment for the taxon selected from the *Main Assessment Workspace*. In total, 55 questions (Qs) must be answered for an assessment to be completed, even though there is no response order imposed and the assessment can be accessed/resumed at any time (this feature was already introduced in FISK v2 as an improvement to the FISK v1 more basic GUI). The only constraint is that for any question, information relative to *Response*, *Confidence* and *Justification* must be provided. As in FISK v2, 'fast-navigation' (*Jump to Q*) options are available in this dialog, with the additional possibility of clearing either individual questions (*Clear Q Fields*) or the entire assessment (i.e. all 55 Qs: *Clear All Qs*) as well as to quit any changes without saving (hence, reverting back to the original assessment i.e. prior to editing: *Close No Commit*) instead of saving any changes and exiting the dialog (*Commit and Close*).



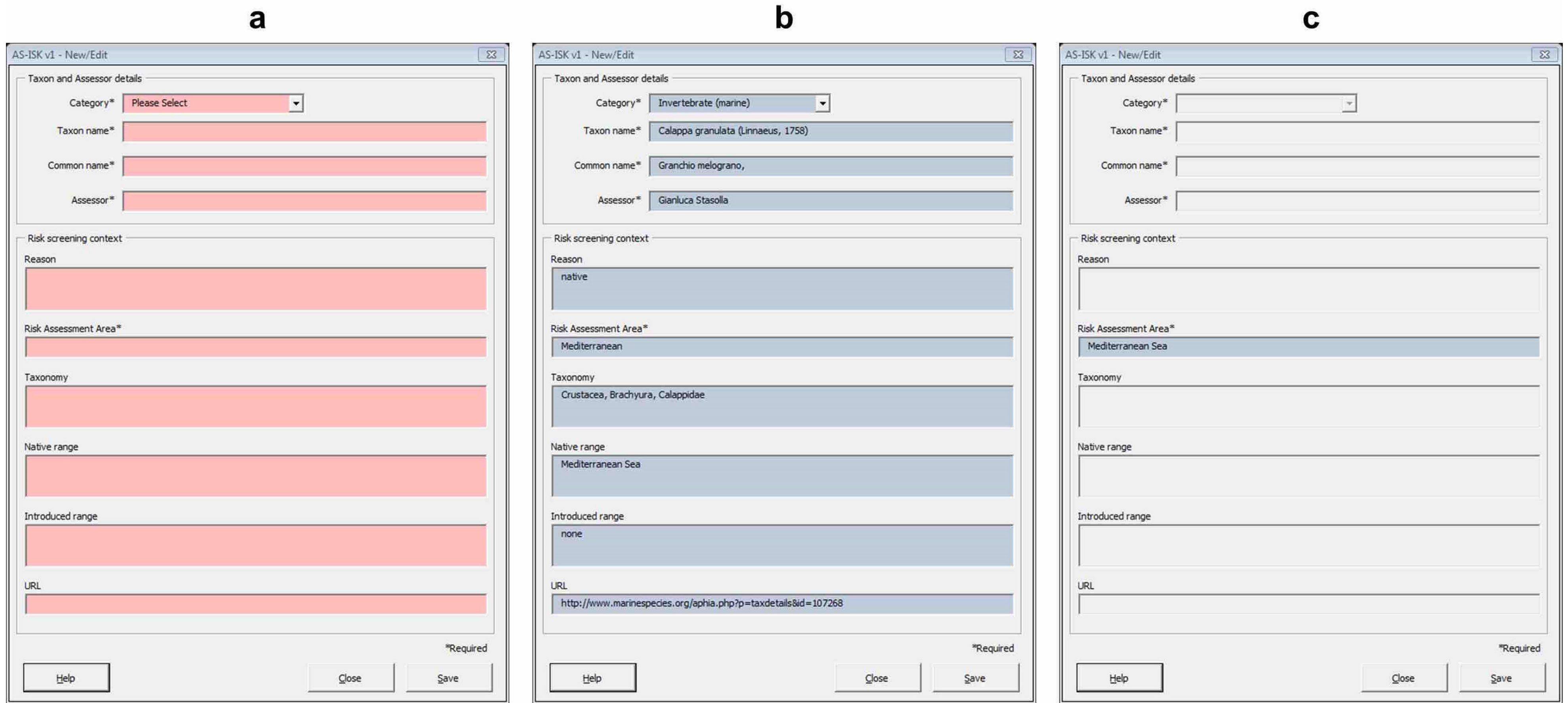
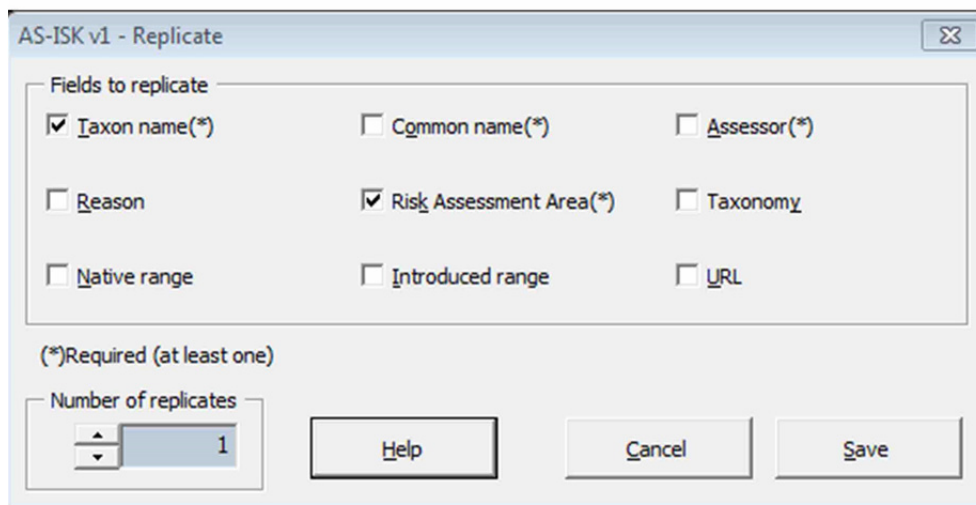


Figure S3. AS-ISK *New/Edit* dialog when (a) creating a new assessment, (b) editing an existing one, or (c) batch-editing multiple existing ones.



**Figure S4.** AS-ISK *Replicate* dialog.

The assessor is required to: i) respond to a sequence of questions, with each answer accompanied by appropriate bibliographic references and/or other information (e.g. use of expert opinion) to justify the response; and ii) rank the level of confidence/certainty associated with their response using the confidence rankings recommended by the International Programme on Climate Change (IPCC 2005): ‘Low’ confidence (2 out of 10 chance), ‘Medium’ confidence (5 out of 10 chance), ‘High’ confidence (8 out of 10 chance), ‘Very high’ confidence (9 out of 10 chance); see also Copp et al. (2008, 2016a).

In line with AS-ISK’s smart GUI approach, for each question, information is provided to the assessor on the Q being answered and to which section (i.e. BRA, Qs 1–49; or CCA, Qs 50–55) it belongs, with the corresponding full text and guidance also displayed. Extant assessments from FISK, MFISK, FI-ISK, MI-ISK or Amph-ISK (see *Introduction*) can be imported to AS-ISK, and a question compatibility field appears for BRA Qs to assist the assessor in converting the previous assessment to an AS-ISK assessment. Given the lack of 100% backward compatibility between the 49 BRA Qs of the taxonomic “-ISK” toolkits and those of AS-ISK (see Table 1), information is provided on the level of similarity or lack thereof as: ‘Near identical’, ‘Similar’ and ‘Different’. As an improvement to FISK v2, ‘mapping’ is provided relative to the number of *Answered*, *Unanswered* and *Not applicable* Qs (limited to a maximum of five). Smart coloring of the controls throughout informs the assessor as to whether or not the assessment is complete, whereas the edit-mode sensitive colouring has remained identical to that in FISK v2.

AS-ISK v1 - sally lightfoot crab (*Percnon gibbesi* (H. Milne Edwards, 1853)) - Gianluca Stasolla - A. Biogeography/Historical: 1. Domestication/Cultiva... ✖

Basic Risk Assessment - Question 1 of 55

Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?

Question Guidance

The taxon must have been grown deliberately and subjected to substantial human selection for at least 20 generations, or it must be known to be easily reared in captivity (e.g. fish farms, aquaria or garden ponds, loch or fjord enclosures). This may be in the organism's native or introduced ranges.

Response:  Confidence:  -ISK Q Compatibility:

Justification (references and/or other information)

n/d

Jump to Q

1 - Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?

Navigation:     Assessment:

Answered Qs: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55

Unanswered Qs:

Not Applicable Qs: 53 54 55

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Figure S5. AS-ISK Q&A dialog.



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