



Biosecurity
COMMONS

Surveillance Design – Quick Start Guide



Last modified: 6 November 2024

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Surveillance Design

Pre-border measures and border control protocols constitute critical components in mitigating biosecurity risks, although complete threat elimination remains unattainable. In regions potentially exposed to biological threats, regulatory authorities implement comprehensive surveillance systems as their primary risk management framework. These systems are designed to facilitate early detection protocols, enabling authorities to identify and respond to potential outbreaks before they escalate to levels that could precipitate significant economic disruption, social instability, or environmental degradation.

Surveillance systems also serve a crucial verification function, establishing and maintaining documentation of disease-free status within specified regions. This verification mechanism is instrumental in both preserving existing trade relationships and facilitating the restoration of market access following biosecurity incidents. Furthermore, these systems generate critical data regarding ground-level response operations, including the delineation of outbreak, progression monitoring, and quantitative assessment of eradication initiatives.

Regardless of the objective, a fundamental challenge faced by surveillance practitioners is determining where to prioritise surveillance, and how much to allocate.

Biosecurity Commons provides a comprehensive Surveillance Design workflow that enables users to optimize their surveillance resource allocation through sophisticated analytical tools. This system can leverage geographic mapping capabilities, location-specific probability assessments, and actual occurrence data, while incorporating surveillance effectiveness metrics and operational constraints, including budgetary limitations and required detection confidence levels.

The workflow allows users to optimise surveillance allocation using different objectives including:

- **Minimising total costs** (that is surveillance resource costs plus likely incursion management costs, estimated with and without detection)
- **Maximising a total non-monetary benefit measure** (e.g. species richness)
- **Maximising a total saving** (or monetary benefit minus surveillance costs)
- **Maximising overall detection confidence or sensitivity** (that is the probability of detection if the invasive species is present)

For more details about the Surveillance Design please see the [Surveillance Design workflow](#) overview support article.

Linkages to other workflows

Outputs of Surveillance Design can be used directly as inputs in other workflows, such as:

- Informing **Proof of Freedom** by:
 - Using outputs of surveillance sensitivity based on different optimisation strategies to determine confidence or probabilities of absence given no detections occur
- Informing **Resource Allocation** for determining where surveillance effort (and confidence) will be greatest

Creating a Surveillance Design

Step 1. Create a new project

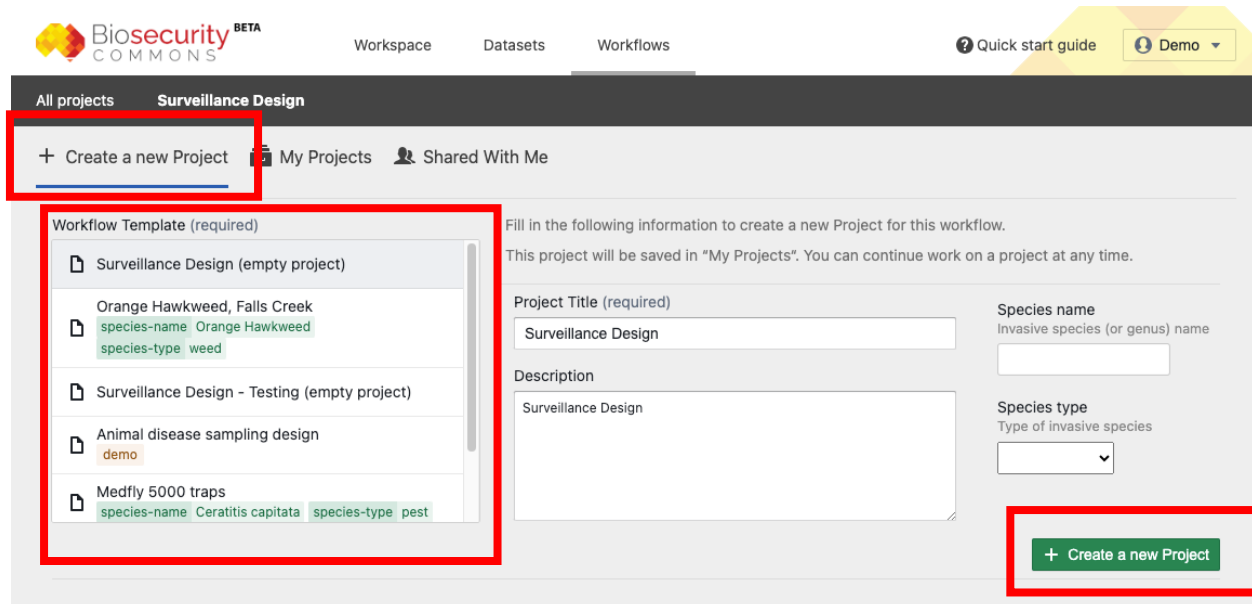
Select the Surveillance Design workflow and then select “Create a new Project” (see screenshot below).

When creating a new surveillance design project, users have the option to select an empty template, initially titled “Biosecurity Surveillance Design”, which can be renamed appropriately, or one of a range of prepopulated templates that have been constructed as examples of the workflow or based on previous case studies (e.g. “Orange Hawkweed, Falls Creek”).

The empty template is ideal for those wishing to create a brand-new surveillance design as it contains:

- The basic structure of the Surveillance Design workflow
- No preloaded datasets (except for the default region, albeit this can be easily changed)

By contrast, example templates provide users with the opportunity to see a completed demonstration of how surveillance designs can be produced, or if based on a real-world case study, how others have attempted to create a model.



Select a template and then give your project an appropriate title. Users can optionally provide additional descriptive details under the Description, Species name and Species type fields. These metadata are presently unused but will provide future flexibility in filtering and summarising projects.

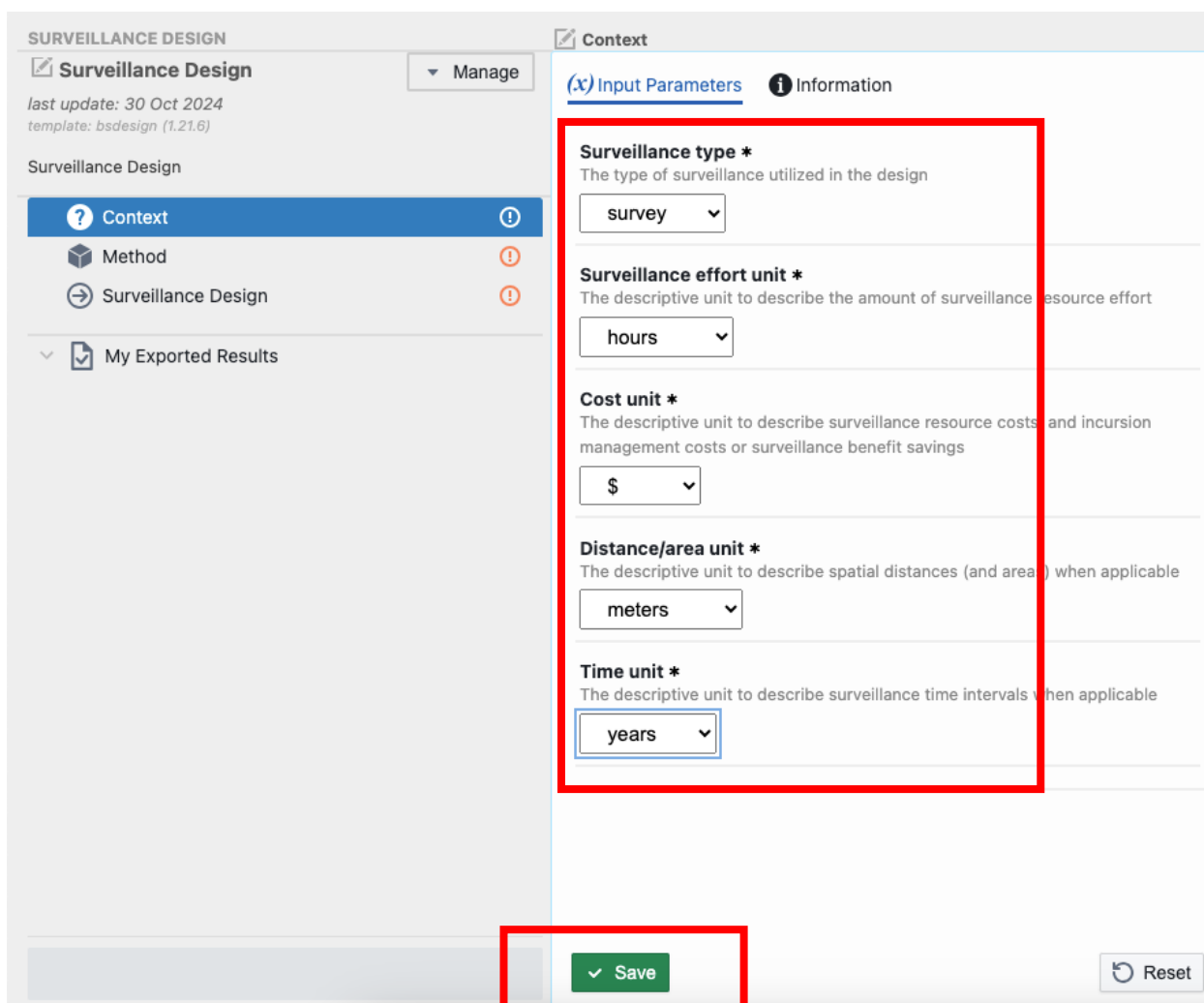
Once details have been provided, click the green “Create a new Project” button in the bottom right-hand corner to continue.

When you start a Surveillance Design workflow from an empty template you will be presented with the core elements of the Surveillance Design workflow on the left side of the screen – “Context”, “Method” and “Surveillance Design”. Orange exclamation points indicate steps that require attention and, as you progress through the project, these change to green ticks when complete.

Step 2. Specify your context

Select appropriate details of the context of your surveillance, including:

- **Surveillance type:** The type of surveillance utilized in the design (e.g. surveys, traps, samples)
- **Surveillance effort unit:** The unit to express quantities of surveillance (e.g. units, hours, traps, samples)
- **Cost unit:** The unit to describe surveillance, management, and/or benefit costs (e.g. \$, hours)
- **Distance/area unit:** Unit for distances or areas where applicable (m or km)
- **Time unit:** Unit for time measures where applicable (years, months, weeks, days, etc.)



SURVEILLANCE DESIGN

Surveillance Design Manage

last update: 30 Oct 2024
template: bsdesign (1.21.6)

Surveillance Design

- Context
- Method
- Surveillance Design
- My Exported Results

Context

(x) Input Parameters Information

Surveillance type *
The type of surveillance utilized in the design
survey

Surveillance effort unit *
The descriptive unit to describe the amount of surveillance resource effort
hours

Cost unit *
The descriptive unit to describe surveillance resource costs and incursion management costs or surveillance benefit savings
\$

Distance/area unit *
The descriptive unit to describe spatial distances (and area) when applicable
meters

Time unit *
The descriptive unit to describe surveillance time intervals when applicable
years

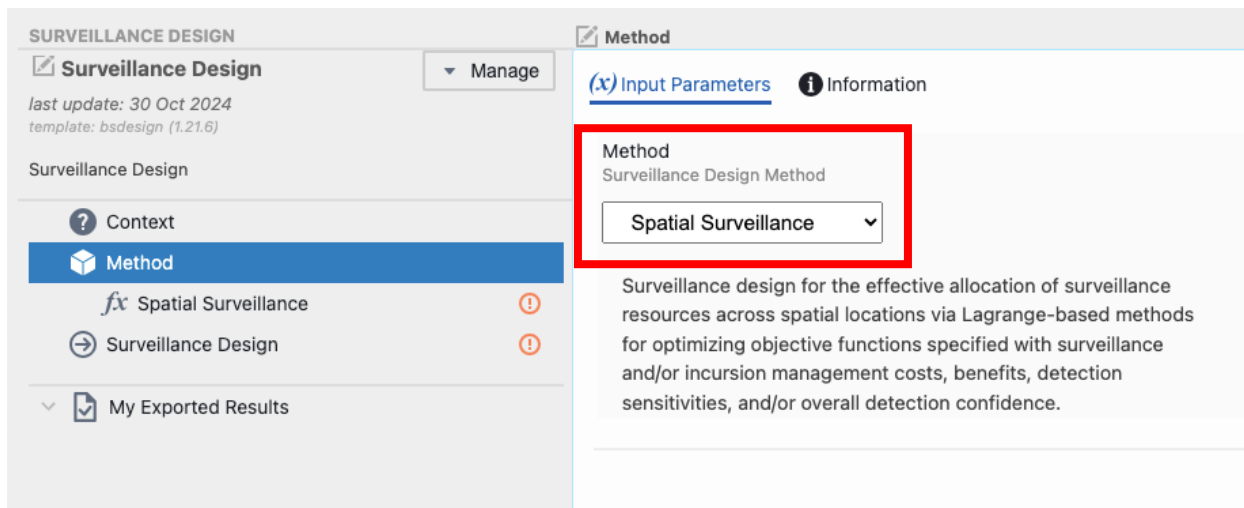
Save Reset

“Save” your selections when finished.

Step 3. Specify your method

Select your surveillance design method. Currently the following methods are available:

- **Spatial Surveillance:** For the effective allocation of surveillance resources across spatial locations
- **Sampling Surveillance:** For the effective allocation of surveillance sampling across one or more divisions (parts, locations, categories, etc.)



The screenshot displays the 'SURVEILLANCE DESIGN' interface. On the left, a sidebar shows navigation options: 'Context', 'Method' (highlighted in blue), 'Spatial Surveillance', 'Surveillance Design', and 'My Exported Results'. The main content area is titled 'Method' and includes tabs for '(x) Input Parameters' and 'Information'. A red box highlights a dropdown menu labeled 'Method' with the text 'Surveillance Design Method' and the selected option 'Spatial Surveillance'. Below this, a descriptive text reads: 'Surveillance design for the effective allocation of surveillance resources across spatial locations via Lagrange-based methods for optimizing objective functions specified with surveillance and/or incursion management costs, benefits, detection sensitivities, and/or overall detection confidence.'

Other surveillance design methods are anticipated in future versions of the Biosecurity Commons platform.

Depending on the surveillance type the user selects, different options will become available.

1. Spatial Surveillance

Selecting “Spatial Surveillance” will prompt users to specify the following:

- **Region** (*required*): Study spatial region for the design
- **Occurrence probability** (*required*): Probability values to represent the likelihood of invasive species occurrence at each region spatial location
- **Efficacy** (λ) (*required*): Detection rate configuration parameter for each region spatial location, such that the detection probability when present is $1 - \exp(-\lambda * \text{allocation})$ for a given allocation of surveillance resources. May be single value or spatially distributed across locations.
- **Optimisation strategy** (*required*): For finding an effective surveillance allocation (options described above) selection:
 - Cost (minimum)
 - Benefit (maximum)
 - Saving (maximum)
 - Detection (maximum)
- **Allocated surveillance cost** (*optional*): Cost per unit of allocated surveillance
- **Fixed cost** (*optional*): Fixed additional cost applied to allocated locations (e.g. travel cost)
- **Constraint** (*required when optimisation strategy is benefit or detection*): Available allocation budget or overall target confidence (*sensitivity*). Results in dynamic inputs
 - Surveillance budget (*Required when budget constraint selected*): Allocation budget value in appropriate units
 - Confidence (*Required when confidence constraint selected*): Target overall detection confidence or sensitivity (e.g. 0.95)
- **Minimum Allocation** (*optional*): Minimum permissible allocation quantity (avoids infeasibly small allocations to locations)
- **Discrete Allocation** (*optional*): Checkbox to indicate allocation should be whole numbers (e.g. traps, samples)

SURVEILLANCE DESIGN

Surveillance Design Manage

Last update: 30 Oct 2024
template: bodesign (1.21.6)

Surveillance Design

- Context
- Method
- Spatial Surveillance**
 - REGION
Bogong High Plains template WGS84
 - OCCURRENCE PROBABILITY
Orange hawkweed suitability WGS84
 - EFFICACY (LAMBDA)
Orange hawkweed surveillance efficacy WG
- Surveillance Design
- My Exported Results

Spatial Surveillance Input Parameters Information

Region *
The region for surveillance design

Bogong High Plains template WGS84

Modify Info View

Occurrence probability *
Probability values to represent the likelihood of pest occurrence at each spatial location specified by 'region'. Values are assumed to be relative when their maximum is greater than 1

Orange hawkweed suitability WGS84

Modify Info View

Efficacy (lambda) *
Efficacy or detection rates for each spatial location specified by 'region', such that the probability of detecting an incursion, when present, can be expressed via $pr(\text{detect}|\text{presence}) = 1 - \exp(-\lambda \times \text{allocation})$, for a given allocation of surveillance resources.

Specify efficacy as either a single value for the entire region or via a spatial layer

Across Locations

Orange hawkweed surveillance efficacy WGS84

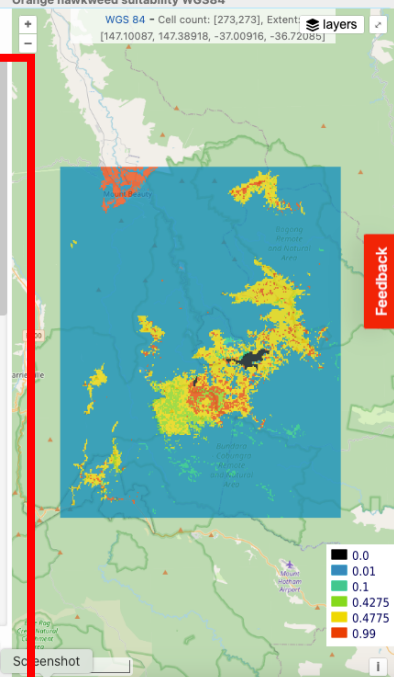
Save Reset Screenshot

Orange hawkweed suitability WGS84

WGS 84 - Cell count: [273,273], Extent: [147.10087, 147.38918, -37.00916, -36.72086]

layers

Feedback



“Save” your selections when finished.

2. Sampling Surveillance

Selecting “Sampling Surveillance” will prompt users to specify the following:

- **Sampling type** (*required*): Discrete or continuous sampling design
- **Optimal** (*required*): For finding an effective surveillance allocation (options described above) selection
 - Cost (minimum)
 - Benefit (maximum)
 - Saving (maximum)
 - Detection (maximum)
- **CSV** (*required*): Table containing appropriate parameter columns (dependent on optimal selected)
 - Common columns
 - **region_id** (*required*): Identifier for each division (part, location, category, etc.)
 - **establish_pr** (*required*): Establishment probability for each division
 - **prevalence** (*required*): Design prevalence for each division
 - **sample_sens** (*required*): Sample sensitivity (probability of detection when present) for each division
 - **fixed_cost** (*optional*): Fixed additional cost applied to each allocated division
 - **sample_cost** (*optional*): Cost per sample at each division
 - **total_indiv** (*optional*): Total individuals (e.g. trees, animals) that could be sampled at each division
 - Additional columns for optimal cost
 - **mgmt_cost_detected** (*required*): Estimated management cost for each division when incursion detected
 - **mgmt_cost_undetected** (*required*): Estimated management cost for each division when incursion undetected
 - Additional columns for optimal benefit
 - **benefit** (*required*): Non-monetary benefit measure for each division
 - Additional columns for optimal saving
 - **benefit** (*required*): Monetary benefit measure for each division
- **Constraint** (*required when optimisation strategy is benefit or detection*): Available allocation budget or overall target confidence (sensitivity). Results in dynamic inputs
 - Surveillance budget (*required when budget constraint selected*): Allocation budget value in appropriate units
 - Confidence (*required when confidence constraint selected*): Target overall detection confidence or sensitivity (e.g. 0.95)

SURVEILLANCE DESIGN

Surveillance Design Manage

last update: 30 Oct 2024
template: bsdesign (1.21.6)

Surveillance Design

- Context
- Method
- Sampling Surveillance**
 - Discrete sampling parameters for optimal detection
- Surveillance Design
- My Exported Results

Sampling Surveillance Input Parameters Information

Sample type *
The type of sampling used
discrete

Optimal *
The strategy used for finding an effective surveillance resource allocation. One of (minimum) 'cost', (maximum) 'saving' (or cost-dependent benefit), (maximum) 'benefit' (independent of surveillance costs), or (maximum) 'detection' sensitivity
detection

CSV *
CSV parameters
Discrete sampling parameters for optimal detection
Modify Info View

Constraint *
budget

Budget
The cost budget or constraint for the sampling allocation in the surveillance design. Units should be consistent with 'sample_cost' when specified. Otherwise the units should be consistent with the 'surv_qty_unit' parameter specified in the Context (e.g. traps or samples)
765

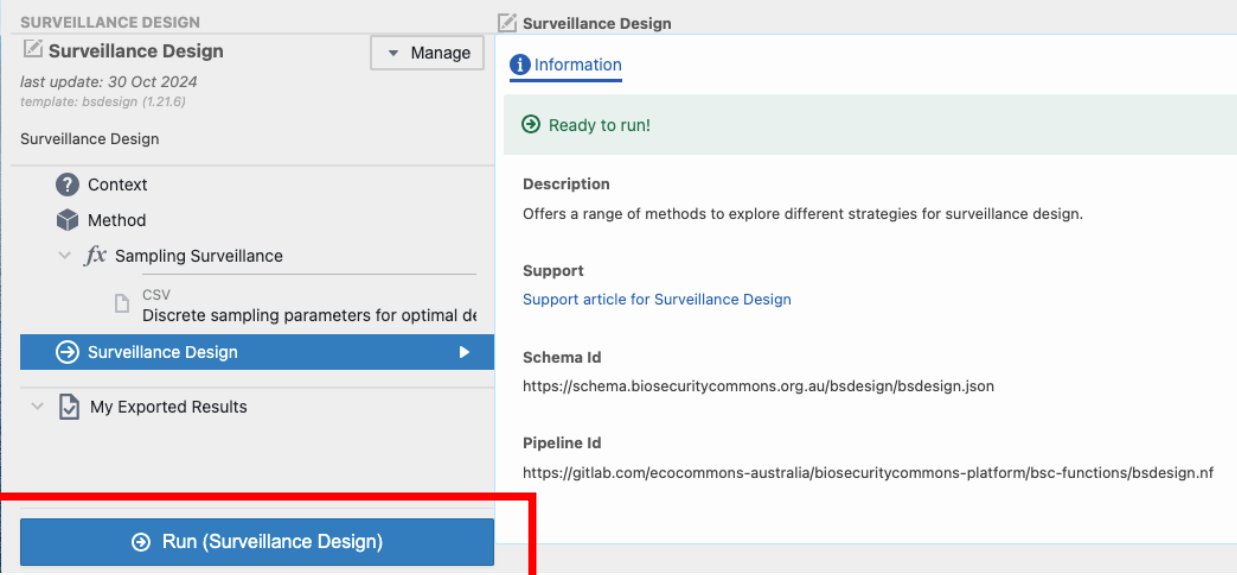
Save Reset

	region_id*	establish_pr*	sample_sens*	prevalence*
1	1	0.001	1	0.01
2	2	0.002	1	0.04
3	3	0.003	1	0.02
4	4	0.004	1	0.03
5	5	0.005	1	0.02
6				

“Save” your selections when finished.

Step 4. Optimise your surveillance design

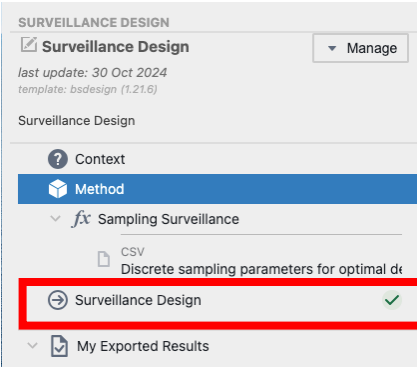
Once the Context and Method branches have been successfully configured you will be able to run your Surveillance Design, which will optimise the allocation of surveillance resources based on the objective function, surveillance efficacy and any constraints included under “Method”.



The screenshot shows the 'SURVEILLANCE DESIGN' interface. On the left, there is a sidebar with a 'Manage' button and a list of components: 'Context', 'Method', 'Sampling Surveillance' (with a sub-item 'Discrete sampling parameters for optimal dt'), 'Surveillance Design' (highlighted with a blue bar and a right-pointing arrow), and 'My Exported Results'. At the bottom of this sidebar, a blue button labeled 'Run (Surveillance Design)' is highlighted with a red rectangular box. On the right, the 'Information' panel shows a green status indicator 'Ready to run!', a description, support link, schema ID, and pipeline ID.

Click the blue ‘Run’ button in the bottom left to run your project. The output page will be updated as the job progresses from “Created”, “Submitted”, “Started” and “Success”.

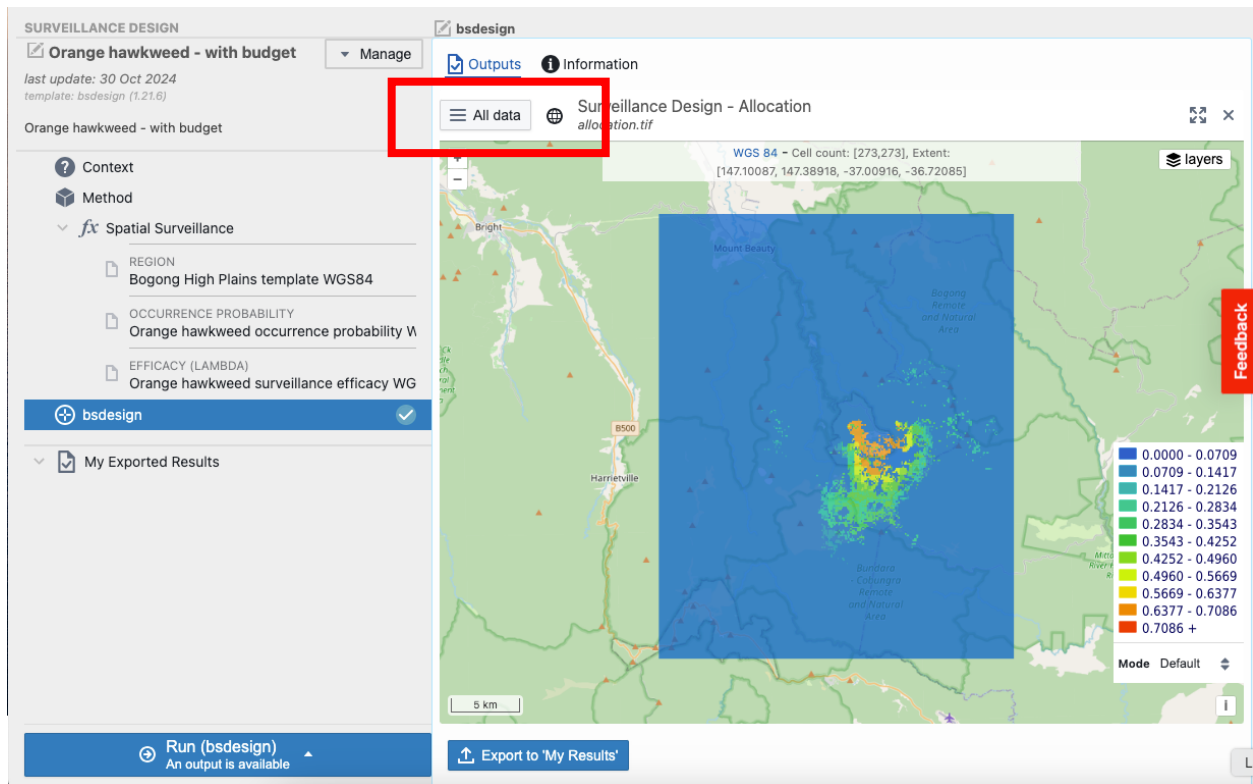
Once it has finished, a green tick will appear next to Surveillance Design.



This screenshot shows the same interface as the previous one, but the 'Surveillance Design' item in the sidebar now has a green checkmark to its right. This 'Surveillance Design' item and its checkmark are highlighted with a red rectangular box.

The model surveillance allocation output will automatically be displayed as a viewable allocation in the output pane.

For spatial surveillance designs the output will present a map of the spatial allocations.



Users can zoom in or out of regions of interest. Interactive maps also allow users to change the type of legend displayed.

Clicking on the “All data” button allows users to view and download all the outputs.

SURVEILLANCE DESIGN

Orange hawkweed - with budget Manage

last update: 30 Oct 2024
template: bsdesign (1.21.6)

Orange hawkweed - with budget

Context

Method

Spatial Surveillance

- REGION
Bogong High Plains template WGS84
- OCCURRENCE PROBABILITY
Orange hawkweed occurrence probability W
- EFFICACY (LAMBDA)
Orange hawkweed surveillance efficacy WG

bsdesign ✓

My Exported Results

Run (bsdesign)
An output is available

bsdesign

Outputs **Information**

View job info Mode

- Surveillance Design - Allocation**
allocation.tif View
- Surveillance Design - Sensitivity**
sensitivity.tif View
- Surveillance Design - Summary**
summary.csv View
- Job script**
bsdesign.R View
- Log file**
bsdesign.Rout View
- Metadata**
metadata.json View

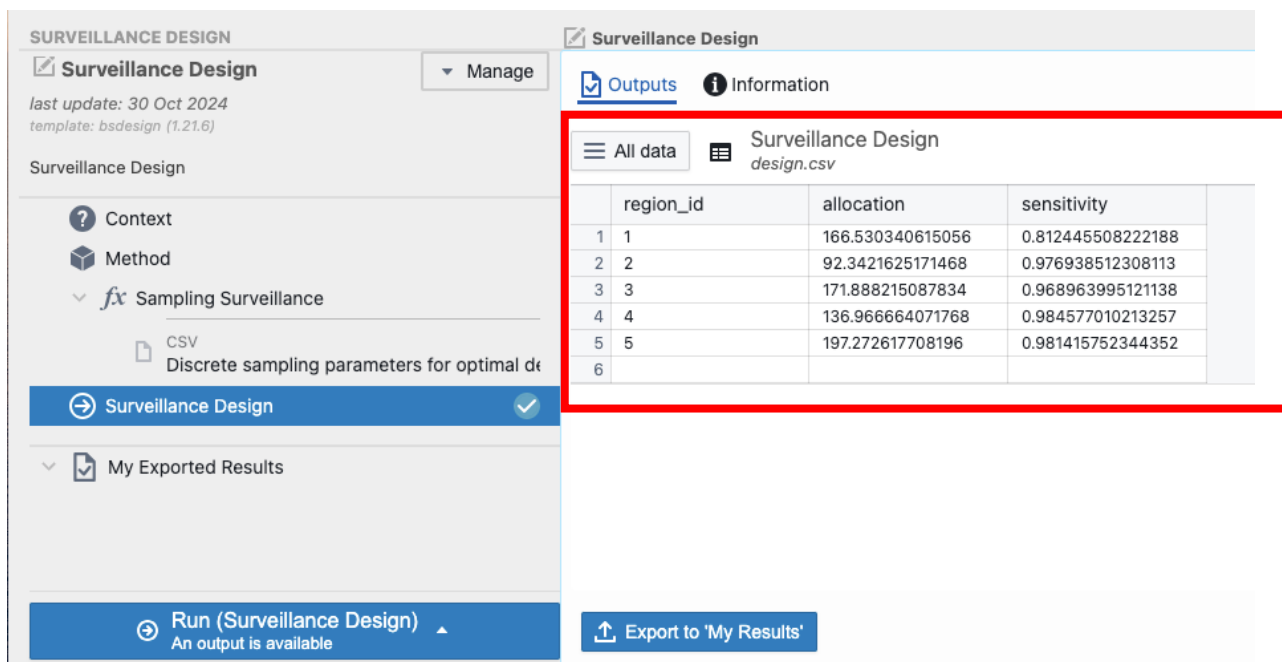
1

Export to 'My Results'

These spatial surveillance design outputs include:

- **Surveillance Design - Allocation** (*Spatial surveillance only*): A GeoTIFF containing the number of allocated units of surveillance across geographic space
- **Surveillance Design - Sensitivity** (*Spatial surveillance only*): A GeoTIFF of probabilities of detection given surveillance allocation
- **Surveillance Design - Summary**: A .csv file containing summary information relevant to optimisation objective, such as columns describing the optimal amount of surveillance units, management costs, total costs and detection confidence across the study region
- **Job script**: A copy of the R script used to build the risk map
- **Log file**: A text file containing processes, messages, and other details associated with model runs
- **Metadata**: A .json file containing the metadata required to run the model on Biosecurity Commons
- **Input parameters** (*All models*): Input parameters required to run the Job Script

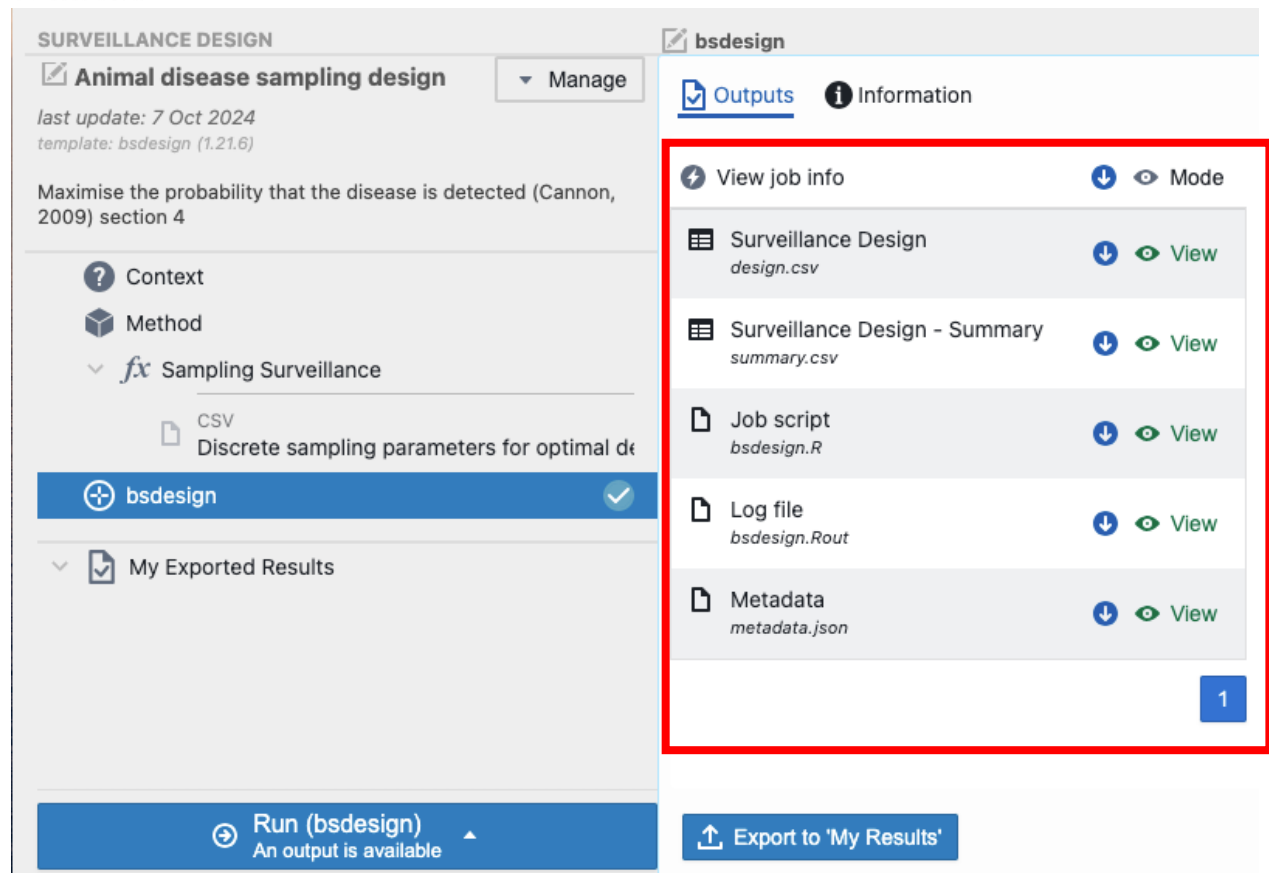
For sampling surveillance designs the output will present a table of the allocations for each division (parts, locations, categories, etc.) .



The screenshot shows the 'Surveillance Design' output interface. On the left, there is a sidebar with navigation options: 'Context', 'Method', 'Sampling Surveillance', and 'My Exported Results'. The 'Surveillance Design' option is selected and highlighted in blue. Below it, there is a 'Run (Surveillance Design)' button with a checkmark and the text 'An output is available'. On the right, the 'Outputs' tab is active, showing a table of data. The table is titled 'Surveillance Design design.csv' and has three columns: 'region_id', 'allocation', and 'sensitivity'. The table contains six rows of data, with the first five rows having numerical values and the sixth row being empty. The table is highlighted with a red border.

	region_id	allocation	sensitivity
1	1	166.530340615056	0.812445508222188
2	2	92.3421625171468	0.976938512308113
3	3	171.888215087834	0.968963995121138
4	4	136.966664071768	0.984577010213257
5	5	197.272617708196	0.981415752344352
6			

Clicking on the “All data” button allows users to view and download all the outputs.



SURVEILLANCE DESIGN

Animal disease sampling design Manage

last update: 7 Oct 2024
template: bsdesign (1.21.6)

Maximise the probability that the disease is detected (Cannon, 2009) section 4

Context
Method
fx Sampling Surveillance

CSV
Discrete sampling parameters for optimal de

bsdesign ✓

My Exported Results

Run (bsdesign)
An output is available

Export to 'My Results'

bsdesign

Outputs Information

- View job info Mode
- Surveillance Design
design.csv View
- Surveillance Design - Summary
summary.csv View
- Job script
bsdesign.R View
- Log file
bsdesign.Rout View
- Metadata
metadata.json View

1

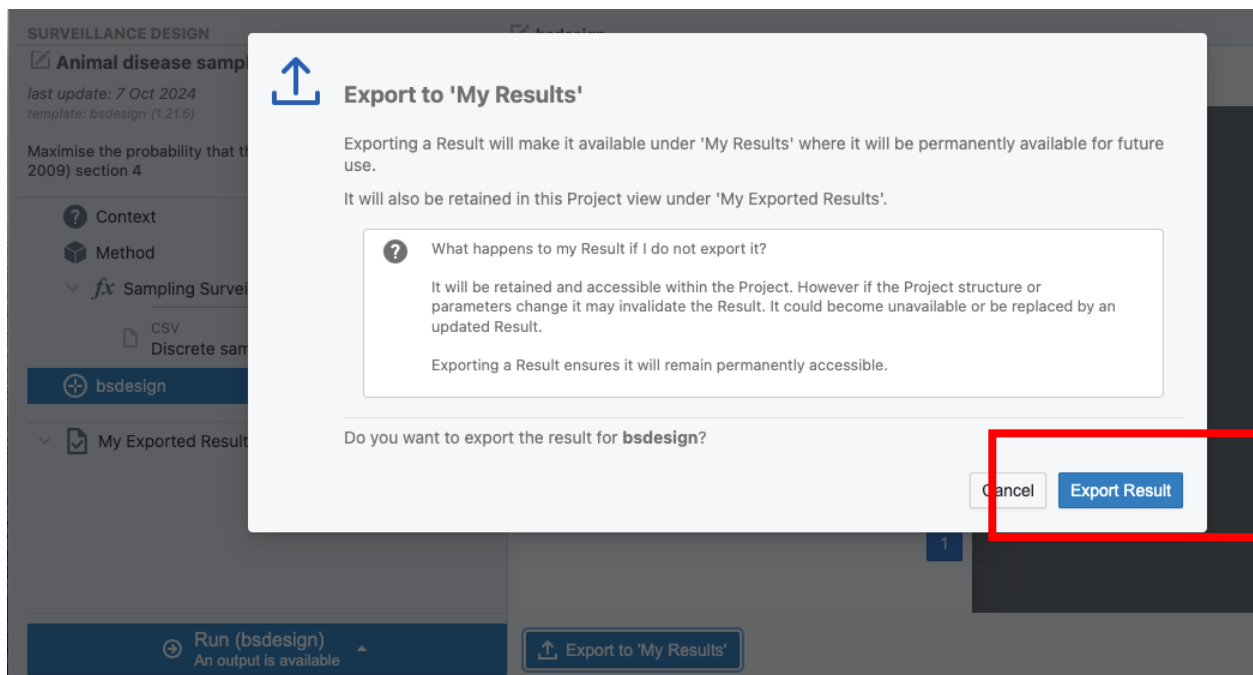
These sampling surveillance design outputs include:

- **Surveillance Design** (*Sampling surveillance only*): A .csv containing the allocated effort per patch/location and its associated sensitivity
- **Surveillance Design - Summary**: A .csv file containing summary information relevant to optimisation objective, such as columns describing the optimal amount of surveillance units, management costs, total costs and detection confidence across the study region
- **Job script**: A copy of the R script used to build the risk map
- **Log file**: A text file containing processes, messages, and other details associated with model runs
- **Metadata**: A .json file containing the metadata required to run the model on Biosecurity Commons
- **Input parameters** (*All models*): Input parameters required to run the Job Script

Step 5. Exporting outputs for use in other workflows

Users may wish to export outputs for use in other projects or other workflows.

To do this, view the output of interest, and select “Export to My Results” in the bottom left corner of the interactive map.



This output will now be discoverable in the user’s “My results” database, which in turn makes the layer available for use in other workflows.

