Cumulative Effects: The Only Effects that Matter!

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Overview

- **One Basic Concept**
- **Two Examples**
- **Four Principles for CE Progress**

Why are cumulative effects the only effects that matter?

- **what REALLY matters is the sustainability of valued components of the environment (let's call them VCs)**

- **VCs NEVER experience only one causal agent (driving force, stressor) on their condition/sustainability**

- **for environmental assessment (of any sort), it means we should ALWAYS be searching for cumulative effects, i.e., what are the multiple stressors/forces acting on a VC, and how do they affect the VC interactively and cumulatively?**

What does this mean for cumulative effects assessment?

- **CEA should always start with identification and understanding of VCs – their status, condition, vulnerability, driving forces**

- **analysis then proceeds to the even more difficult arena of discerning the full package of driving forces and how they interact to influence the status and condition of the chosen VCs**

CE Typologies – are they useful?

- **they may help in codifying the kinds of interactions to look for, e.g.:**
  - **additive**
  - **synergistic**
  - **compensatory**
  - **masking**

- **but . . . they do not assist much in the actual search for and creation of evidence about CEs**

An example close to home . . .

- **VC: me**
- **condition indicator: my heart**
- **what factors under our control drive heart condition:**
  - **smoking**
  - **drinking**
  - **exercise**
  - **diet**
- **if all four drivers are in play, how do we understand the cumulative risks?**

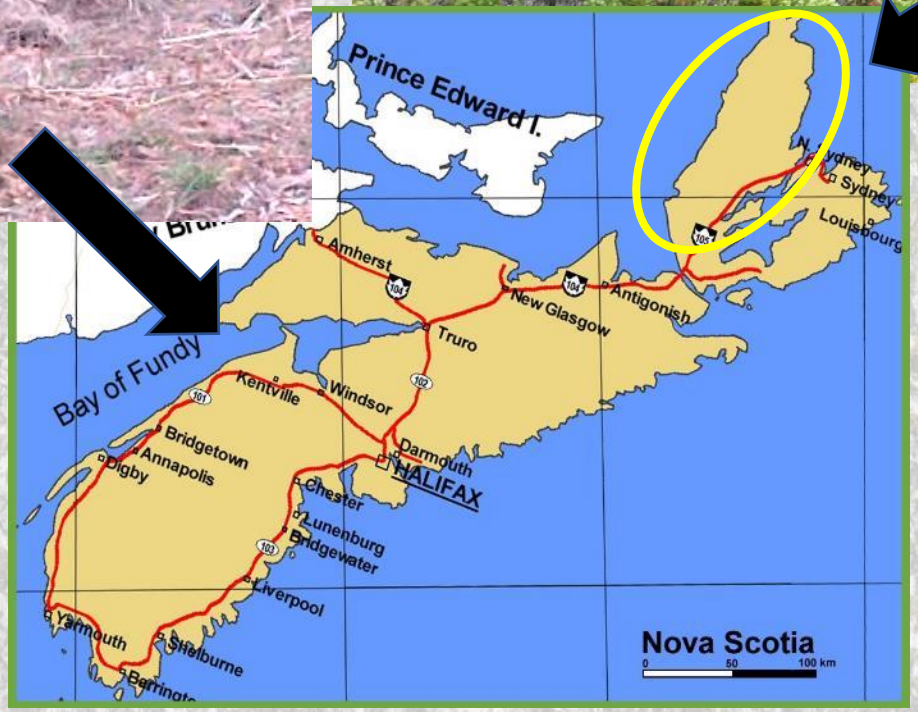
The North Atlantic Right Whale

The North Atlantic Right Whale

- **What stressors on the population?**
  - **harvest (until 1930s)**
  - **vessel collisions**
  - **entanglement in fishing gear**
  - **habitat degradation**
  - **contaminants**
  - **noise**
  - **mere presence of vessels**
  - **inadequate food supplies**
  - **climate change?**

- **source: Brown, M.W., Fenton, D., Smedbol, K., Merriman, C., Robichaud-Leblanc, K., and Conway, J.D. 2009. Recovery Strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 66p.**

Moose of Nova Scotia



Moose of Nova Scotia

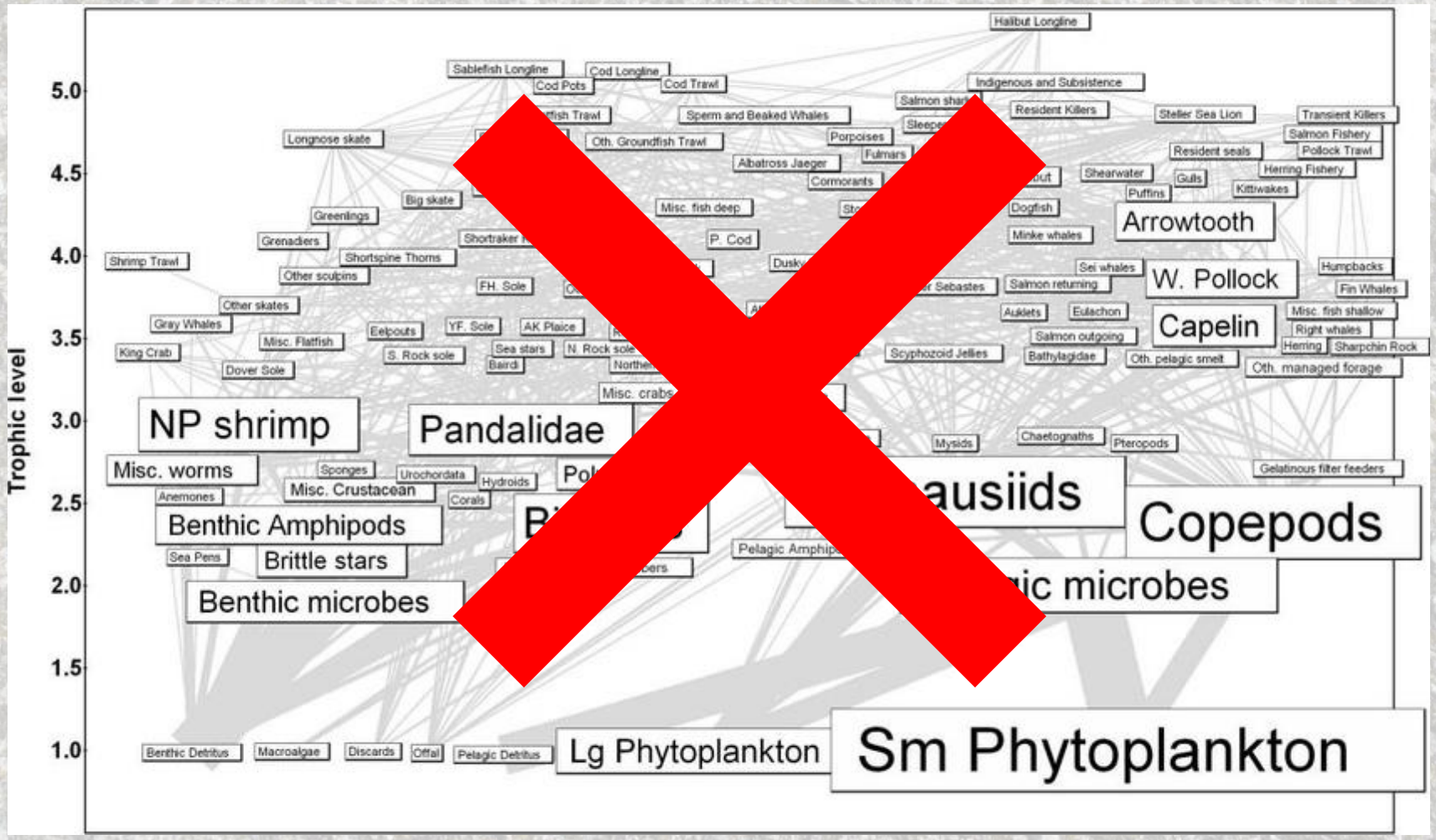
Population Stressor	Mainland Moose* (under one thousand)	Cape Breton Moose (several thousand)
Habitat degradation - Development - Forest practices	Both abundant	Little development; some timber harvest
Vehicle Collisions	Abundant	Abundant
Brainworm	Abundant	None
Winter tick	Abundant	None
Harvest	If done, illegal	Annually, legal
Human access to habitat	Plenty	Restricted
Acid rain and heavy metals	Suspected	Not suspected
Heat stress	Increasing	Not a factor (yet)

* Nova Scotia Department of Natural Resources. 2007. Recovery Plan for Moose (*Alces alces americana*) in Mainland Nova Scotia.

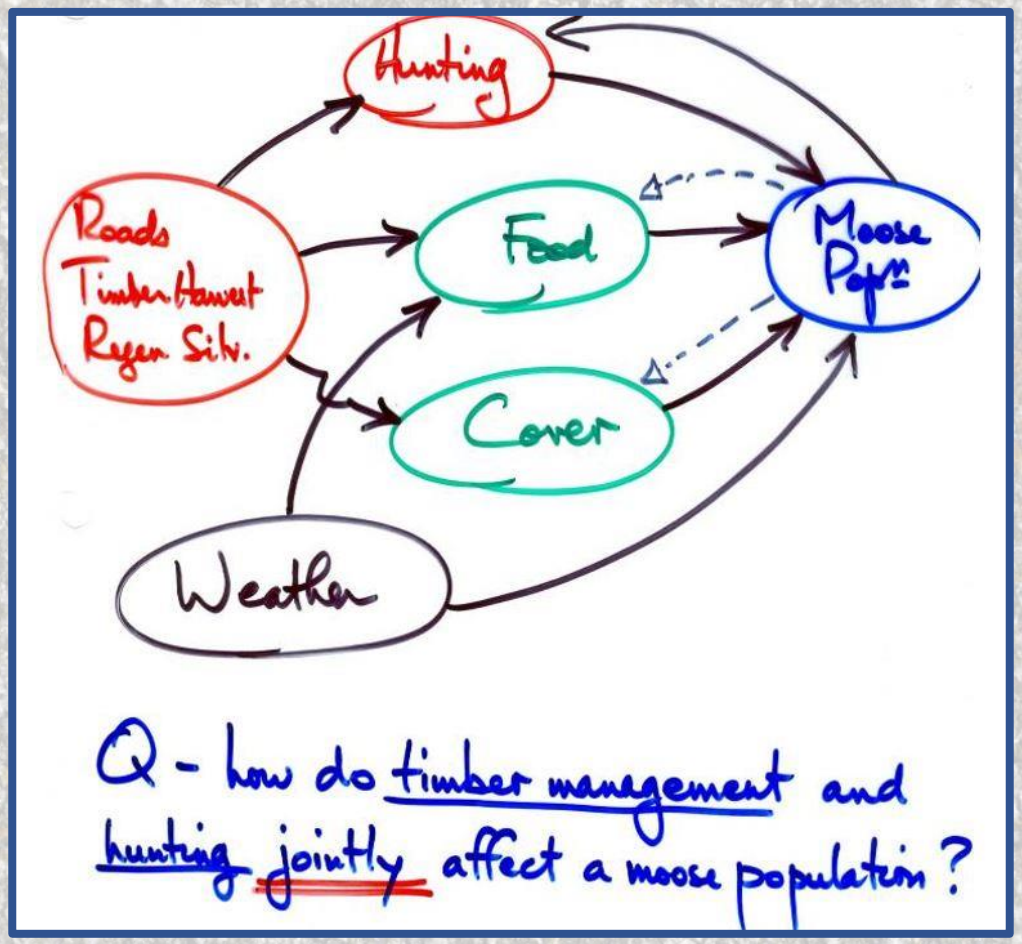
Principles for CEA Progress

- **Focus**
- **Scenarios**
- **Simulation Modelling**
- **Collaboration**

Principles for CEA Progress: Focus



Principles for CEA Progress: Focus

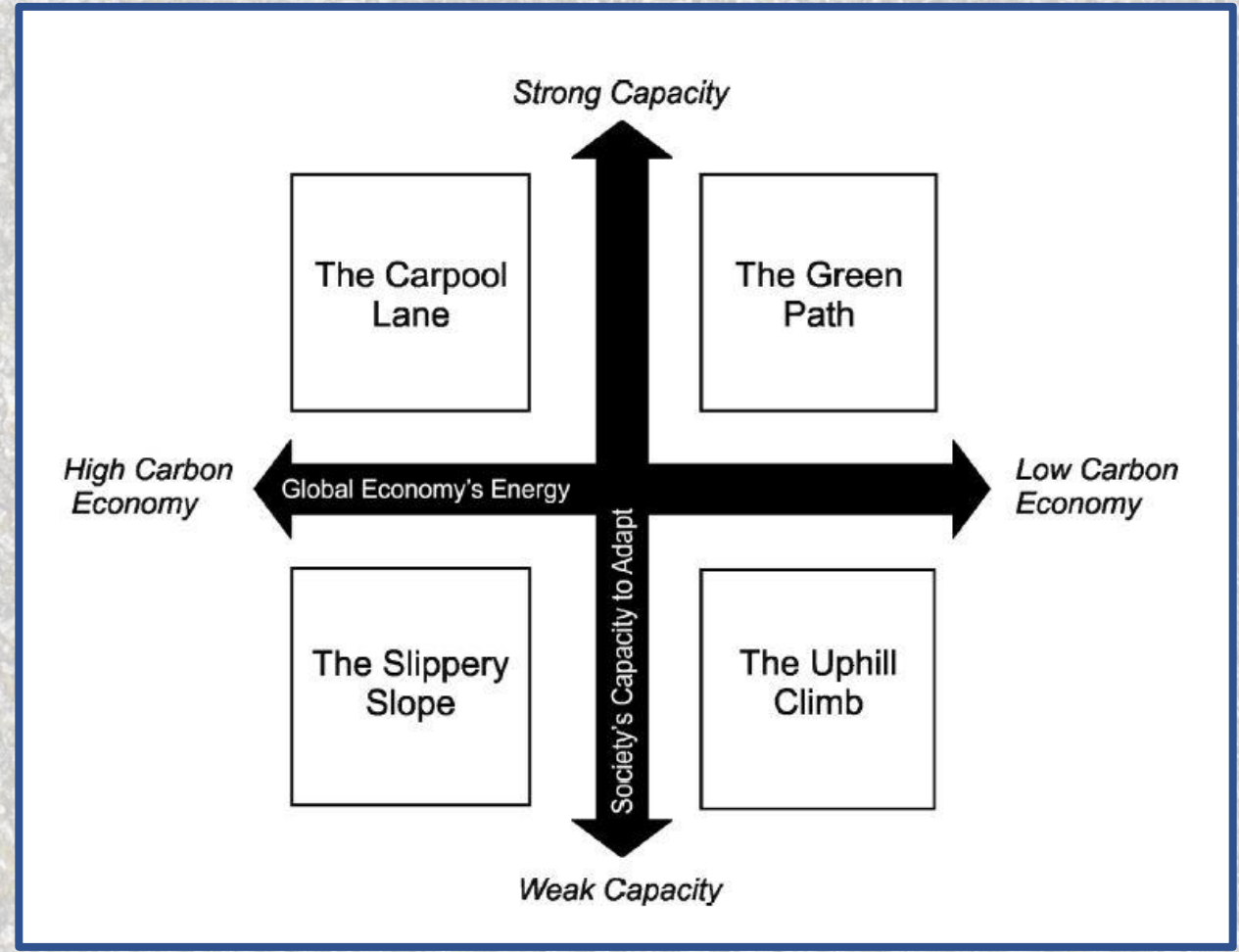


Morrison-Saunders A, Pope J, Gunn JAE, Pope A. 2014. Strengthening impact assessment: a call for integration and focus. Impact Assess Project Appraisal 32(1):2-8. http://dx.doi.org/10.1080/14615517.2013.872841

Principles for CEA Progress: Scenarios

- **Need scenarios for human-activity packages in CEA**
- **The hardest futures to predict are the ones with human actions in them – impossible!!**
- **Avoid low/med/high scenario-building, and also "most likely" scenario-building – these are blinkers when future realities may be far into our peripheral visions**

Principles for CEA Progress: Scenarios



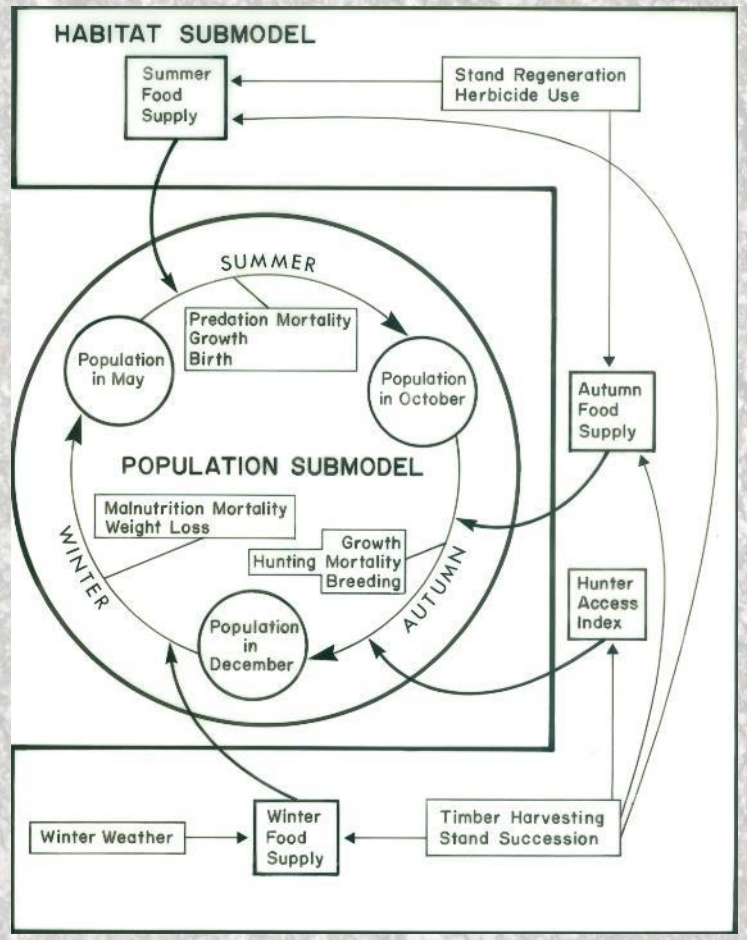
Creed, I.F., P.N. Duinker, J.W.N. Steenberg, and J.N. Serran. 2018. Managing risks to Canada's boreal zone: transdisciplinary thinking in pursuit of energy security. Environmental Reviews 27(3):407-418. (doi: 10.1139/er-2018-0070)

Principles for CEA Progress: Simulation Modelling

- **Empirical science and professional judgement, no matter how good both are, will not shed sufficient light onto complex questions of cumulative effects!**

- **Biophysical cause-effect linkages are amenable to quantitative simulation techniques to:**
  - **explore possibilities**
  - **expose key uncertainties for empirical initiatives**

Principles for CEA Progress: Simulation Modelling



$$N_{ab} = \sum_{c=1}^{d} (N_c \times S_c); \quad (2)$$

$$M = ((N2 \times FR2 \times FS2) + (N1 \times FR1 \times FS1))/SR; \quad (3)$$

$$F = ((N2 \times FR2 \times FS2) + (N1 \times FR1 \times FS1))/(1 - SR); \quad (4)$$

$$WT_{ab} = \left(\sum_{c=1}^{d} (WT_c + ((ES_{ce} - MER_{ce})/EC)) \times Nc \times Sc\right)/N_{ab}; \quad (5)$$

$$MER_{ab} = DMER_{ab} \times WT^{0.75} \times D_e; \quad (6)$$

$$ES_{ab} = (K_{ij} \times PN/N_{ab}) + (W_{ab}(K_{ij} \times PW)/(\sum_{a=1}^{6} (N_{ab} \times WT_{ab}))) + (K_{ij} \times PS/N3) \quad (7)$$

Walters, C.J. 1986. Adaptive Management of Renewable Resources. MacMillan, New York. 374 pp.

Principles for CEA Progress: Collaboration

- **The big CE questions require big teams**
  - **scientists of many stripes**
  - **stakeholders**
  - **key decision-makers**

Principles for CEA Progress: Collaboration

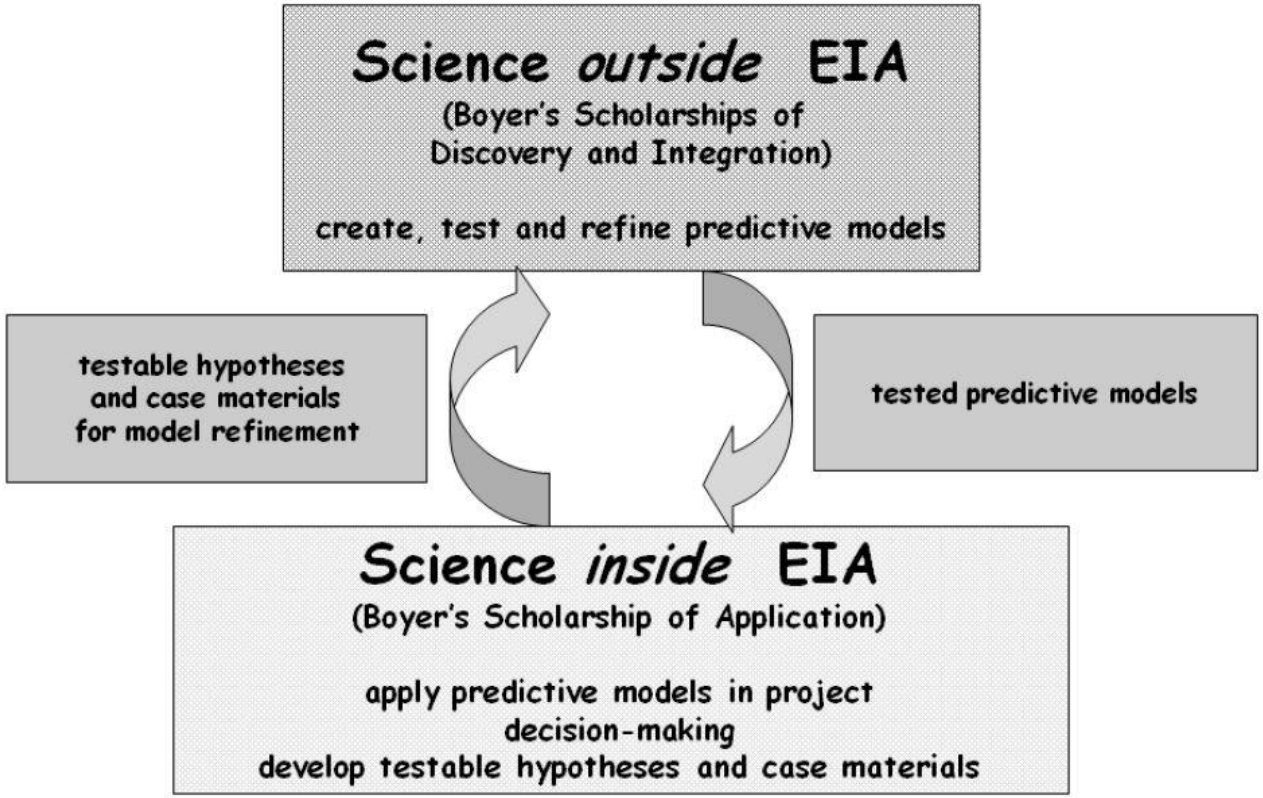


Figure 1. Relationships between science and EIA, with recognition of appropriate forms of scholarship from Boyer (1990)

Greig, L.A. and P.N. Duinker. 2011. A proposal for further strengthening science in environmental impact assessment in Canada. Impact Assessment and Project Appraisal 29(2):159-165. doi: 10.3152/146155111X12913679730557

Some References

- **Sinclair, A.J., M. Doelle, and P.N. Duinker. 2017. Looking up, down, and sideways: reconceiving cumulative effects assessment as a mindset. Environmental Impact Assessment Review 62:183-194. dx.doi.org/10.1016/j.eiar.2016.04.007**
- **Duinker, P.N., E.L. Burbidge, S.R. Boardley, and L.A. Greig. 2013. Scientific dimensions of cumulative effects assessment: toward improvements in guidance for practice. Environmental Reviews 21:40-52. (dx.doi.org/10.1139/er-2012-0035)**
- **Greig, L.A. and P.N. Duinker. 2011. A proposal for further strengthening science in environmental impact assessment in Canada. Impact Assessment and Project Appraisal 29(2):159-165. doi: 10.3152/146155111X12913679730557**
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- **Duinker, P.N. and L.A. Greig. 2006. The impotence of cumulative effects assessment in Canada: ailments, and ideas for redeployment. Environmental Management 37(2):153-161. DOI: 10.1007/s00267-004-0240-5**

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