



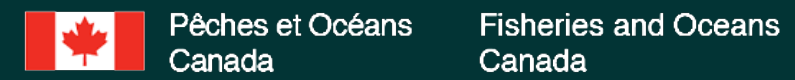
Western Painted Turtles and red-Eared Slider, D. Merriford, Crawford 2019, via Alamy

BC's Most Wanted: A Systematic Assessment of Invasive Species Impacts to Species at Risk in BC

Nataschia Tamburello¹, Aline Litt¹

ISCMV Fall Forum & AGM, Virtual Meeting – October 5th, 2022

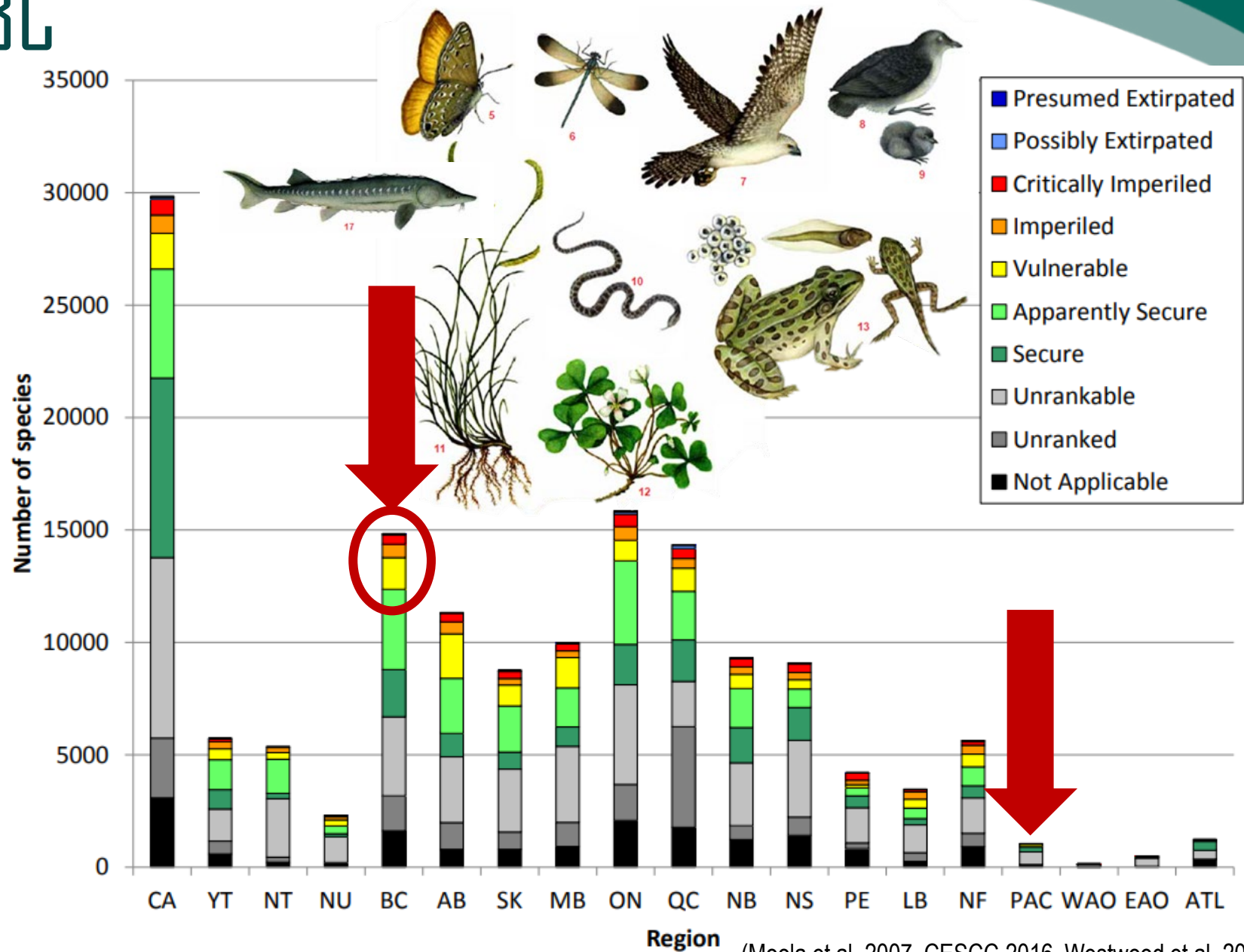
1 – ESSA Technologies Ltd





Species at Risk in BC

- BC has among the **highest biodiversity** of any province AND the **most species at risk (SAR)** of extinction.
- 1,600+ species provincially assessed as being at risk or of special concern.
- 200+ species federally listed under SARA.

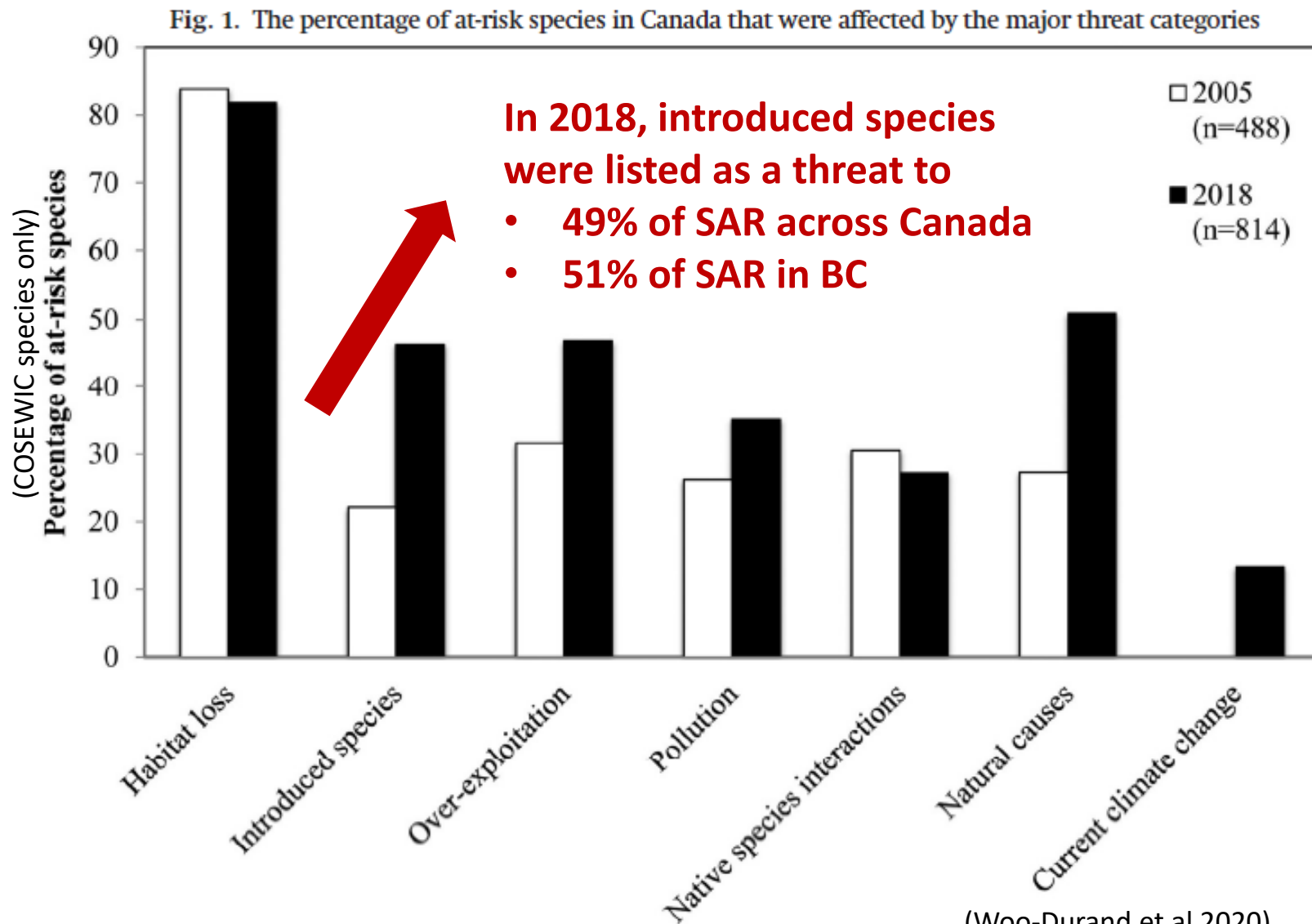


(Moola et al. 2007, CESSC 2016, Westwood et al. 2019)



Species at Risk in BC - At Risk from What?

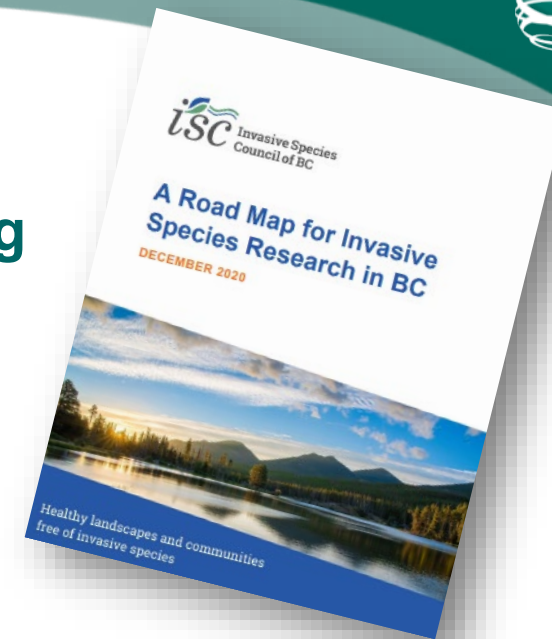
- Canada-wide reviews have shown...
- Species at risk from multiple threats – **including invasive species**
- Risks from most threats are increasing – **again including invasive species**





Species at Risk in BC - At Risk from What?

- Many questions remain! This study seeks to **increase understanding of which, where, how, and how much** IS impact SAR in BC
- Helps meet goals of ISCBC Road Map for IS Research in BC
- Hope is to use results for targeting prevention & mgmt. activities





Our Approach – Scoping & Screening

- Hundreds of SAR to investigate on a small timeline & budget – started by leveraging **raw data from prior national studies for screening** species
- Started with **SAR (COSEWIC & SARA) with “invasive species”** flagged as a threat in either paper (**N = 163 SAR**)

Biological Conservation 166 (2013) 254–265

Threats to Canadian species at risk: An analysis of finalized recovery strategies

Jenny L. McCune^{a,*}, William L. Harrower^a, Stephanie Avery-Gomm^b, Jason M. Brogan^c, Anna-Mária Csergő^a, Lindsay N.K. Davidson^d, Alice Garani^a, Luke R. Halpin^e, Linda P.J. Lipsen^f, Christopher Lee^a, Jocelyn C. Nelson^b, Laura R. Prugh^g, Christopher M. Stinson^h, Charlotte K. Whitneyⁱ, Jeannette Whitton^a

Environ. Rev. 28: 449–456 (2020)

Increasing importance of climate change and other threats to at-risk species in Canada

Catherine Woo-Durand, Jean-Michel Matte, Grace Cuddihy, Chloe L. McGourdji, Oscar Venter, and James W.A. Grant

THANK
YOU!



Our Approach – Scoping & Screening

- Hundreds of SAR to investigate on a small timeline & budget – started by leveraging **raw data from prior national studies for screening** species
- Started with **SAR (COSEWIC & SARA)** with “invasive species” flagged as a threat in either paper (**N = 163 SAR**)
- Further narrowed down list to SAR impacted by **BC Priority Invasive Species List** considered to have highest risk and management potential (**N =182 IS**)



Provincial Priority Invasive Species
BC Inter-Ministry Invasive Species Working Group
February 2020

Plant	Provincial EDRR	Water hyacinth*	<i>Eichhornia</i>	<i>crassipes</i>
Plant	Provincial EDRR	Water lettuce*	<i>Pistia</i>	<i>stratiotes</i>
Plant	Provincial EDRR	Yellow floating heart	<i>Nymphoides</i>	<i>peltata</i>
Plant	Provincial EDRR	Yellow starthistle*	<i>Centaurea</i>	<i>solstitialis</i>
Fungus	Provincial Containment	Death cap	<i>Amanita</i>	<i>phalloides</i>
Insects and spiders	Provincial Containment	Apple maggot	<i>Rhagoletis</i>	<i>pomonella</i>

Final Focal List of N = 92 SAR for Detailed Assessment



Results

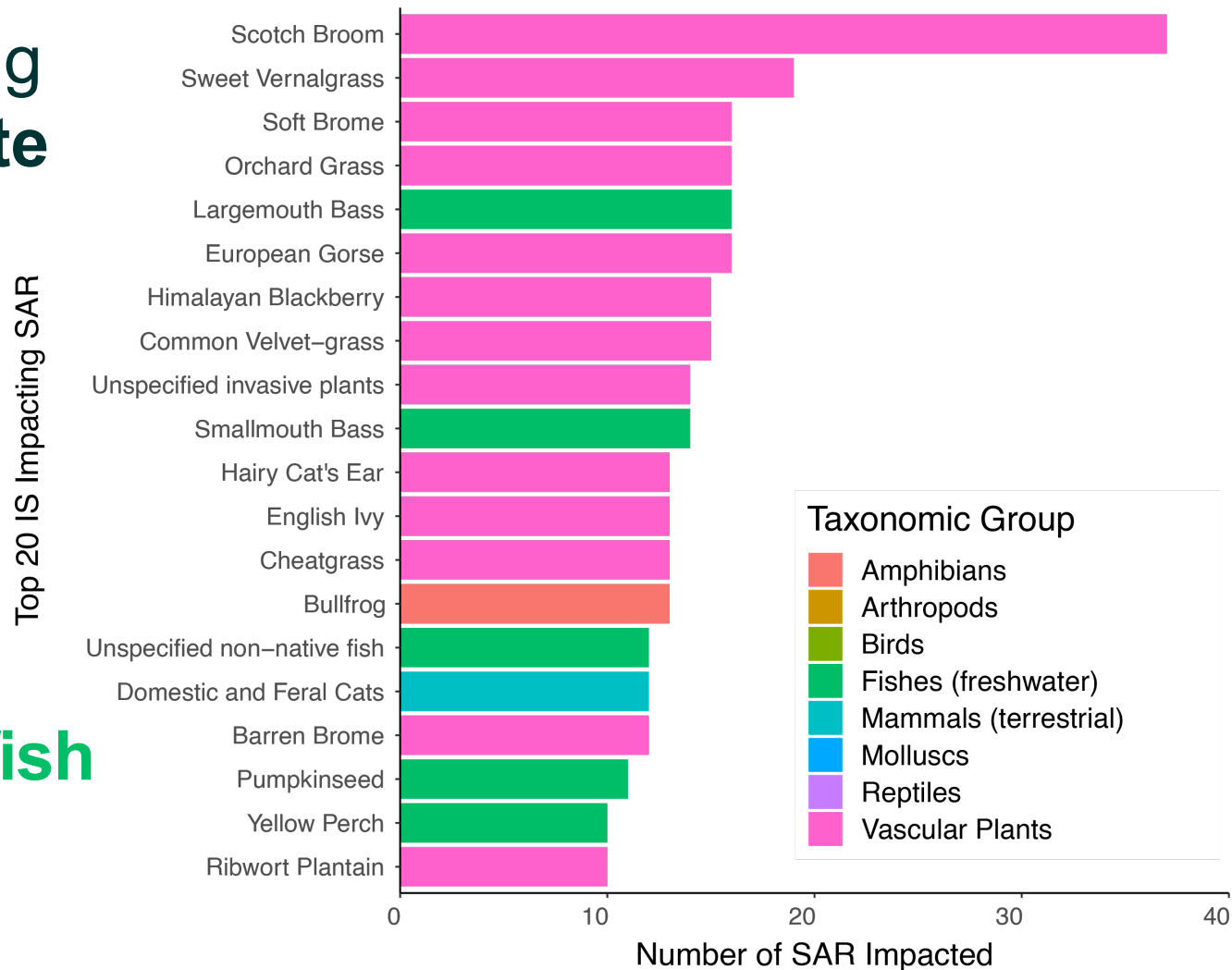
For 784 unique SAR-IS impact pairs





1. WHICH IS are impacting SAR?

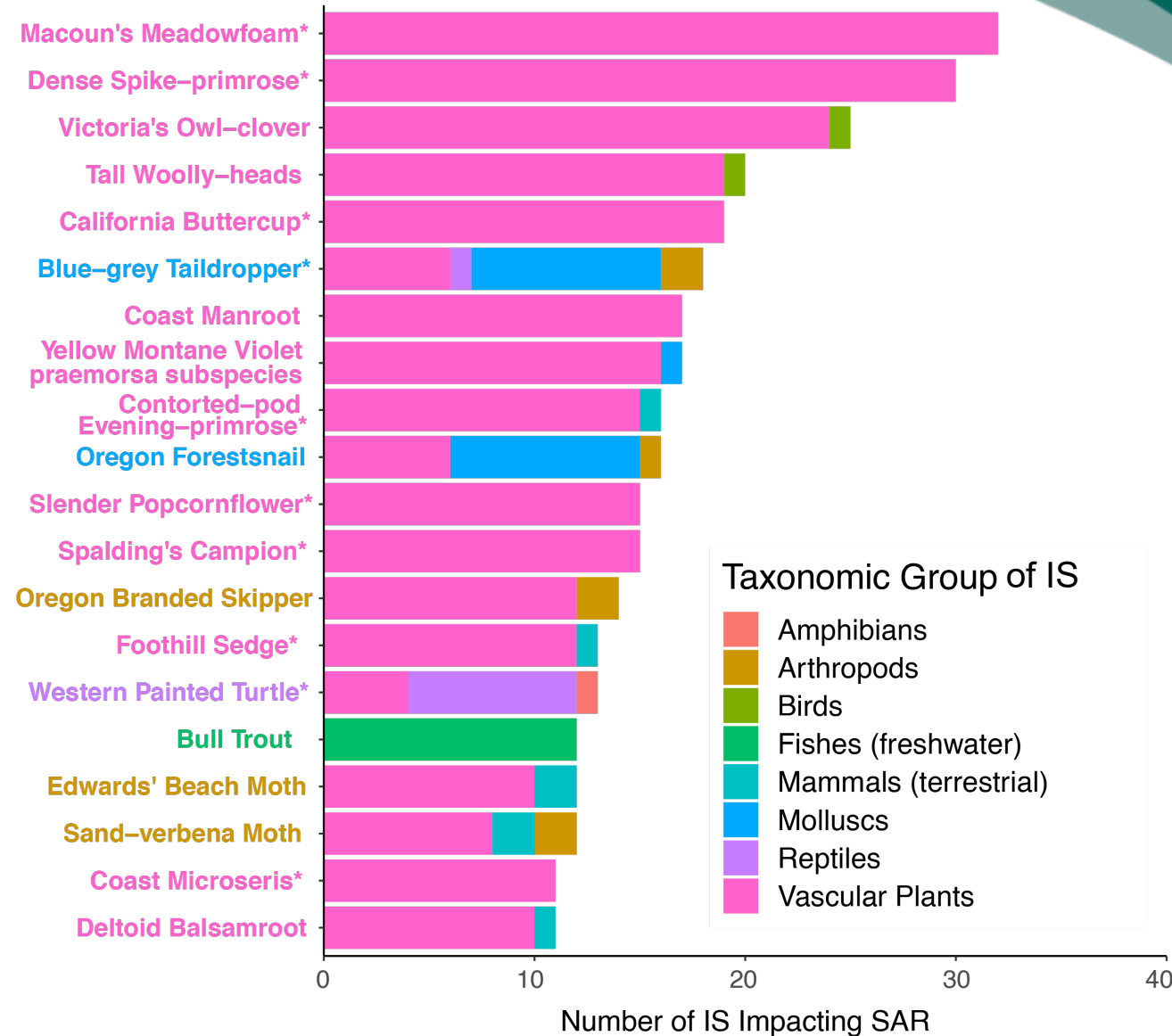
- A small number of IS are having **impacts on a disproportionate number of SAR.**
- Most are **plants**
 - Scotch broom
 - Grasses
 - Blackberry
 - Etc.
- Next most common are (sport) **fish**
 - Basses
 - Pumpkinseed
 - Perch



1. WHICH SAR are most impacted?

- Most SAR impacted by the greatest number of IS are **plants**
- Next most common are **arthropods**
- Also a **reptile** and a **fish**
- SAR tend to be impacted by IS in the **same taxon**

Top 20 SAR Most Impacted by IS



1. WHICH SAR are most impacted?

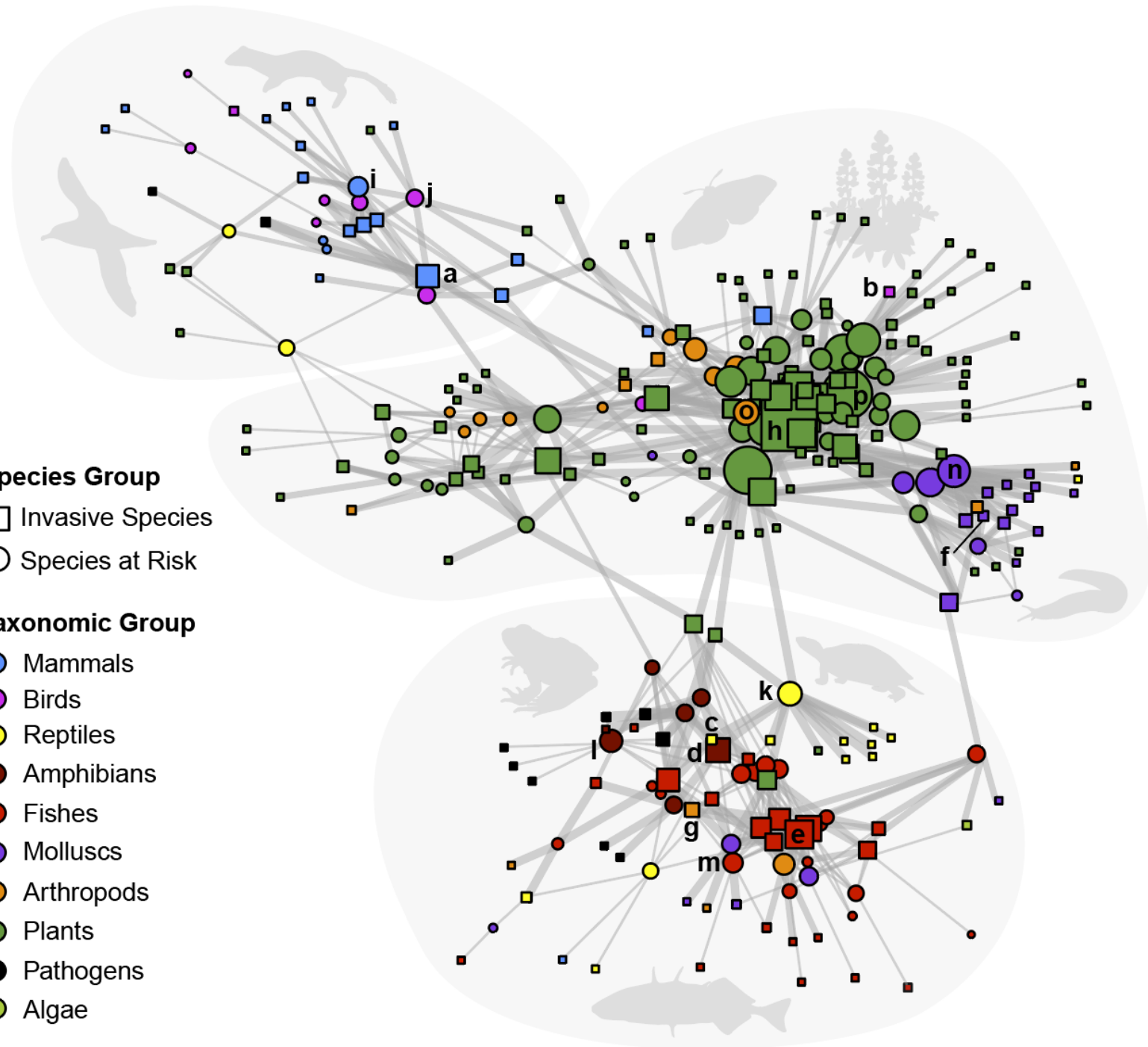
- A (partial) network diagram to visualize:
 - ‘Clusters’ of IS-SAR impact in different ecological communities (e.g., vertebrates, plants and arthropods, aquatic species).
 - Species that are impacting or impacted by the MOST other species (largest nodes = most connections).
 - IS with the highest DEGREE on impacts on SAR (thicker lines = most impact).

Species Group

- Invasive Species
- Species at Risk

Taxonomic Group

- Mammals
- Birds
- Reptiles
- Amphibians
- Fishes
- Molluscs
- Arthropods
- Plants
- Pathogens
- Algae





1. WHICH SAR are most impacted?

- And the most impacting and impacted by taxonomic group are...

(letters correspond to the previous network diagram).

Taxon	Most Impactful Invasive Species		Most Impacted Species at Risk			
Mammals		Domestic Cats (<i>Felis catus</i>)	12		Ermine (<i>Mustela erminea</i>)	10
Birds		Canada Goose (<i>Branta canadensis</i>)	3		Pink-footed Shearwater (<i>Puffinus creatopus</i>)	8
Reptiles		Red-Eared Slider (<i>Trachemys scripta elegans</i>)	3		Western Painted Turtle (<i>Chrysemys picta bellii</i>)	13
Amphibians		Bullfrog (<i>Lithobates catesbeianus</i>)	13		Northern Leopard Frog (<i>Lithobates pipiens</i>)	12
Fishes		Largemouth bass (<i>Micropterus salmoides</i>)	16		Coastrange Sculpin (Cultus Lake) (<i>Cottus aleuticus</i>)	10
Molluscs		Chocolate arion (<i>Arion rufus</i>)	5		Blue-grey tailedropper (<i>Prophysaon coeruleum</i>)	19
Arthropods		Signal Crayfish (<i>Pacifastacus leniusculus</i>)	6		Oregon Branded Skipper (<i>Hesperia colorado oregonia</i> Edwards)	14
Plants		Scotch Broom (<i>Cytisus scoparius</i>)	36		Macoun's Meadowfoam (<i>Limnanthes macounii</i>)	32



2. WHERE are IS impacting SAR?

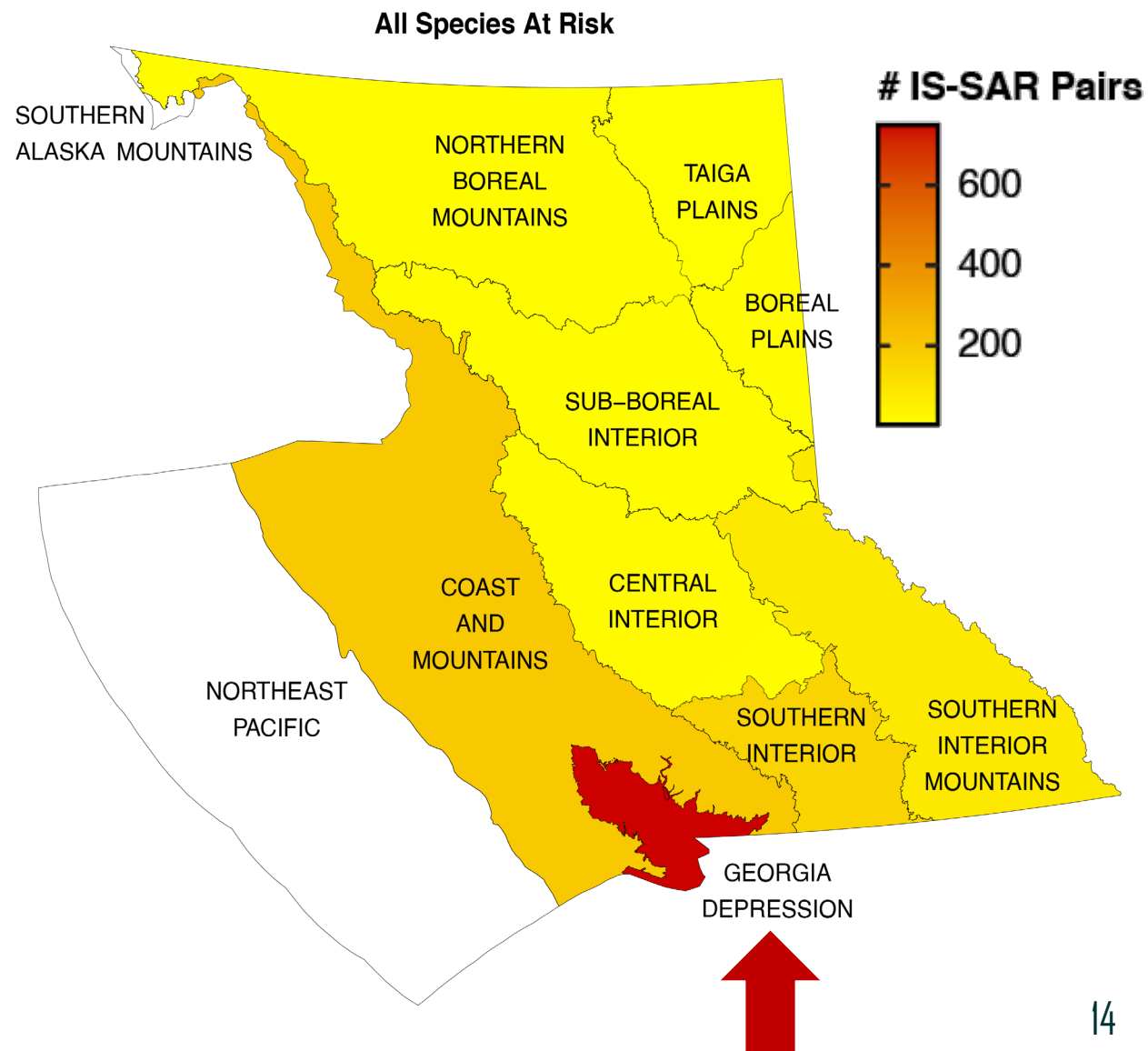
- **Geographies:**
 - Ecoprovinces of SAR as unit of analysis





2. WHERE are IS impacting SAR?

- **Geographies:**
 - Ecoprovinces of SAR as unit of analysis
 - Significant bias towards IS impacts on SAR in the **Georgia Depression**, likely reflecting the concentration of human activity in this region

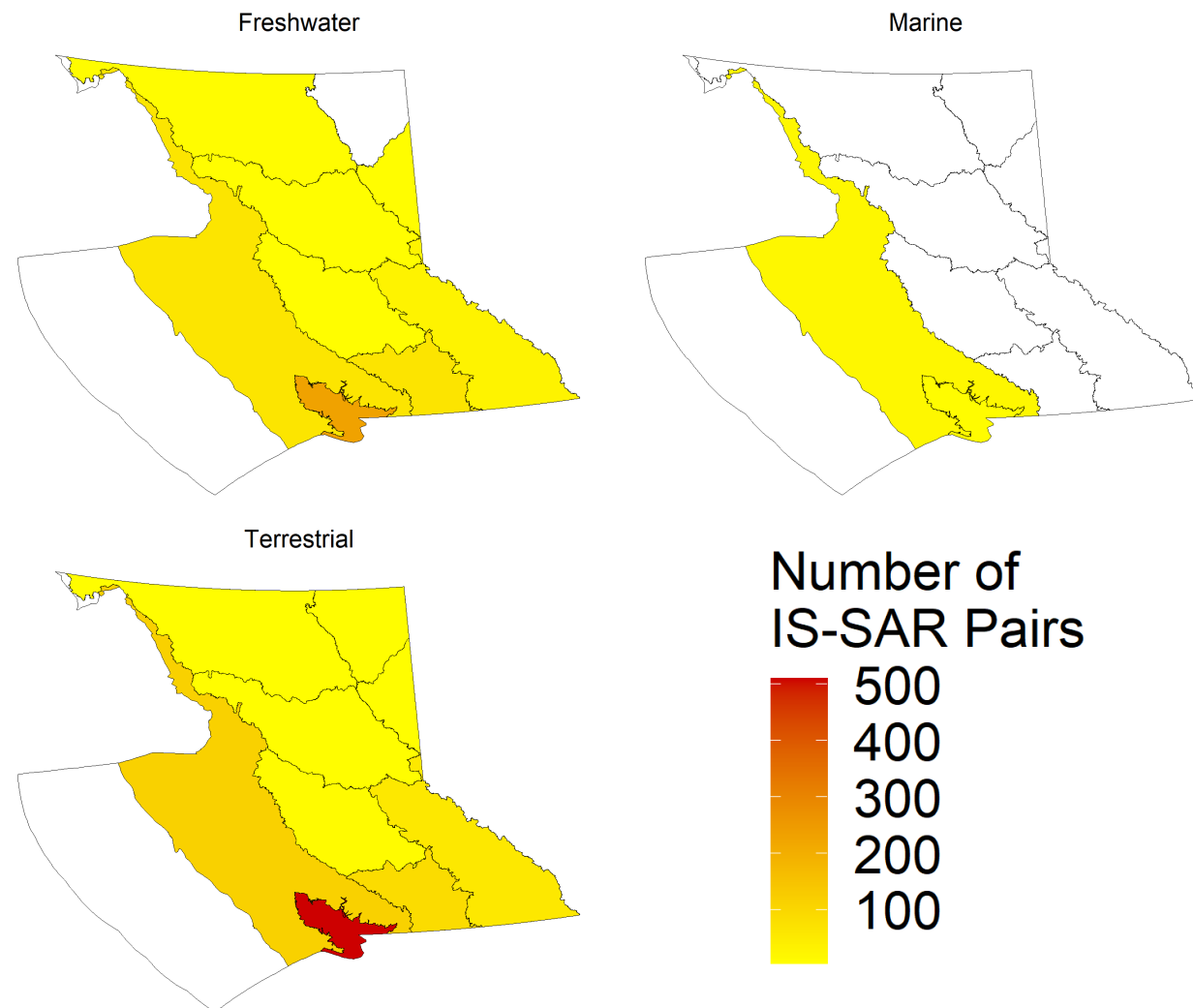




2. WHERE are IS impacting SAR?

- **Habitat Types:**

- Significant bias towards IS impacts in terrestrial habitats, then freshwater
- Little representation of marine IS-SAR impacts not surprising
 - Marine IS are not included on BC's priority list
 - Marine SAR mostly listed due to overexploitation
 - These interactions are harder to study

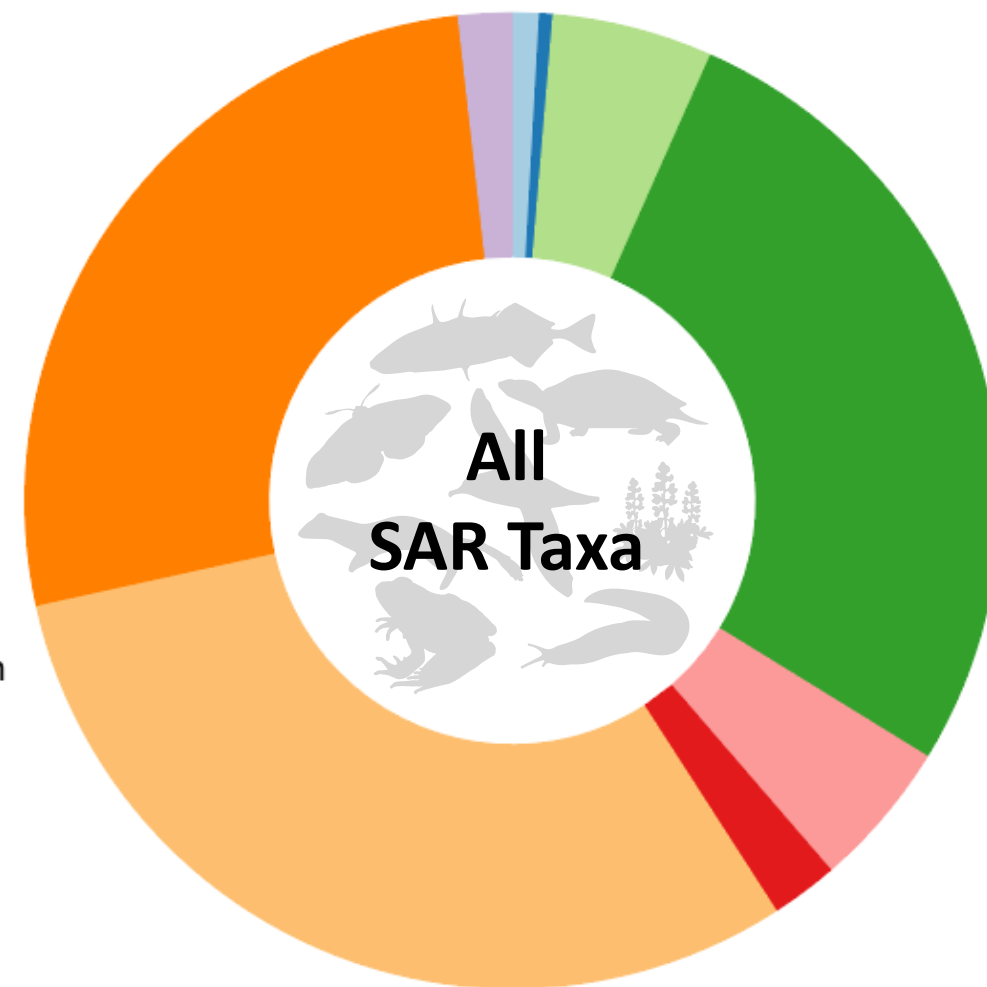
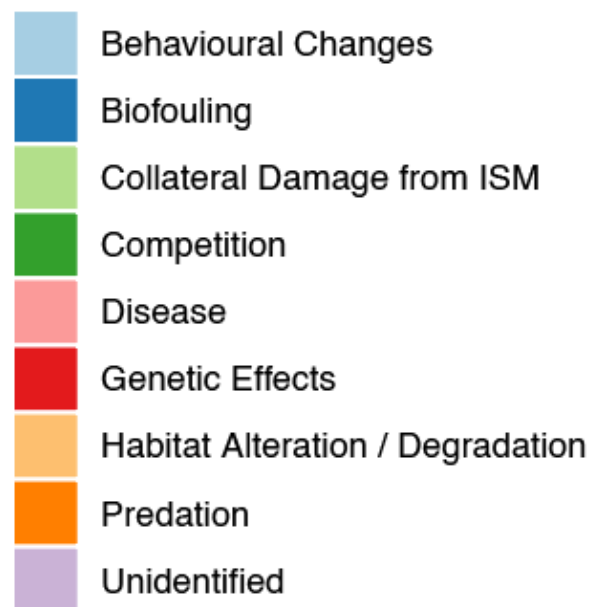




3. HOW are IS impacting SAR?

- Mechanisms of IS impact vary across IS-SAR pairs (multiple mechanisms possible)
- Most common:
 - Predation
 - Habitat Alteration
 - Competition

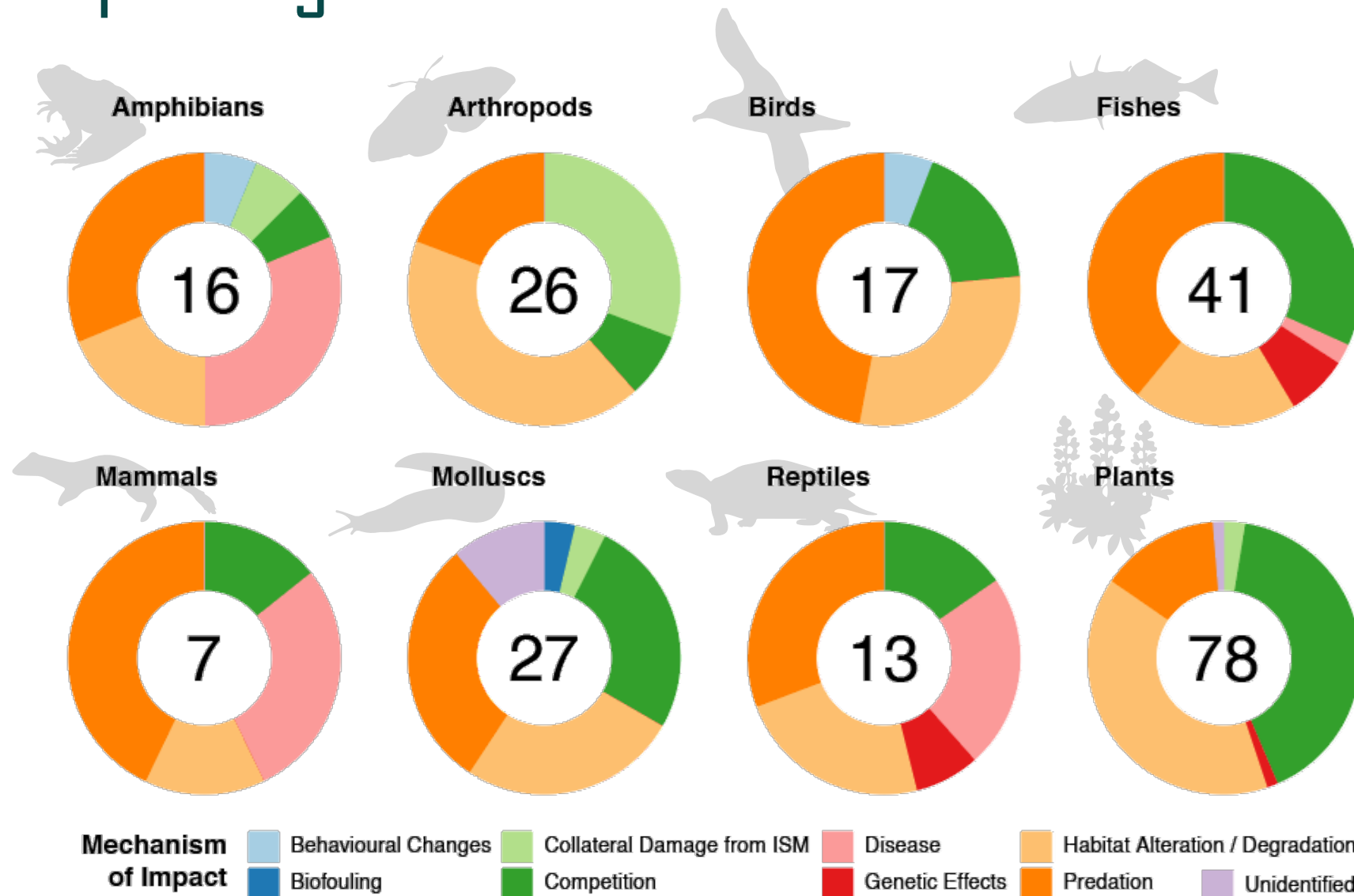
Mechanism of Impact





3. HOW are IS impacting SAR?

- Mechanisms of IS impact vary across SAR taxa (multiple mechanisms possible)
- Predation & habitat alteration most common across taxa.

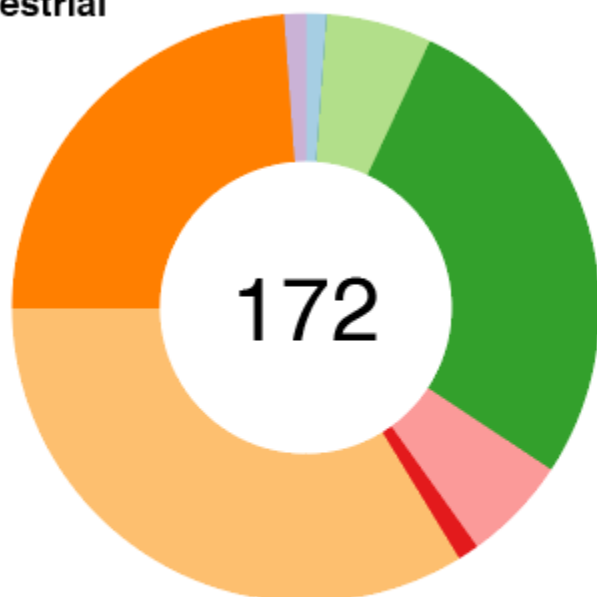




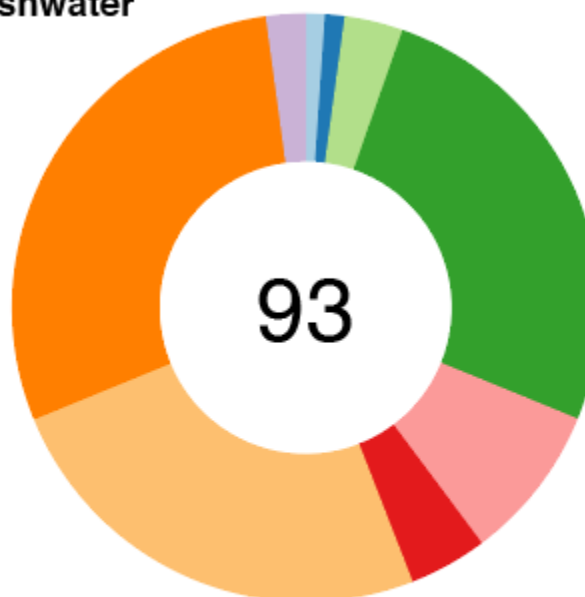
3. HOW are IS impacting SAR?

- BUT mechanisms of IS impact **don't** vary too much across **SAR habitats** (multiple habitats possible)

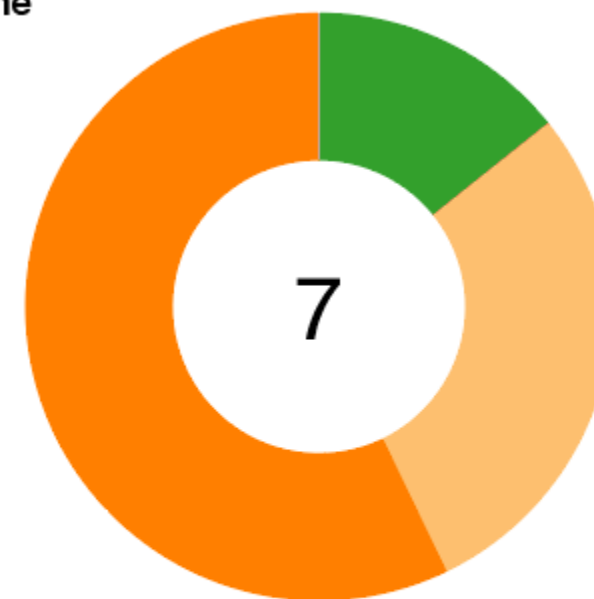
Terrestrial



Freshwater



Marine



Mechanism of Impact

Behavioural Changes
Biofouling

Collateral Damage from ISM
Competition

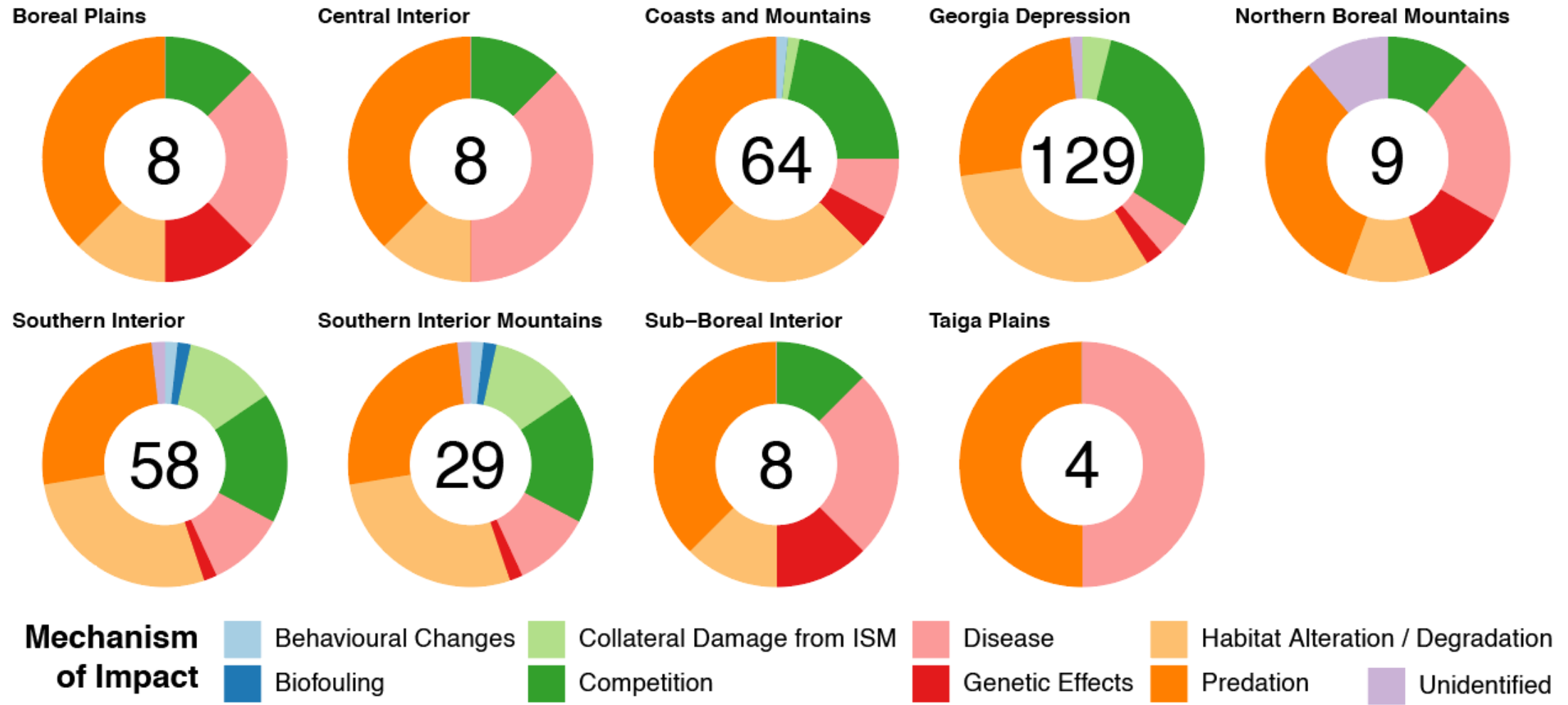
Disease
Genetic Effects

Habitat Alteration / Degradation
Predation
Unidentified



3. HOW are IS impacting SAR?

- OR across **SAR ecoprovinces** (multiple ecoprovinces possible)



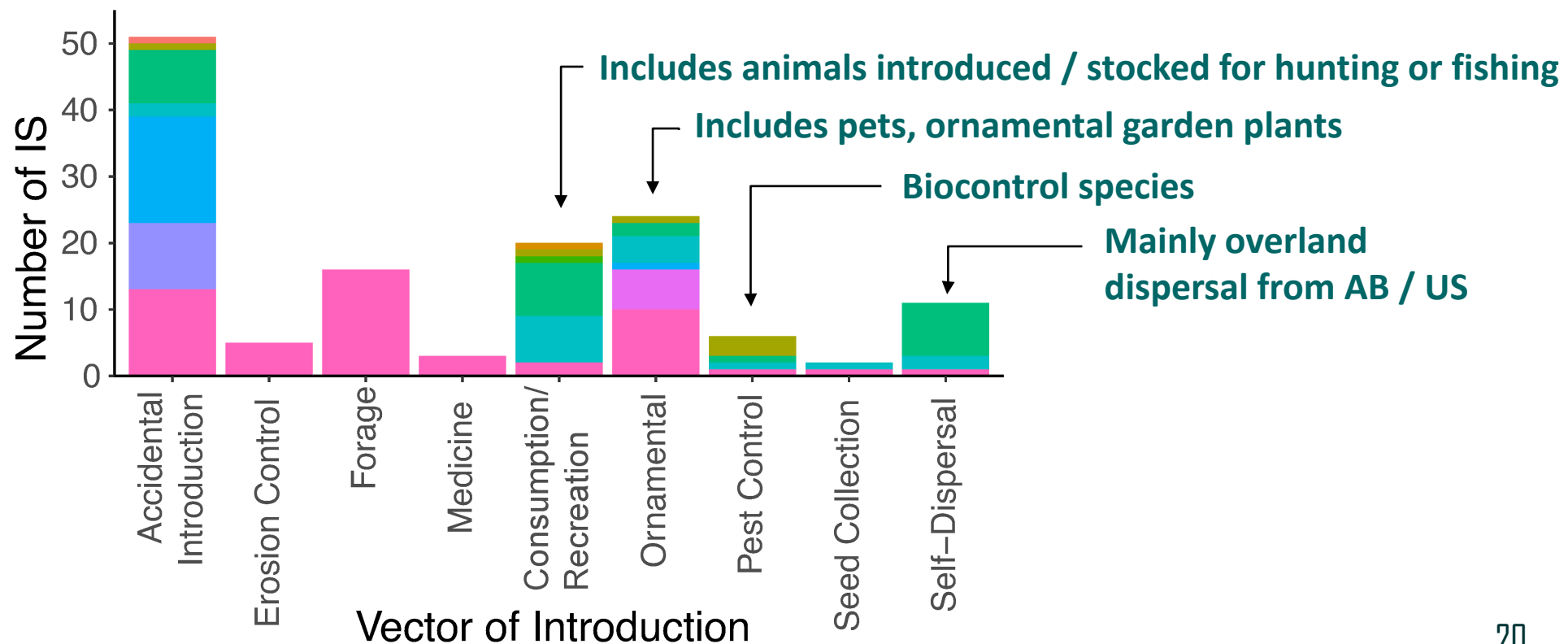


3. HOW were IS impacting SAR introduced?

- Most non-natives impacting SAR were **intentionally introduced**
- Data for 111 IS

IS Taxonomic Group

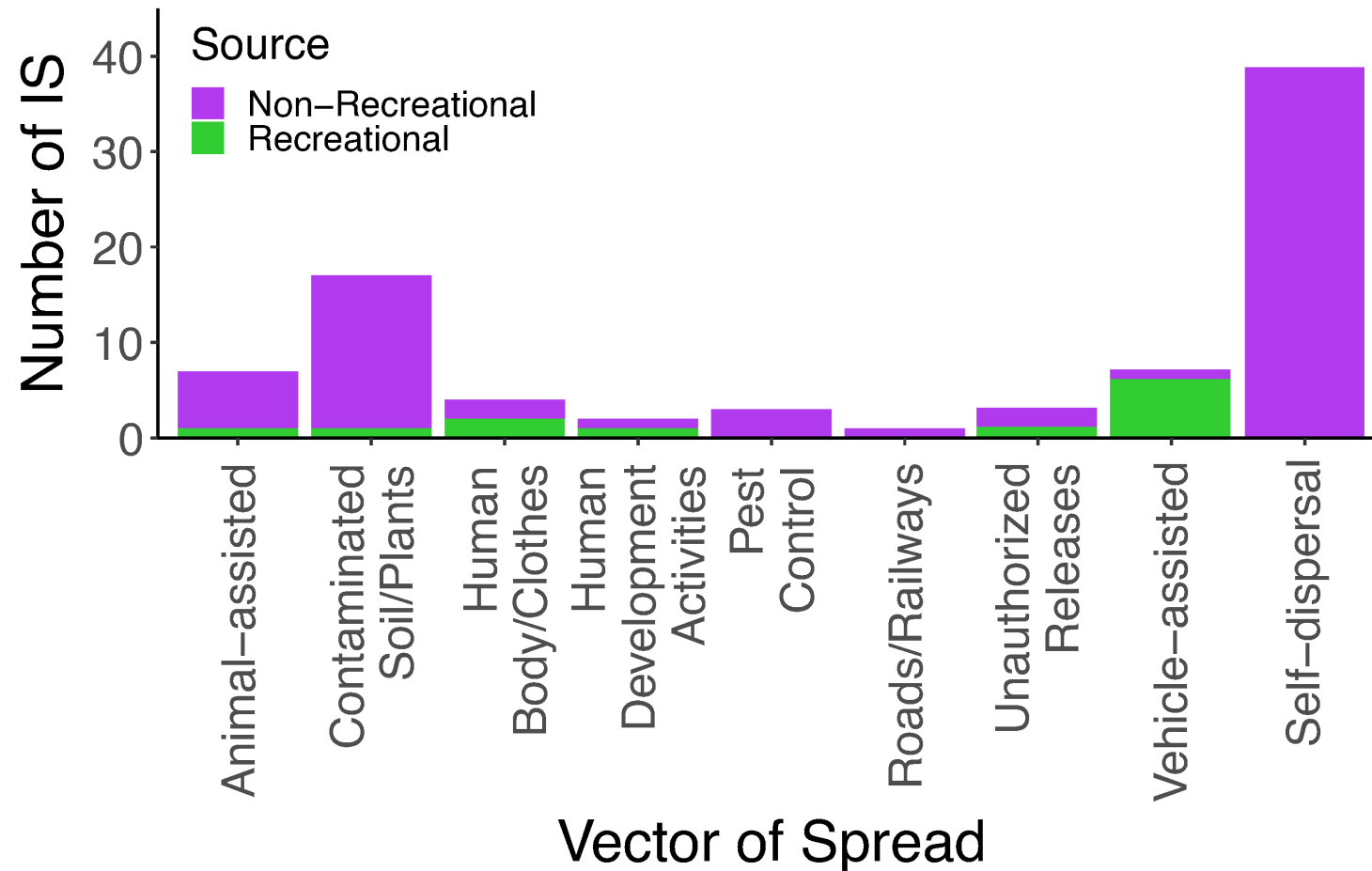
- Algae
- Amphibians
- Arthropods
- Birds
- Fishes (freshwater)
- Mammals (terrestrial)
- Molluscs
- Pathogen
- Reptiles
- Vascular Plants





3. **HOW** are IS impacting SAR spread?

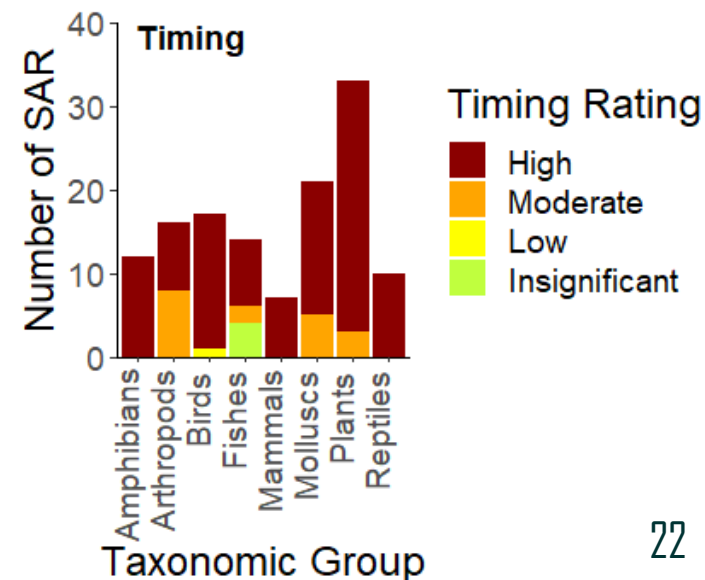
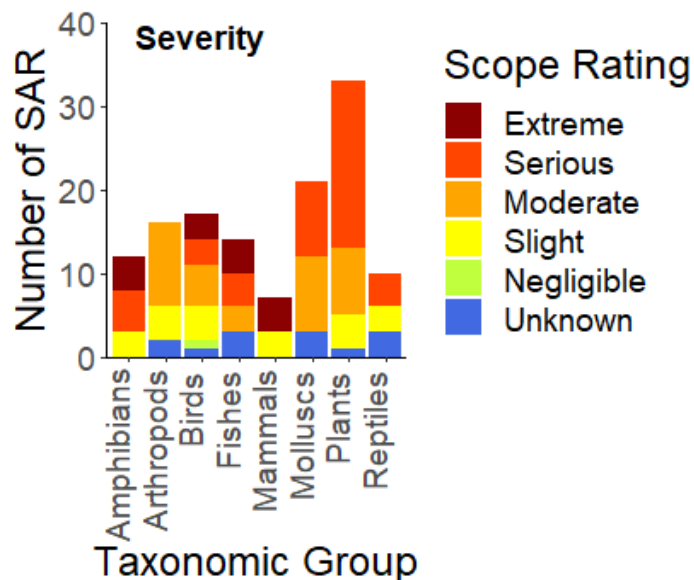
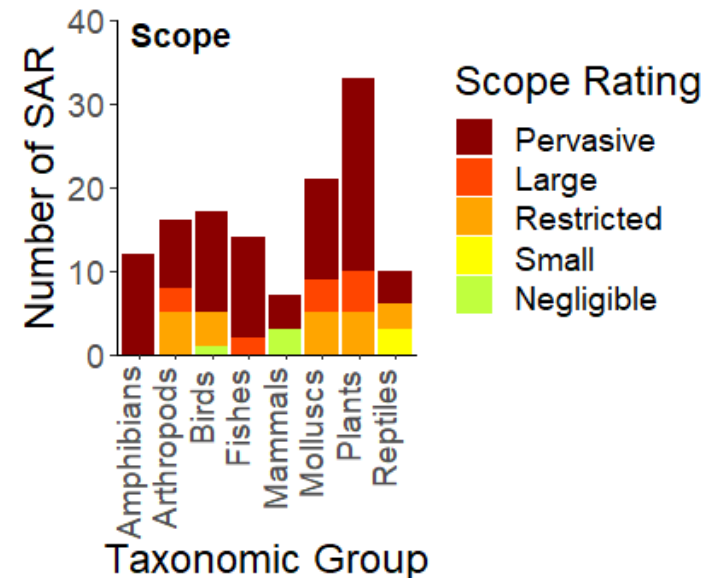
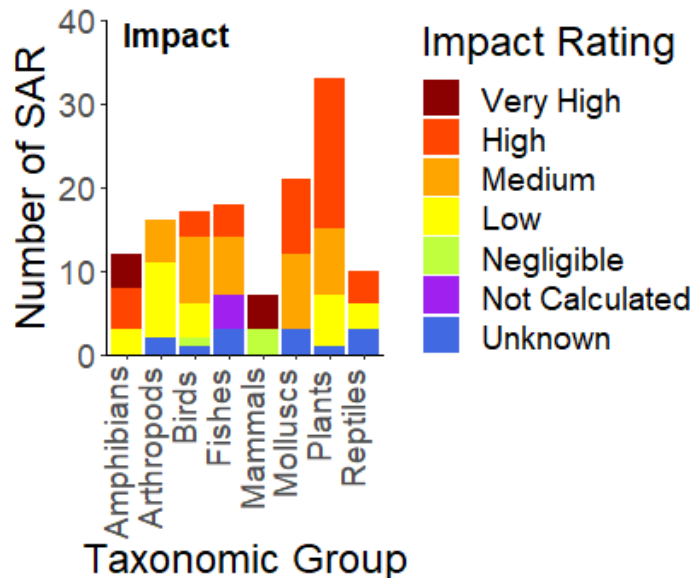
- Most IS spread **unintentionally**
- Spread through a range of human activities, some of which are associated with the **recreational sector**
(relevant for ISCBC outreach efforts)





4. HOW MUCH are IS impacting SAR?

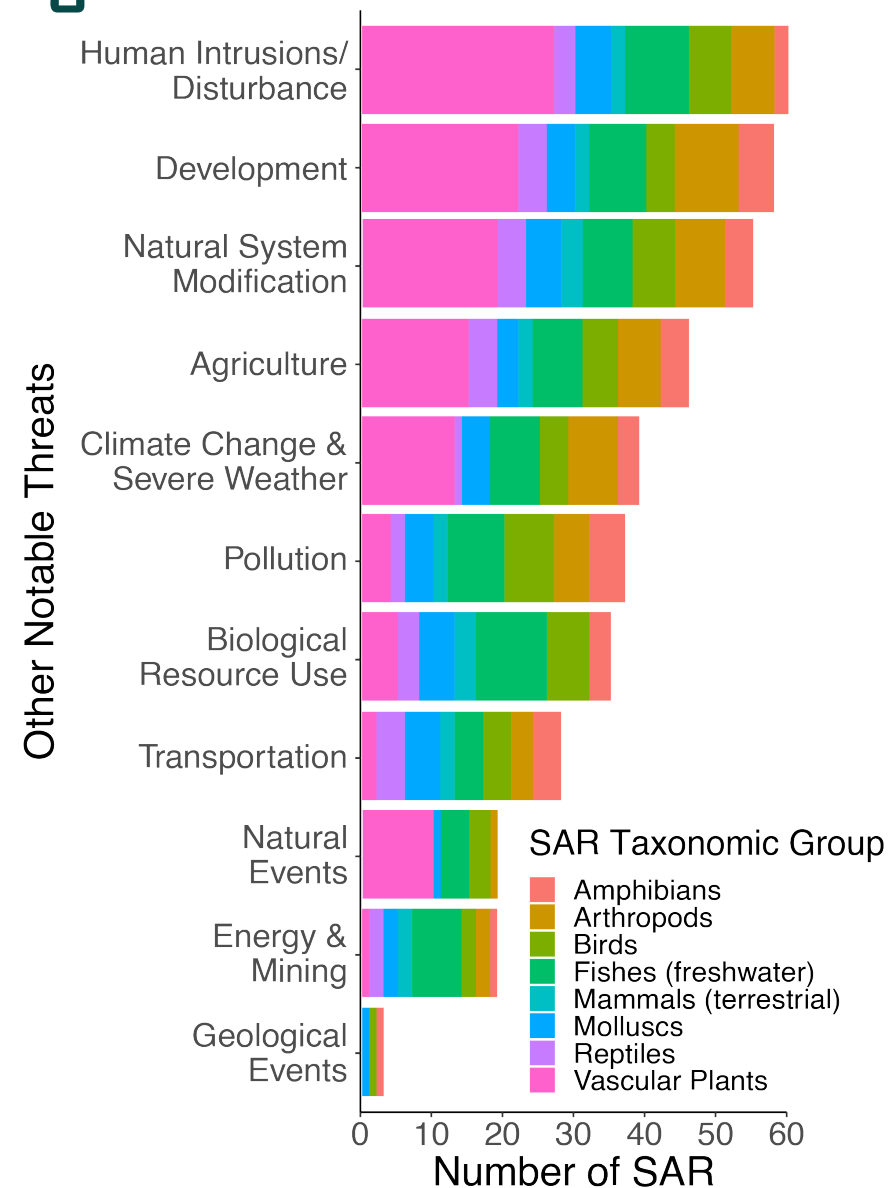
- Scope of threats from IS are **pervasive** and these threats are **current and continuing** for a majority of focal SAR in all taxonomic groups.
- **Severity** and **impact** ratings are more variable





5. WHAT other threats are impacting these SAR?

- SAR face many cumulative effects other than IS - on average, SAR were impacted by **three other threat categories** (using data from Woo-Durand et al. (2020) and McCune et al. (2013))
- **Human intrusions or disturbances and development** are top additional threats
- Not surprising given distribution of IS-SAR pairs **roughly aligns with the distribution of human population density in BC** which are linked to human development, trade, and habitat degradation





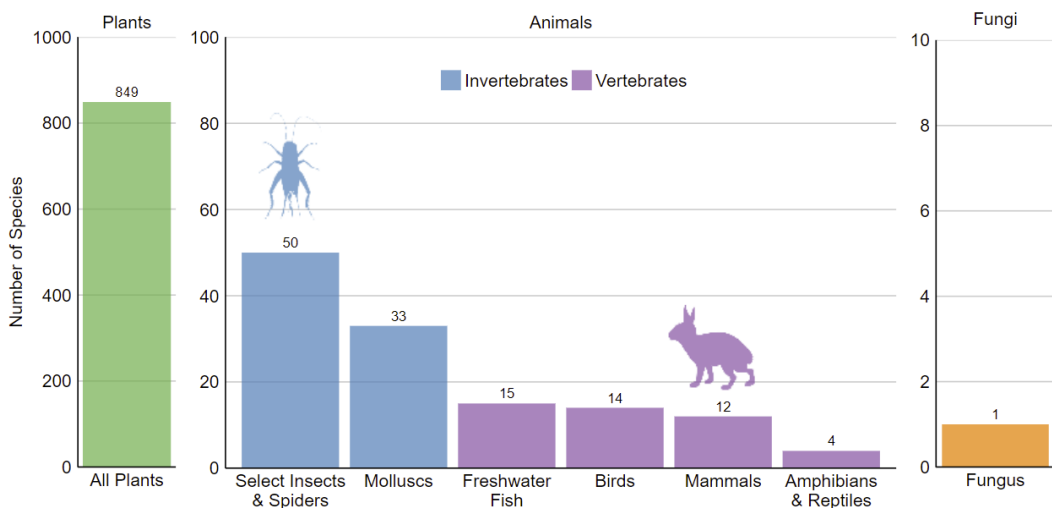
Case Studies





Case Study: BC's "Most Wanted"

- 13 of top 20 'most wanted' IS are **plants**
Aligns with plants being most common IS taxon in BC overall
- Top offender = **Scotch Broom**, documented threat to **36 SAR**
 - Associated with a suite of other focal IS plants, including #2, #3 and #4 of top 20
 - **Challenging to combat** because it thrives in disturbed areas, is highly fecund, and seeds viable for 30 yrs





Case Study: Role of Collateral Damage from ISM

- Most commonly seen for control efforts **directed at invasive insects and plants**
- E.g., European Gypsy Moth control efforts threaten 6 arthropod SAR
 - Immediate threat: pesticide called Btk (bacterium)
 - Potential threat: Tachinid flies
- **Prevention of IS** a much better approach than control after introduction
 - If IS control is necessary, it is crucial to consider potential negative offsets before implementation.



Caterpillar of the European Gypsy Moth.

Photo Credit: "Gypsy moth caterpillar (Lymantria dispar)" by NatureFreak07 is licensed under CC BY 2.



Case Study: Localized Invasions of Native Species

- **Impacts depend on how we define IS**
- **IS can also include native species with increasing populations or broadening distributions**
 - Haida Gwaii: Sitka Black-tailed Deer, Common Raccoon, Red Squirrels
 - Vancouver Island: Canada Geese
- **Range shifts of native species will continue to change without human assistance due to **climate change****



Sitka Blacktailed Deer on Haida Gwaii.
Photo Credit: "057A1387.jpg" by [M. J. J. J.](#) licensed under CC



Case Study: Invasions Resulting in Extirpations of SAR

- **Growing number of global extirpations & extinctions** caused by IS
- “Cautionary tales” of unmitigated impacts IS can have



Cassin's Auklet

Photo Credit: "Cassin's Auklet" by [Vashburris](#) licensed under CC BY 2.0

- **Extinctions from BC:**

- Extinction of Hadley Lake Stickleback pairs by unauthorized introduction of Brown Bullhead
- Collapse of Enos Lake Stickleback pairs into hybrid population, likely caused by introduction of American Signal Crayfish

- **Local extirpations in BC:**

- Macoun's Meadowfoam and Victoria's Owl Clover
- Cassin's Auklet and Ancient Murrelet in Haida Gwaii



Case Study: Invasive Threats to SAR

Important to Indigenous Peoples

- **SAR are significant to Indigenous peoples** for their various cultural, nutritional, medicinal, spiritual and material values and uses that may be threatened by IS
- Indigenous peoples were also and continue to be **stewards** of many SAR
- Significance of SAR to Indigenous groups is **not well documented** in western literature and more work is needed in this space





Key Insights





Key Insights for Building Management Strategies

- **IS have wide-ranging impacts on SAR, some IS more problematic than others.**
- Findings from this review can help prioritize:
 - Interventions to target **SAR most vulnerable to IS impacts**
 - E.g., Macoun's Meadowfoam is SAR impacted by the most IS, and impacts are rated as severe.
 - IS interventions that will assist the **widest range of SAR**
 - E.g., Scotch Broom is IS that impacts the most SAR, so mgmt. could have broader benefits
 - **Most effective management interventions**, based mechanisms of IS impact
 - **Public outreach campaigns** to target common vectors of introduction and spread
 - **Future research** needed to fill gaps or answer outstanding questions



Scotch Broom in bloom.

Photo Credit: "Yellow Scotch Broom" by cas500 licensed under CC BY-SA 2.0



Key Insights for Building Management Strategies

- Findings from this review can also help to inform more complex approaches, e.g.,
- Advanced prioritization frameworks
 - Priority threat management (PTM)
 - Structured decision making (SDM)
- More holistic management strategies
 - Threat-based management plans for multiple invaders
 - Community or ecosystem-based recovery plans

Conservation Science and Practice Open Access
A journal of the Society for Conservation Biology

CONTRIBUTED PAPER | [Open Access](#) |

Prioritizing threat management across terrestrial and freshwater realms for species conservation and recovery

Abbey E. Camaclang , Jessica Currie, Emily Giles, Graham J. Forbes, Christopher B. Edge, Wendy A. Monk, Joseph J. Nocera, Graeme Stewart-Robertson, Constance Browne ... [See all authors](#) ▾

First published: 09 December 2020 | <https://doi.org/10.1111/csp2.300> | Citations: 2

Management in Practice

Getting to a decision: using structured decision-making to gain consensus on approaches to invasive species control

Brett van Poorten^{1,3,*} and Martina Beck²

¹British Columbia Ministry of Environment and Climate Change Strategy, 2202 Main Mall, Vancouver, BC, Canada

²British Columbia Ministry of Environment and Climate Change Strategy, 525 Superior Street, Victoria, BC, Canada

³Current Address: School of Resource and Environmental Management, Simon Fraser University, 8888 University Drive, Burnaby, BC, Canada

Conservation Biology

Research Note

The importance of considering multiple interacting species for conservation of species at risk

Joanna M. Burgar , A. Cole Burton, Jason T. Fisher

First published: 10 October 2018 | <https://doi.org/10.1111/cobi.13233> | Citations: 21



Potential Future Work



Potential Avenues for Future Work

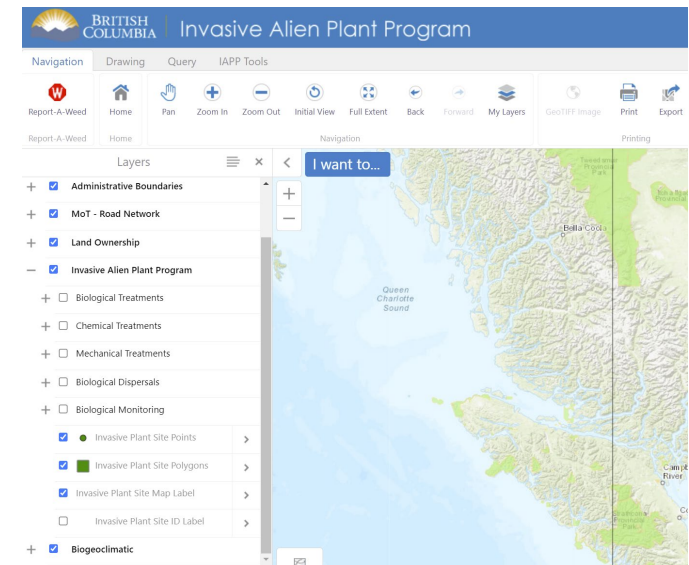
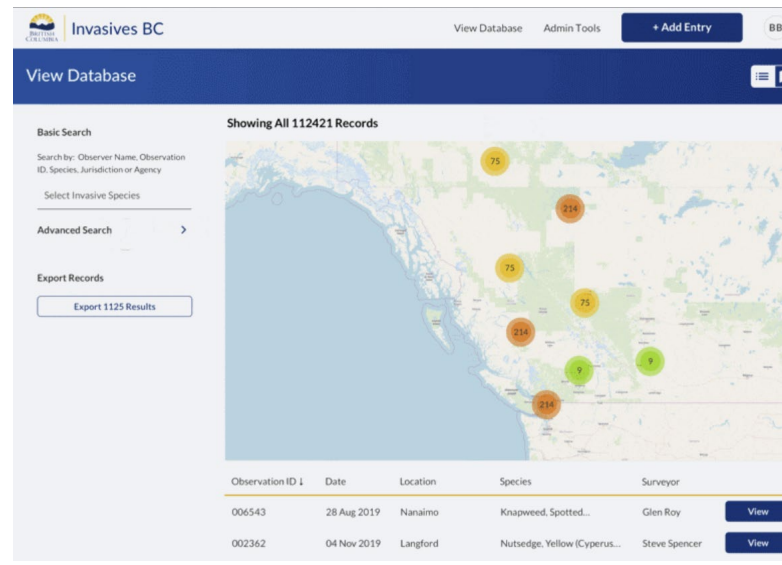
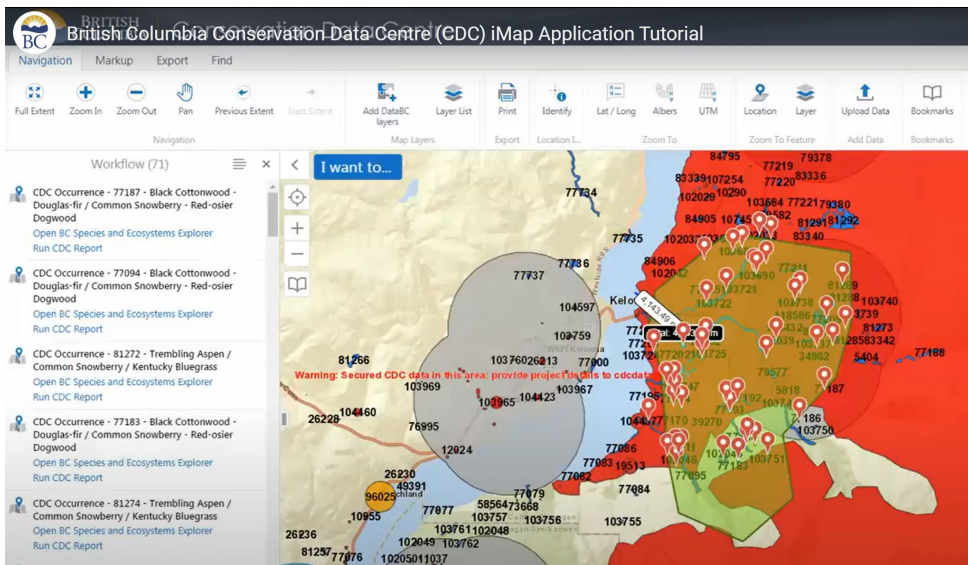
- Fill in data **gaps**, such as...
 - Vectors of introduction and spread,
 - Key locations of IS-SAR interactions,
 - Key interactions between IS-IS / SAR-SAR
 - IS impacts to SAR in marine environments
- Likely to be labor intensive, **focus on most critical SAR** for added efforts via
 - Additional literature review
 - Interviews
 - Targeted field research, etc.



Potential Avenues for Future Work



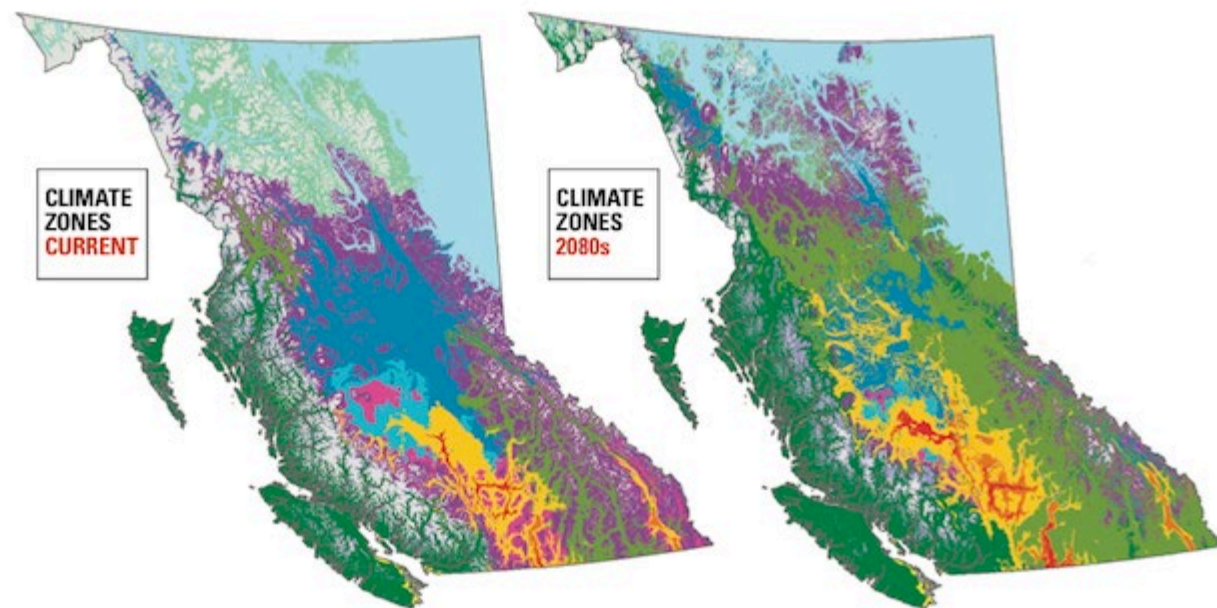
- Conduct a **spatially explicit analysis** of IS and SAR overlaps
 - Would help **prioritize limited management resources** to high-risk IS-SAR pairs
 - Would help tailor interventions to **regionally-specific mechanisms** of dispersal
 - Identify IS-SAR interactions in **areas of significance to Indigenous peoples**, allowing for more targeted community-based management efforts
 - Lean on, e.g., **BD CDC Data (for SAR)** and **Invasives BC + Invasive Alien Plant Program data (for IS)**



Potential Avenues for Future Work

- Better understand implications of IS in context of **climate change**
 - Urgent need for targeted research on the **synergistic effects of climate change and threats from IS to biodiversity**
 - Includes implications for **IS and SAR range shifts** studied via habitat suitability modelling, field surveys
 - Could **inform spatially targeted interventions** – e.g., assisted dispersal of SAR outside of projected invasive species ranges

BIOGEOCLIMATIC ZONES

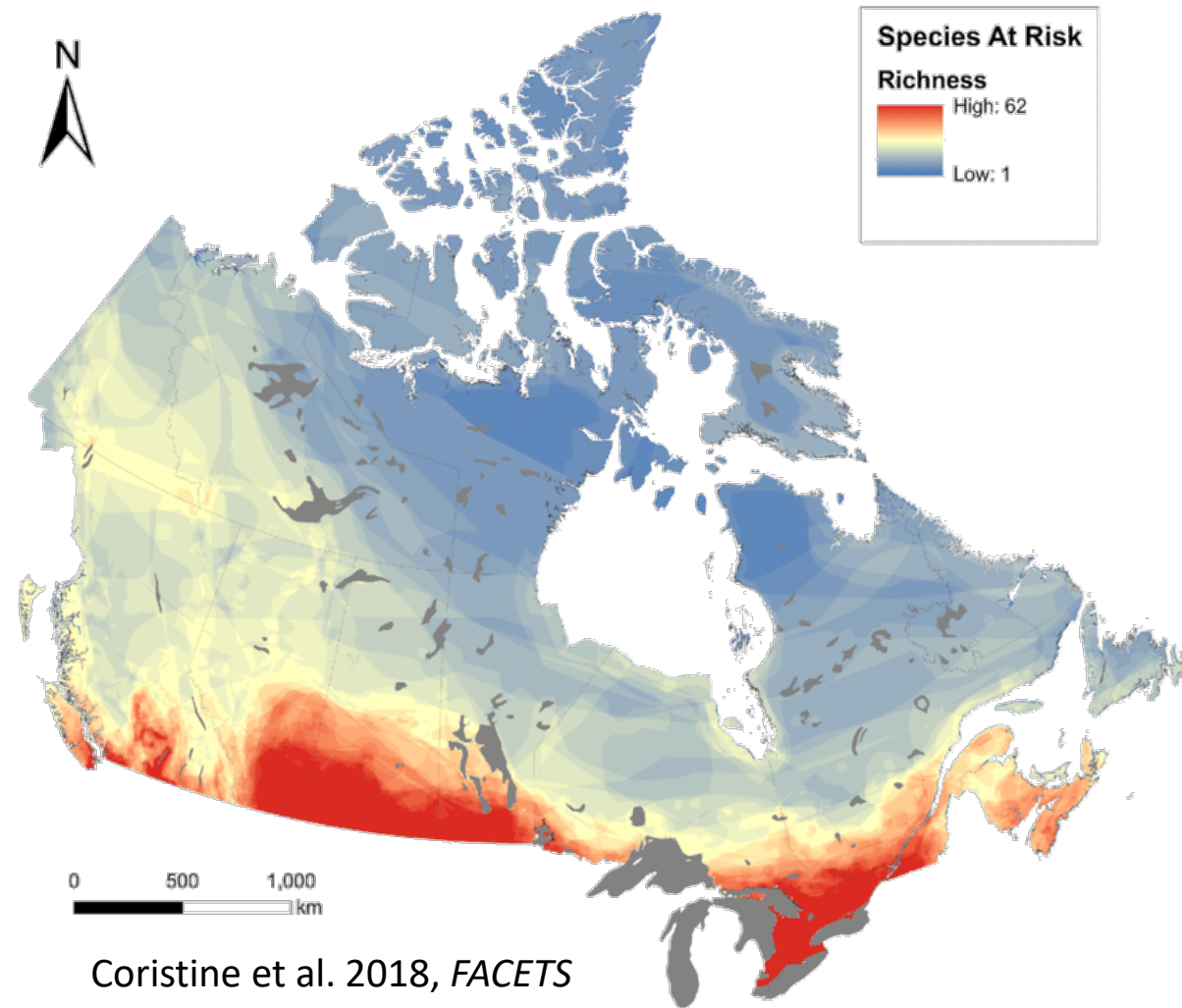
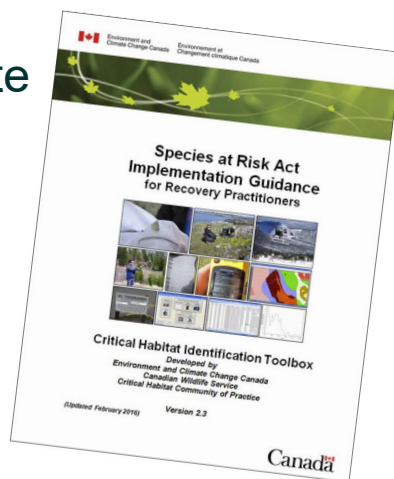


SOURCE: TONGLI WANG, CENTRE FOR FOREST CONSERVATION GENETICS, UBC



Potential Avenues for Future Work

- Expand work to **national scale**
 - Would help with more effective **regional management planning**
 - Would inform **national recovery planning for SAR** and a more comprehensive national response strategy for IS
 - E.g., Could be used to update guidance in the federal **Species at Risk Act Guidance: Critical Habitat Identification Toolbox:**



Coristine et al. 2018, *FACETS*



Western Painted Turtles and red-Eared Slider, D. Merrigan, Crawford 2019, via Alamy

Thank You! Questions?

Contacts Natascia Tamburello (ntamburello@essa.com)

Report <https://bcinvasives.ca/news/new-report-on-species-at-risk/>

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We would like to thank Nick Wong, Sue Staniforth, and Anthony Mallinson at ISCBC for their leadership and on this project as well members of a Technical Review and Advisory Committee assembled for this project (Emily Lomas at BC MOECCS, Brett van Poorten at SFU, and David Fraser [independent biologist]) who provided helpful feedback on our approach and an early version of this presentation.

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