Vulnerability of fynbos fishes to climate change and other human impacts

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NRF National Research Foundation

C•I•B DST Centre of Excellence for Invasion Biology

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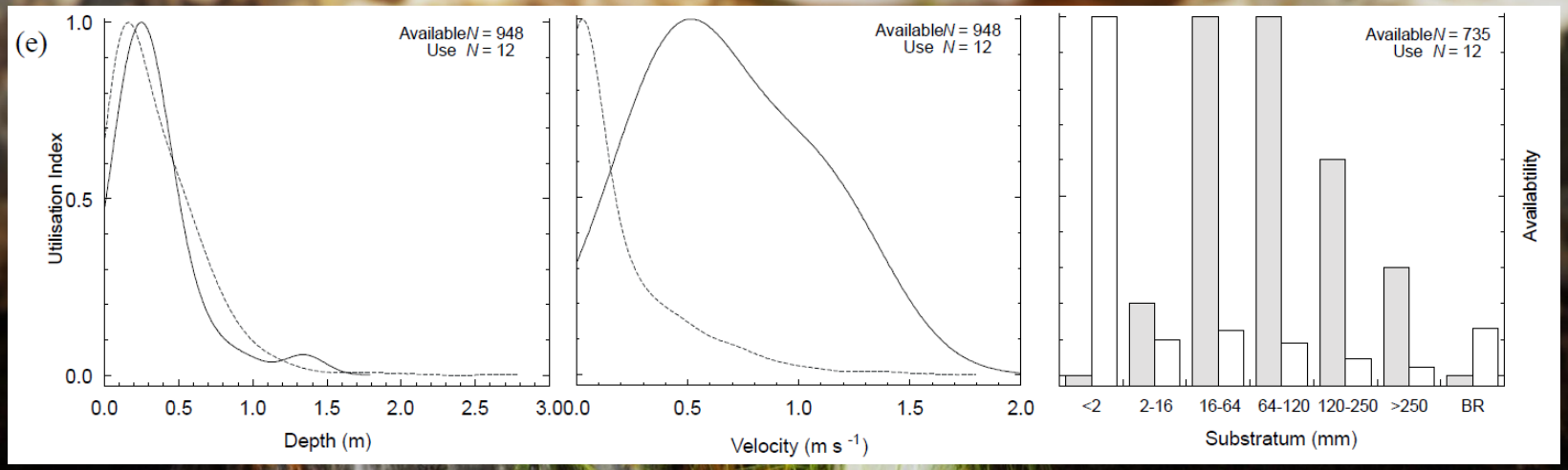

Paxton & King (2009)

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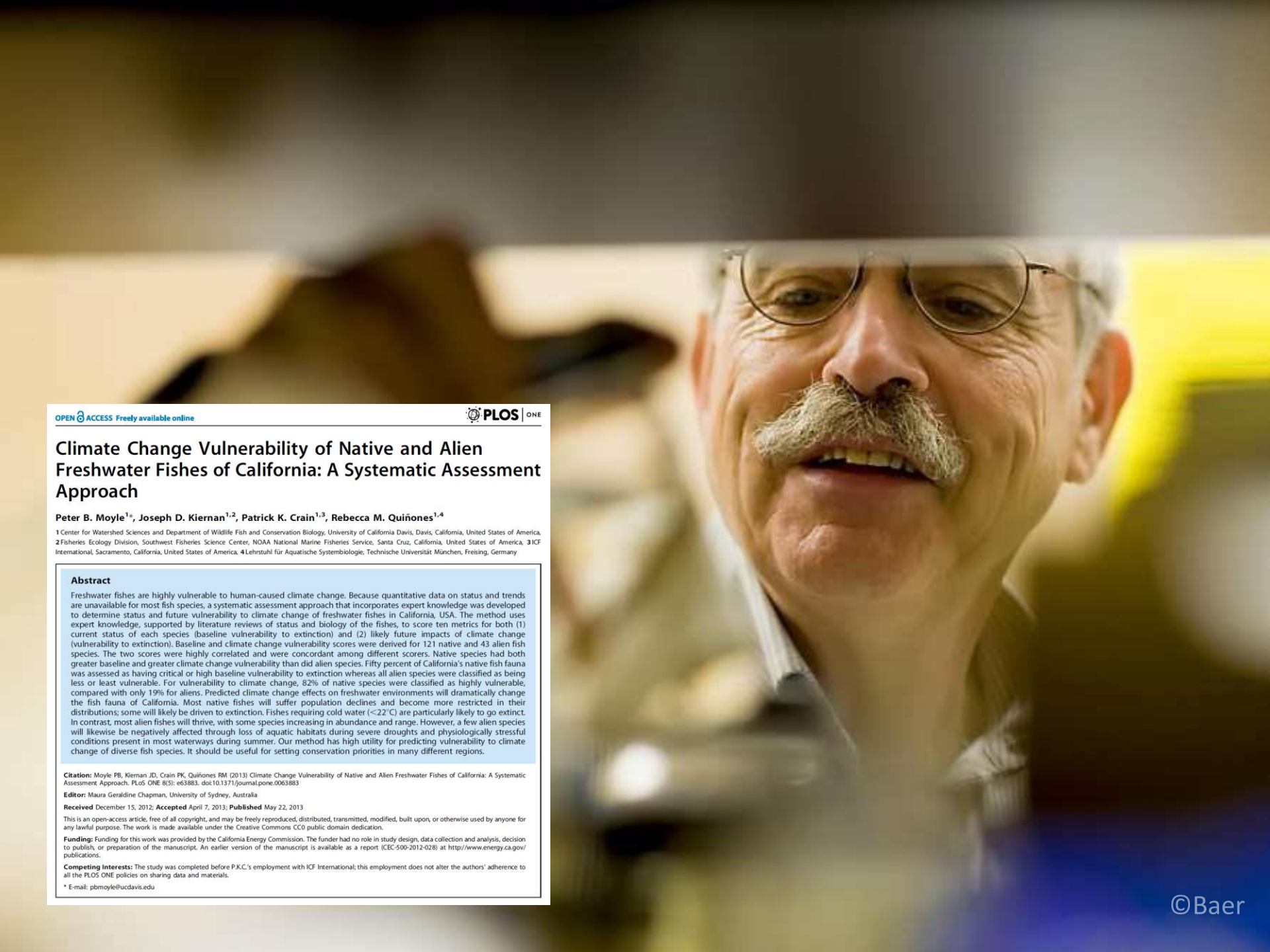

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PLOS ONE

Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A Systematic Assessment Approach

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Abstract

Freshwater fishes are highly vulnerable to human-caused climate change. Because quantitative data on status and trends are unavailable for most fish species, a systematic assessment approach that incorporates expert knowledge was developed to determine status and future vulnerability to climate change of freshwater fishes in California, USA. The method uses expert knowledge, supported by literature reviews of status and biology of the fishes, to score ten metrics for both (1) current status of each species (baseline vulnerability to extinction) and (2) likely future impacts of climate change (vulnerability to extinction). Baseline and climate change vulnerability scores were derived for 121 native and 43 alien fish species. The two scores were highly correlated and were concordant among different scorers. Native species had both greater baseline and greater climate change vulnerability than did alien species. Fifty percent of California's native fish fauna was assessed as having critical or high baseline vulnerability to extinction whereas all alien species were classified as being less or least vulnerable. For vulnerability to climate change, 82% of native species were classified as highly vulnerable, compared with only 19% for aliens. Predicted climate change effects on freshwater environments will dramatically change the fish fauna of California. Most native fishes will suffer population declines and become more restricted in their distributions; some will likely be driven to extinction. Fishes requiring cold water (<22˚C) are particularly likely to go extinct. In contrast, most alien fishes will thrive, with some species increasing in abundance and range. However, a few alien species will likewise be negatively affected through loss of aquatic habitats during severe droughts and physiologically stressful conditions present in most waterways during summer. Our method has high utility for predicting vulnerability to climate change of diverse fish species. It should be useful for setting conservation priorities in many different regions.

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Competing Interests: The study was completed before P.K.C.'s employment with ICF International; this employment does not alter the authors' adherence to all the PLOS ONE policies on sharing data and materials.

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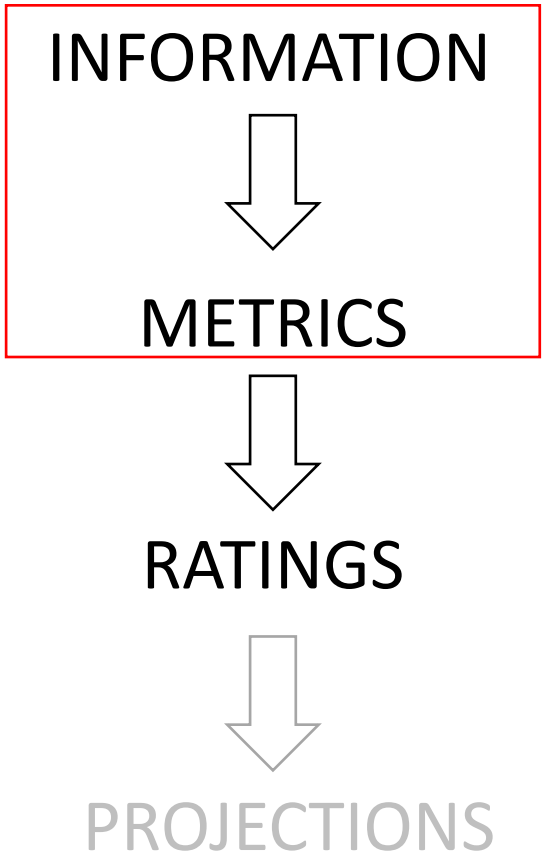

INFORMATION
METRICS
RATINGS
PROJECTIONS







Taxon:_____ Date:_____ Scored By:_____

Current stressors narrative ☐ Justifications ☐

Module 1: baseline vulnerability (Vb) **Score**

1 Current population size (last 10 yrs.)		Best	Alt.
<100	1		
100–500	2		
500–1,000	3		
1,000–10,000	4		
10,000–50,000	5		
>50,000	6		
Certainty: (low = 1 high = 3)		1 2 3	

2 Long-term population trend		Best	Alt.
>80% reduction	1		
>50% reduction	2		
>20% reduction	3		
Apparently stable	4		
Increasing	5		
Certainty: (low = 1 high = 3)		1 2 3	

3 Current population trend (last 10 yrs.)		Best	Alt.
Rapid decline	1		
Slow decline	2		
Apparently stable	3		
Increasing	4		
Certainty: (low = 1 high = 3)		1 2 3	

4 Long-term range trend		Best	Alt.
>80% reduction	1		
>50% reduction	2		
>20% reduction	3		
Apparently stable	4		
Increasing	5		
Certainty: (low = 1 high = 3)		1 2 3	

5 Current range trend (last 10 yrs.)		Best	Alt.
Rapid reduction	1		
Slow reduction	2		
Apparently stable	3		
Increasing	4		
Certainty: (low = 1 high = 3)		1 2 3	

6 Current vulnerability to stressors other than climate change		Best	Alt.
Highly vulnerable	1		
Vulnerable	2		
Not vulnerable	3		
Certainty: (low = 1 high = 3)		1 2 3	

7 Future vulnerability to stressors other than climate change		Best	Alt.
Highly vulnerable	1		
Vulnerable	2		
Low or no vulnerability	3		
Certainty: (low = 1 high = 3)		1 2 3	

8 Life span & reproductive plasticity		Best	Alt.
Must spawn annually	1		
Life span 2-5 yrs; single life history	2		
Life span 4-10 yrs; multiple life histories	3		
Long-lived (>10 years)	4		
Certainty: (low = 1 high = 3)		1 2 3	

9 Stochastic events		Best	Alt.
Highly vulnerable	1		
Vulnerable	2		
Not vulnerable	3		
Likely to benefit	4		
Certainty: (low = 1 high = 3)		1 2 3	

10 Current dependence on human intervention		Best	Alt.
Highly dependent (broodstock/hatcheries)	1		
Dependent (annual intervention)	2		
Somewhat dependent (periodic interventio	3		
Not dependent	4		
Certainty: (low = 1 high = 3)		1 2 3	

Notes:_____

Total score:_____ High:_____ Low:_____

Baseline vulnerability scores:

Vb1	<18	critically vulnerable
Vb2	18-25	highly vulnerable
Vb3	26-33	less vulnerable
Vb4	>33	least vulnerable

Cumulative certainty score:_____

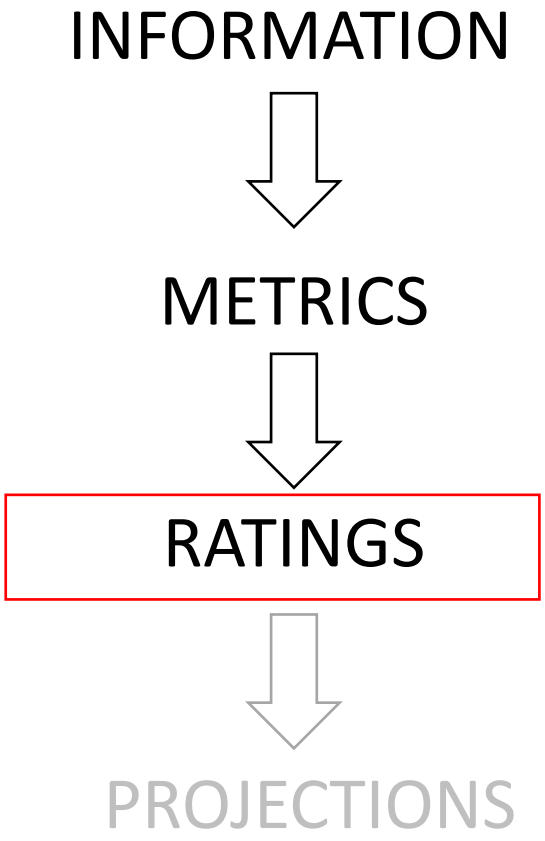
Current stressors narrative ☐ Justifications ☐

Module 1: baseline vulnerability (Vb) **Score**

1 Current population size (last 10 yrs.)		Best	Alt.
<100	1		
100–500	2		
500–1,000	3		
1,000–10,000	4		
10,000–50,000	5		
>50,000	6		
Certainty: (low = 1 high = 3)		1 2 3	

Module 2: climate change vulnerability (Vc)

1 Physiological/behavioral tolerance to temperature increase		Best	Alt.
Very low	1		
Low	2		
Moderate	3		
High (likely to benefit)	4		
Certainty: (low = 1 high = 3)		1 2 3	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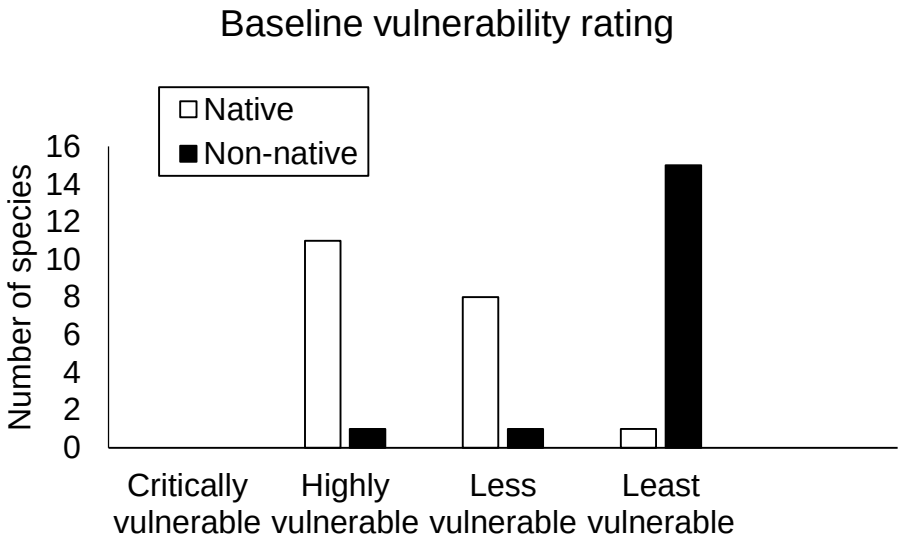
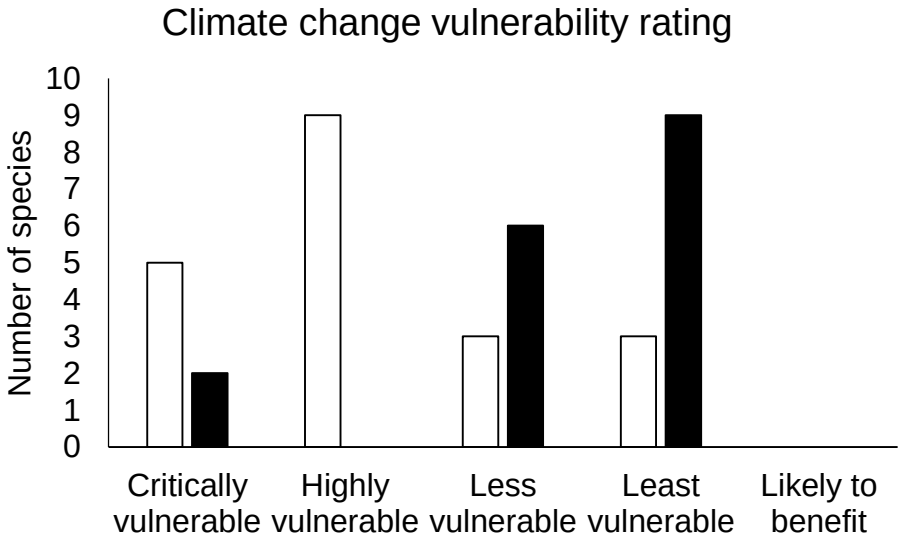

Baseline vulnerability rating
Native
Non-native
Number of species
16
14
12
10
8
6
4
2
0
Critically vulnerable
Highly vulnerable
Less vulnerable
Least vulnerable


Climate change vulnerability rating
Number of species
10
9
8
7
6
5
4
3
2
1
0
Critically vulnerable
Highly vulnerable
Less vulnerable
Least vulnerable
Likely to benefit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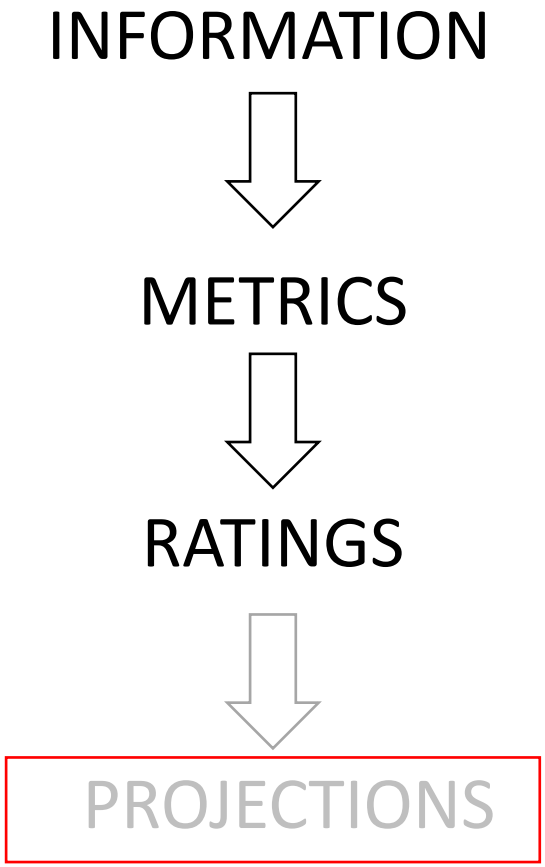
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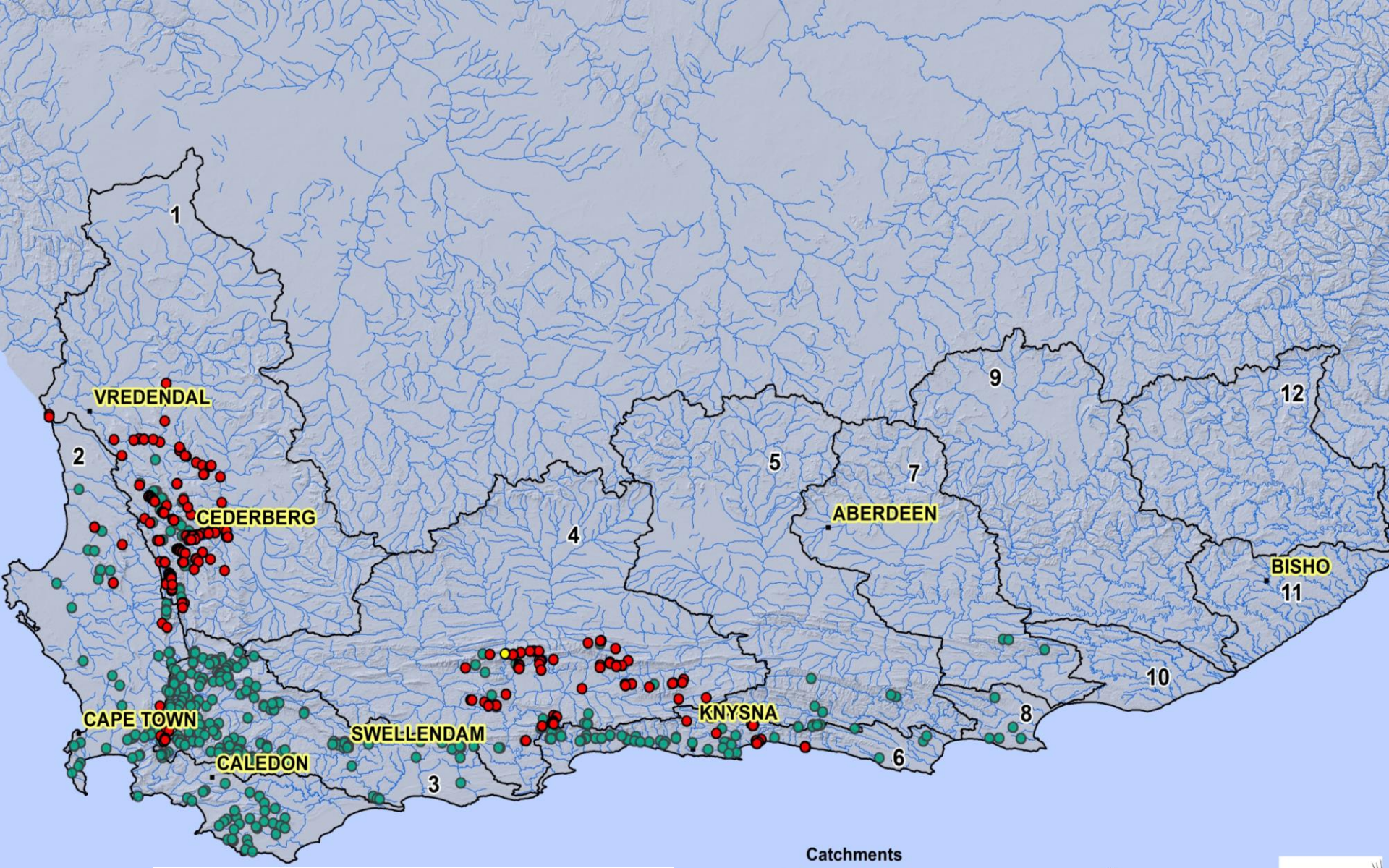

CLIMATE CHANGE VULNERABILITY/ ALL CERTAINTY

- Highly Vulnerable: The species is on the path toward extinction in the wild.
- Less Vulnerable:The species population and range is likely to remain stable.
- Least Vulnerable:The species population and range is likely to remain stable.

Catchments

1.Olifants	2.Berg
3.Breede	4.Gouritz
5.Gamtoos	6.Coastal
7.Sundays.	8.Swartkops
9.Fish	10.Bushmans
11.Kerskamma	12.Great Kei

Scale (A4) - 1:4,000,000

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CLIMATE CHANGE VULNERABILITY/ HIGH CERTAINTY

- Highly Vulnerable: The species is on the path toward extinction in the wild.
- Less Vulnerable:The species population and range is likely to remain stable.

Catchments

1. Olifants 2. Berg
3. Breede 4. Gouritz
5. Gamtoos 6. Coastal
7. Sundays 8. Fish
9. Swartkops 10. Great Kei
11.Kerskamma

Scale (A4) - 1:4,000,000

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STOUT
Dry Stout
LAGER
ALE
WEISS
JAN
PAMPOEN

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