FUTURE Science Program

Forecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems

PICES Science History

Following PICES 1st Integrative Science Program:

Climate Change and Carrying Capacity [1995-2009]

See FUTURE on PICES website:
http://meetings.pices.int/Members/Scientific-Programs/FUTURE

OUTLINE

- Review of **FUTURE** objectives & structure
- A Social-Ecological-Environmental System (SEES) framework
- SEES Case Studies:
    1. The 2014-16 Marine Heat Wave in the eastern Pacific
    2. Species alternation in the western Pacific
    3. Jellyfish blooms in the western Pacific
    4. Transboundary management under climate change
- What's next …?

FUTURE Science Program

PICES FUTURE IMPLEMENTATION

1. To increase understanding of climatic and anthropogenic impacts and consequences on marine ecosystems, with continued leadership at the frontiers of marine science.

2. To develop activities that include the interpretation, clarity of presentation, peer review, dissemination, and evaluation of ecosystem products (e.g., status reports, outlooks, forecasts) and establish a process for engaging interested institutions and other recipients.

See FUTURE Implementation Plan:
http://www.pices.int/members/scientific_programs/FUTURE/FUTURE-SSC

PICES **FUTURE** IMPLEMENTATION

Initial Implementation:
Advisory Panels on Coastal Impacts, Climate Variability, and Outreach/Forecasting
(2009-2014)

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Initial Implementation:
Advisory Panels on Coastal Impacts, Climate Variability, and Outreach/Forecasting
(2009-2014)

2014: FUTURE Evaluation Panel

New Implementation:
FUTURE Scientific Steering Committee
(2015-2019 …)

PICES FUTURE IMPLEMENTATION

FUTURE Scientific Steering Committee

Jackie King, Ian Perry, Tom Therriault

Guangshui Na, Fangli Qiao

Toyomitsu Horii, Mitsutaku Makino, Hiroaki Saito

Sukyung Kang, Sinjae Yoo

Oleg Katugin, Slava Lobanov

Steven Bograd, Manu Di Lorenzo, Ryan Rykaczewski

PICES FUTURE RESEARCH THEMES

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?

See FUTURE Science Plan:
http://www.pices.int/members/scientific_programs/FUTURE/FUTURE_final_2008.pdf

PICES FUTURE RESEARCH THEMES

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?

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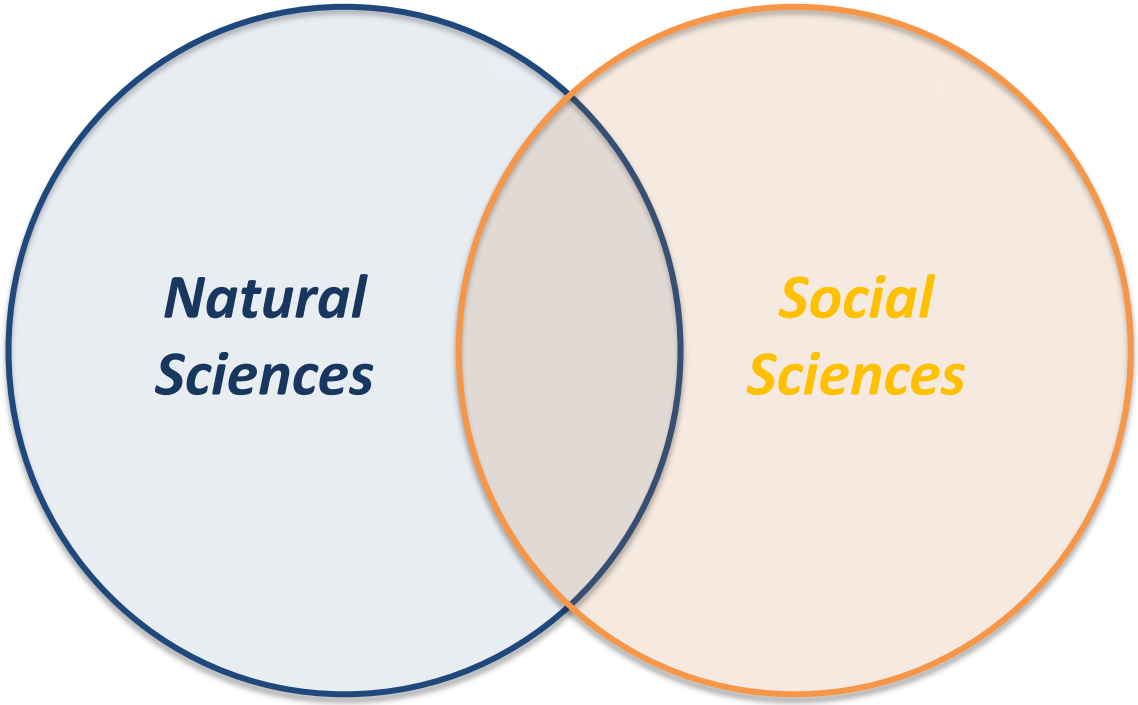
http://www.pices.int/members/scientific_programs/FUTURE/FUTURE_final_2008.pdf

PICES FUTURE RESEARCH THEMES

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?
3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?

See FUTURE Science Plan:
http://www.pices.int/members/scientific_programs/FUTURE/FUTURE_final_2008.pdf

CHALLENGES OF THE **FUTURE** PROGRAM

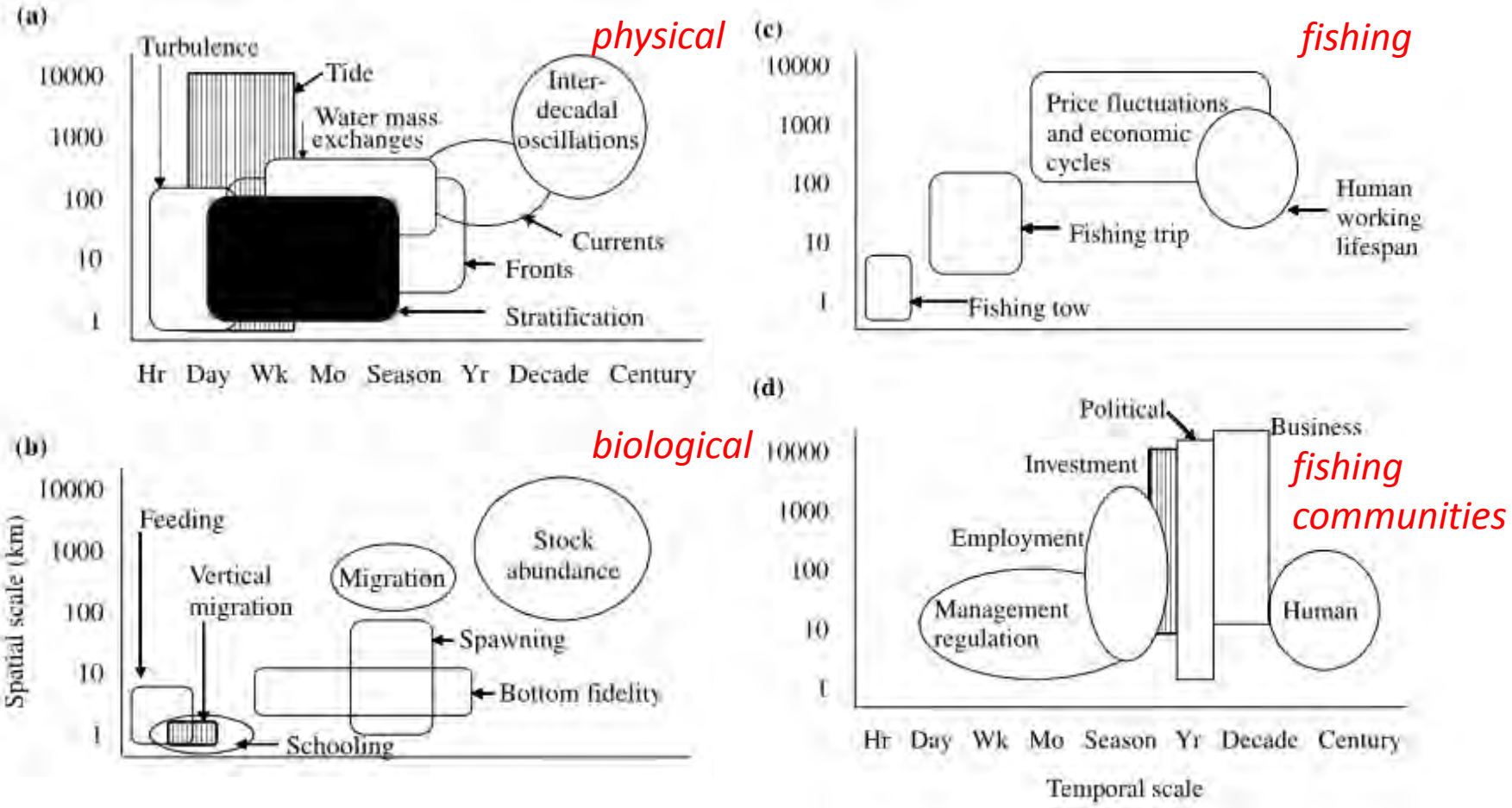


CHALLENGES OF THE FUTURE PROGRAM

Space-time diagram of characteristic processes

Natural Sciences

Social Sciences



Perry and Ommer (2003)

CHALLENGES OF THE FUTURE PROGRAM

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1. Investigate interactions across disciplinary boundaries and scales.
2. These interactions are complex and nonlinear, and occur across a broad range of spatial and temporal scales …
3. … which complicates management approaches to shared problems.

FUTURE Science Program

How does PICES address these challenges ?

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Social-Ecological-Environmental System (SEES) Approach:

- Embraces reciprocal links among people and nature
- Harnesses knowledge from natural & social sciences

Heather Leslie (U Maine)

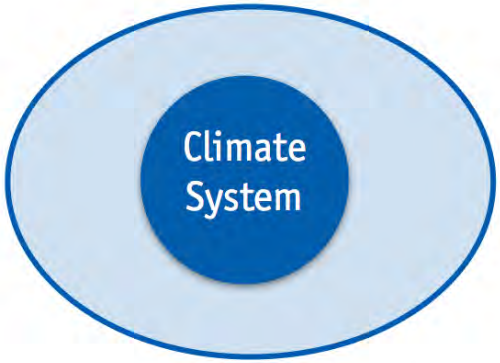
FUTURE Science Program

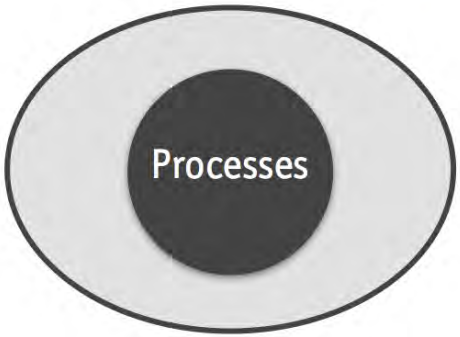
How does PICES address these challenges ?

Social-Ecological-Environmental System (SEES) Approach:

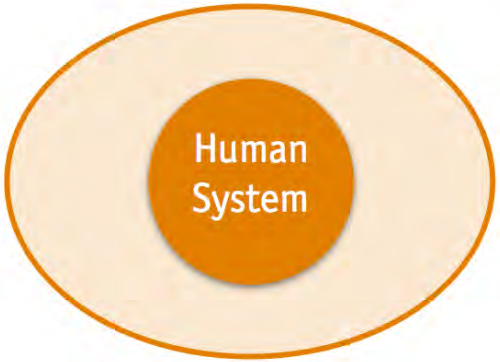
- Embraces reciprocal links among people and nature
- Harnesses knowledge from natural & social sciences
- **Identifies:**
  - **Potential collaborations amongst PICES Expert Groups**
  - **Critical research gaps in FUTURE Science Program**

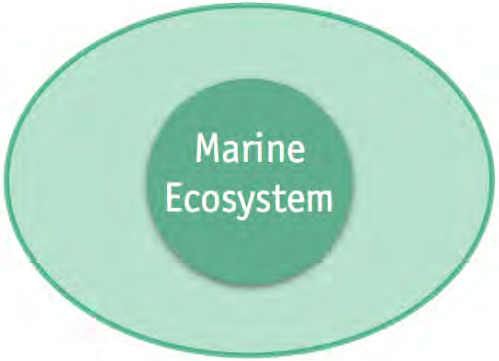
Elements of **FUTURE**
SCIENCE PROGRAM FOR 2020





dimensions of FUTURE Science Plan ...





GOAL

understand the PREDICTABILITY & SUSTAINABILITY of
Social-Ecological-Environmental Systems

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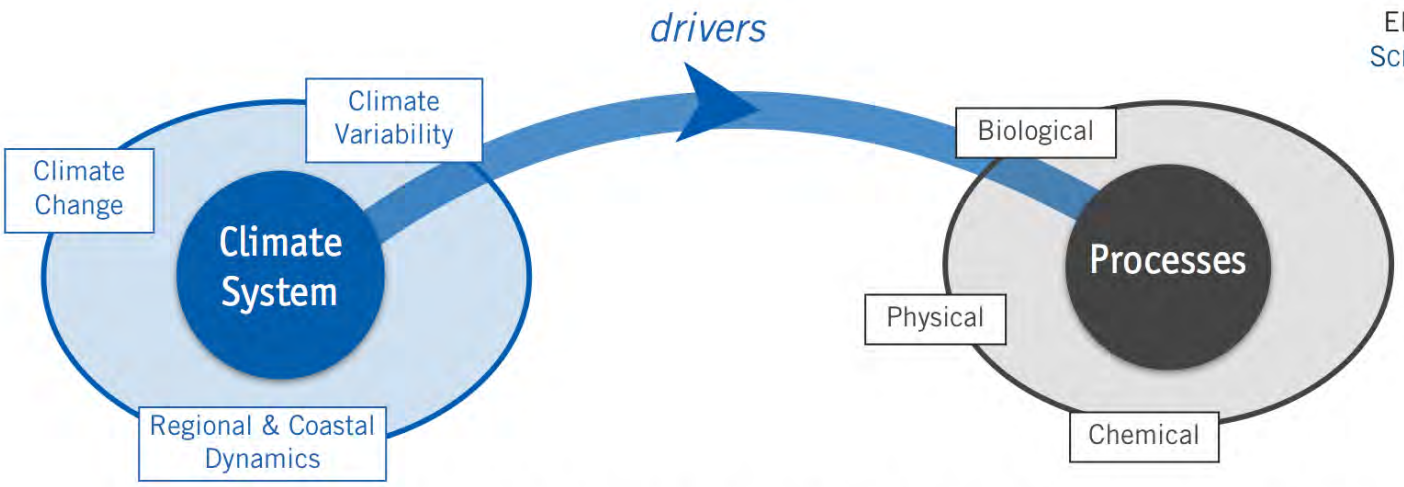

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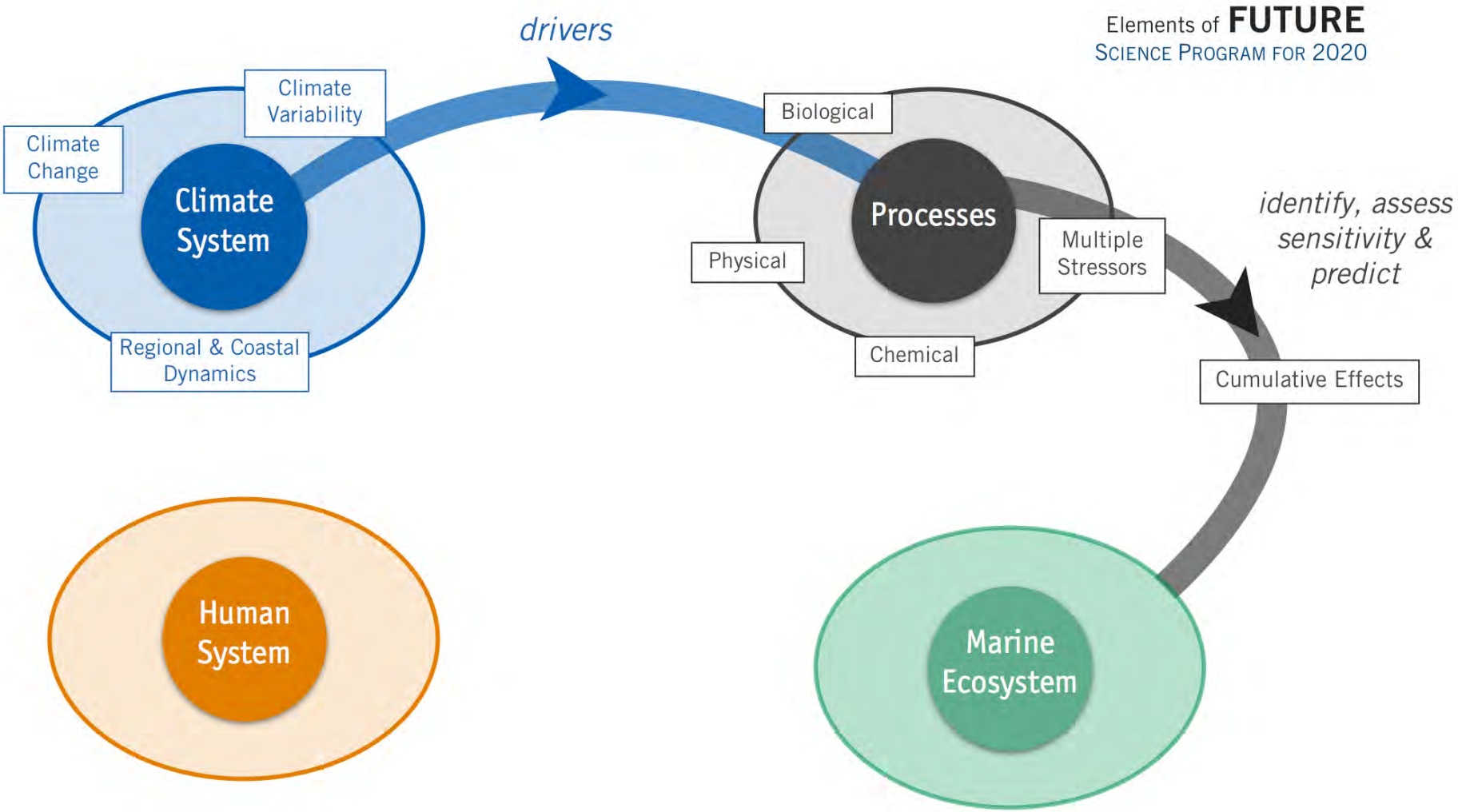
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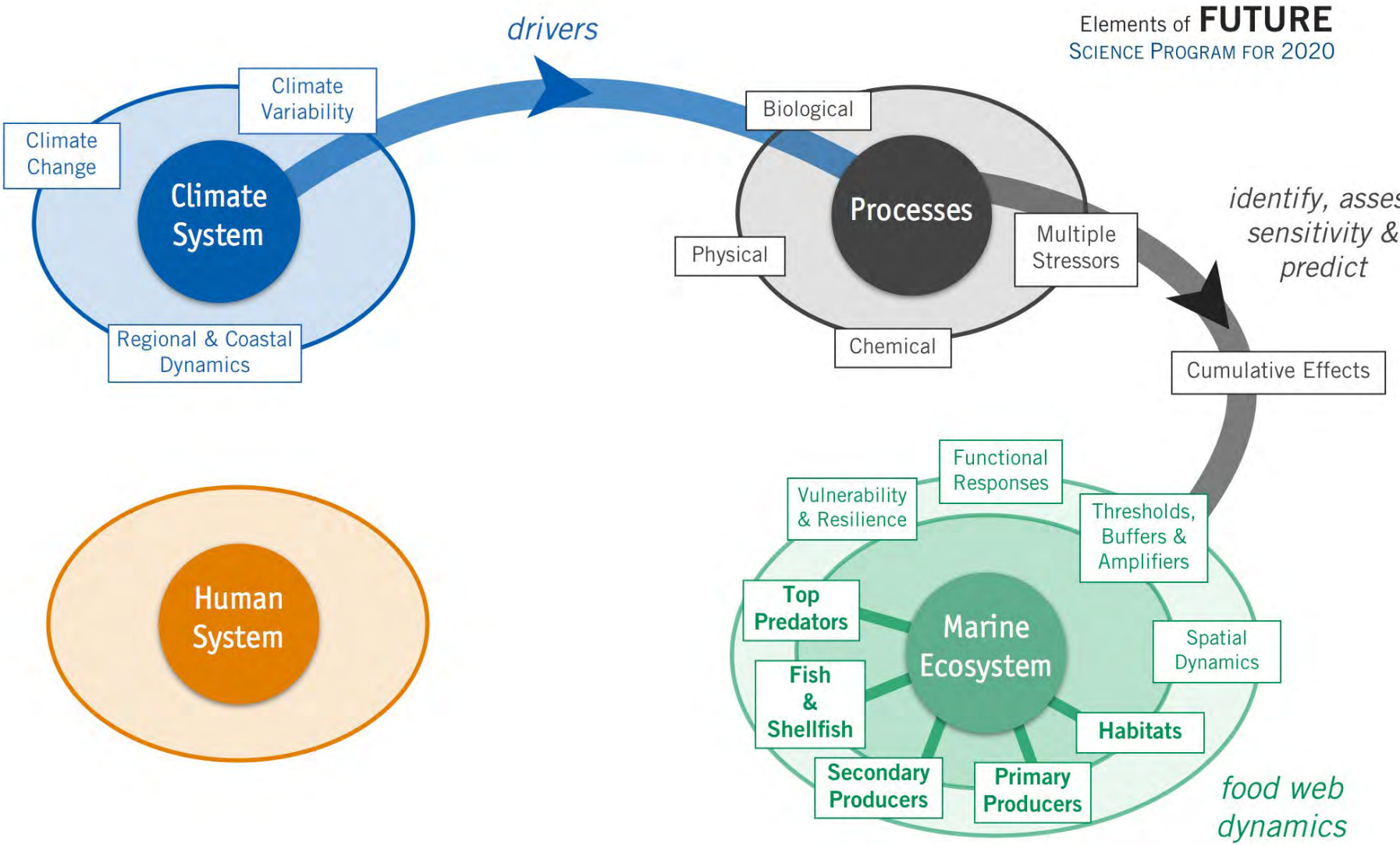
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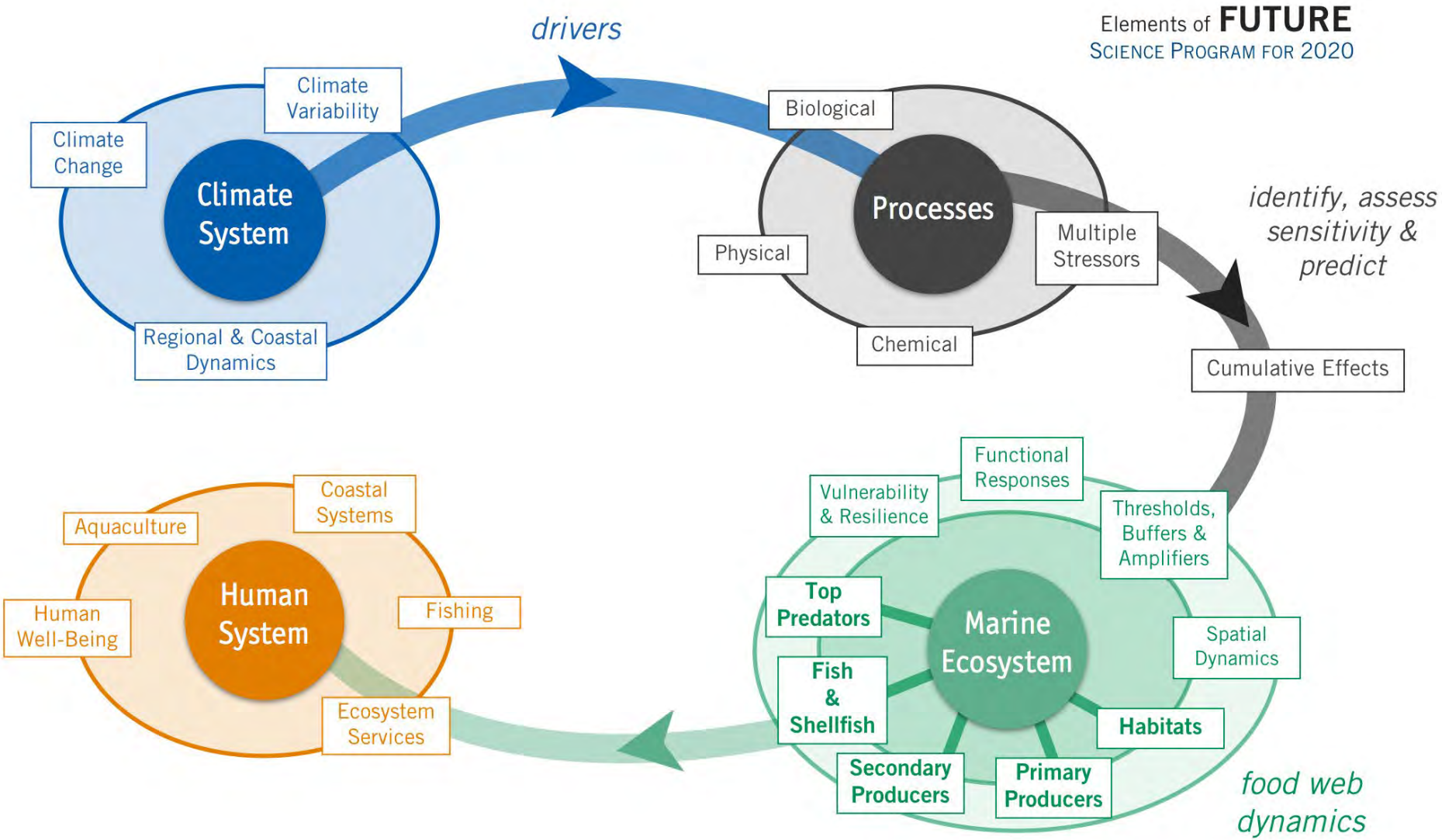
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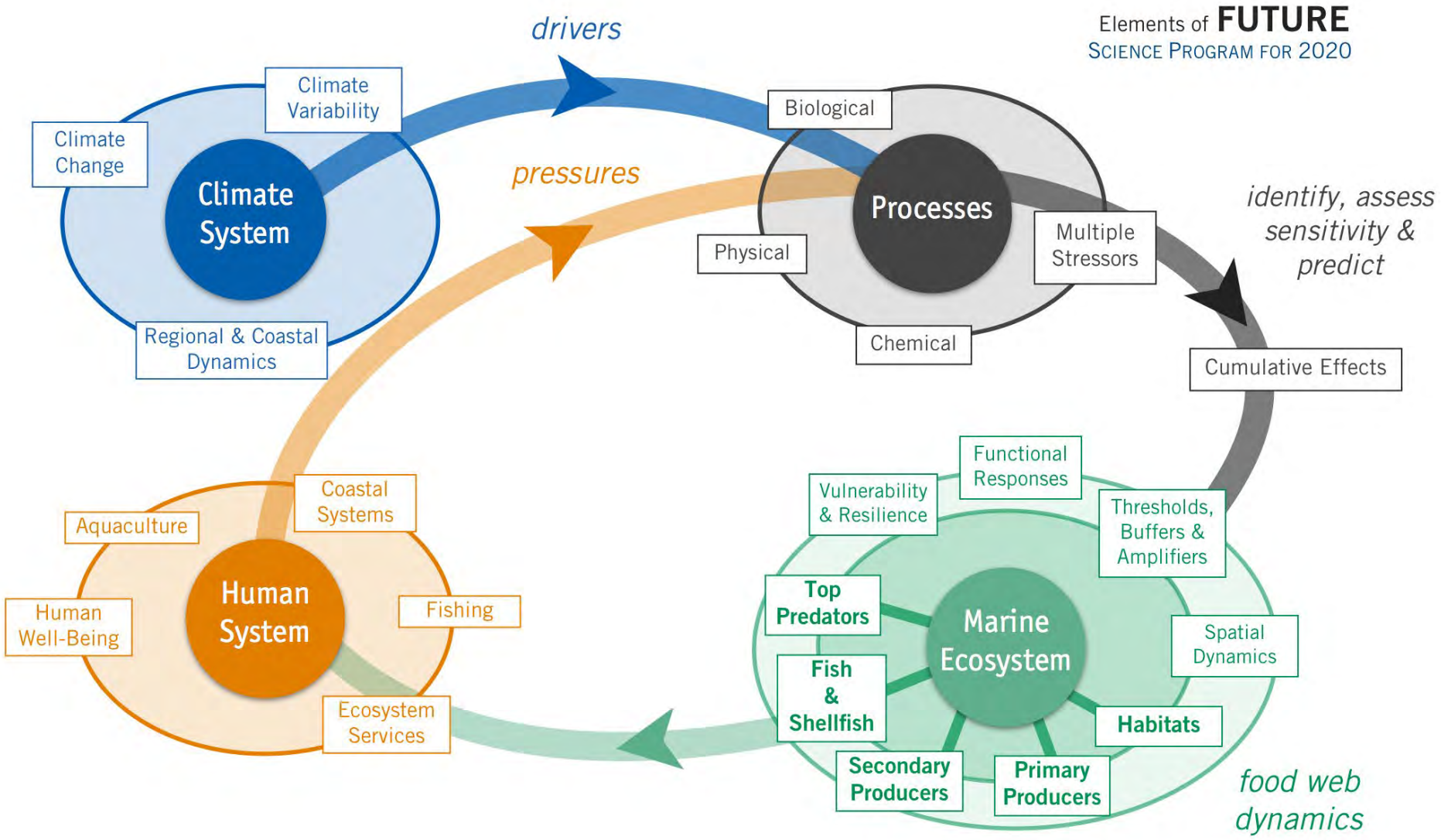
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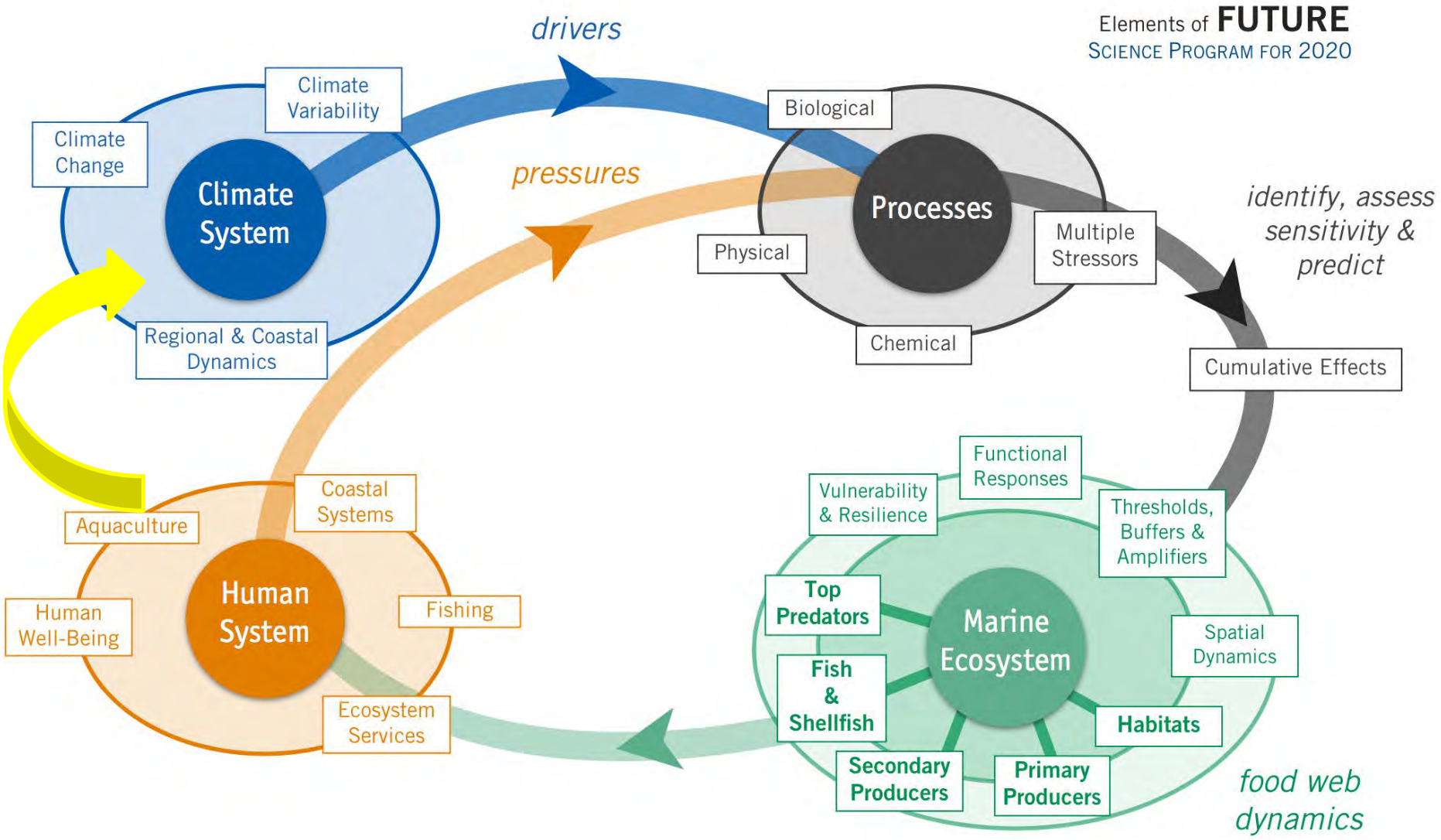
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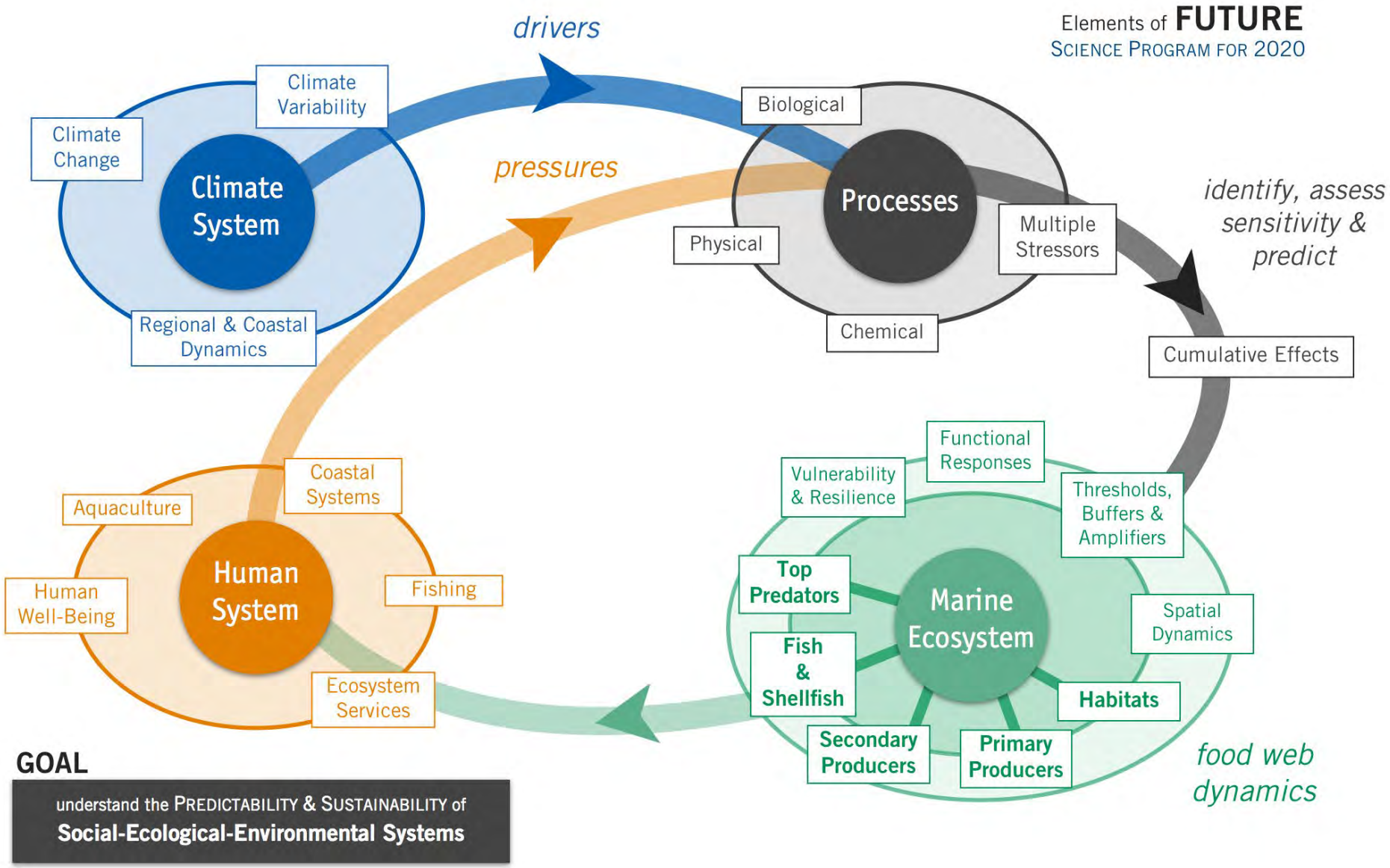
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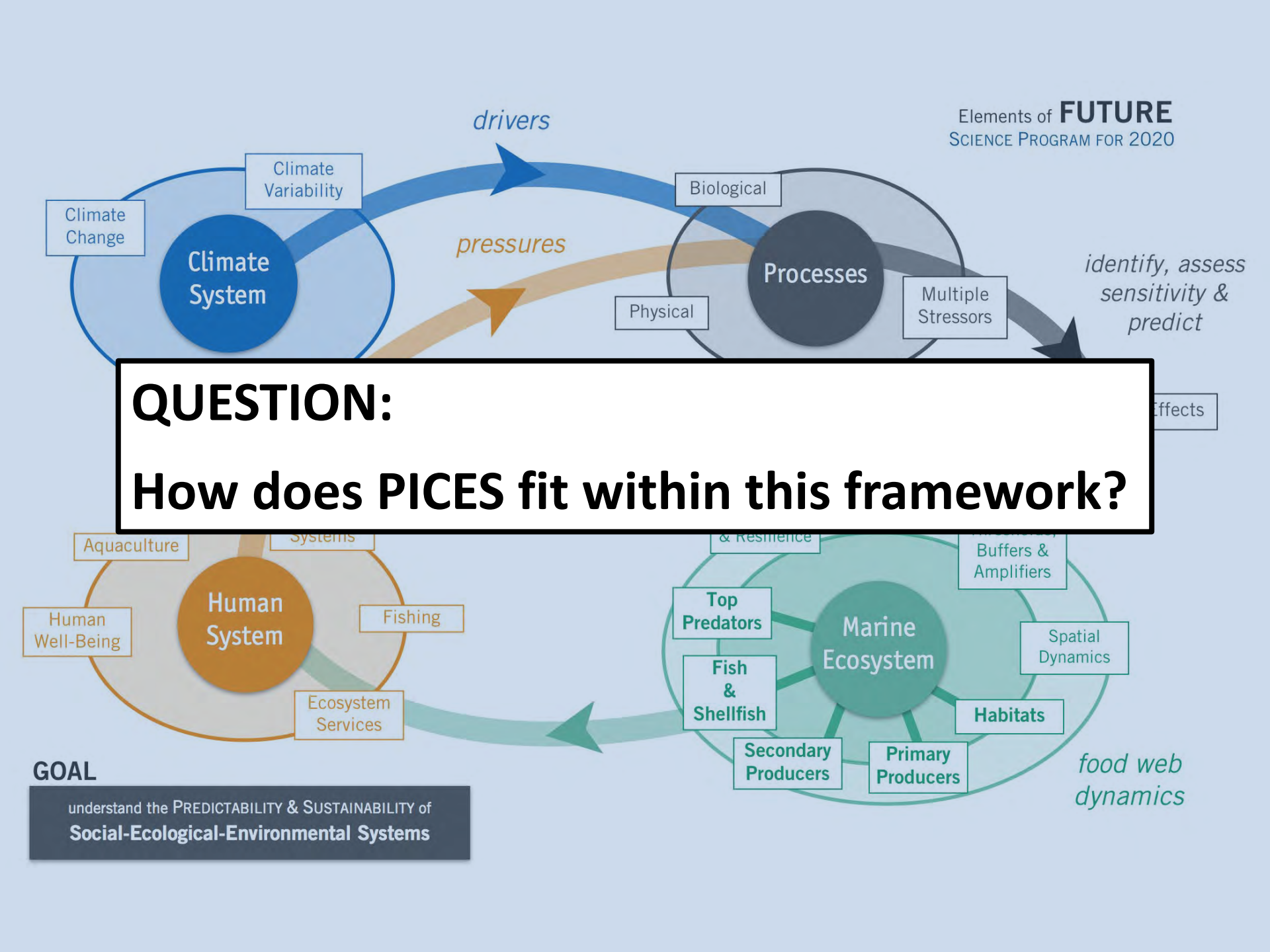
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Aquaculture
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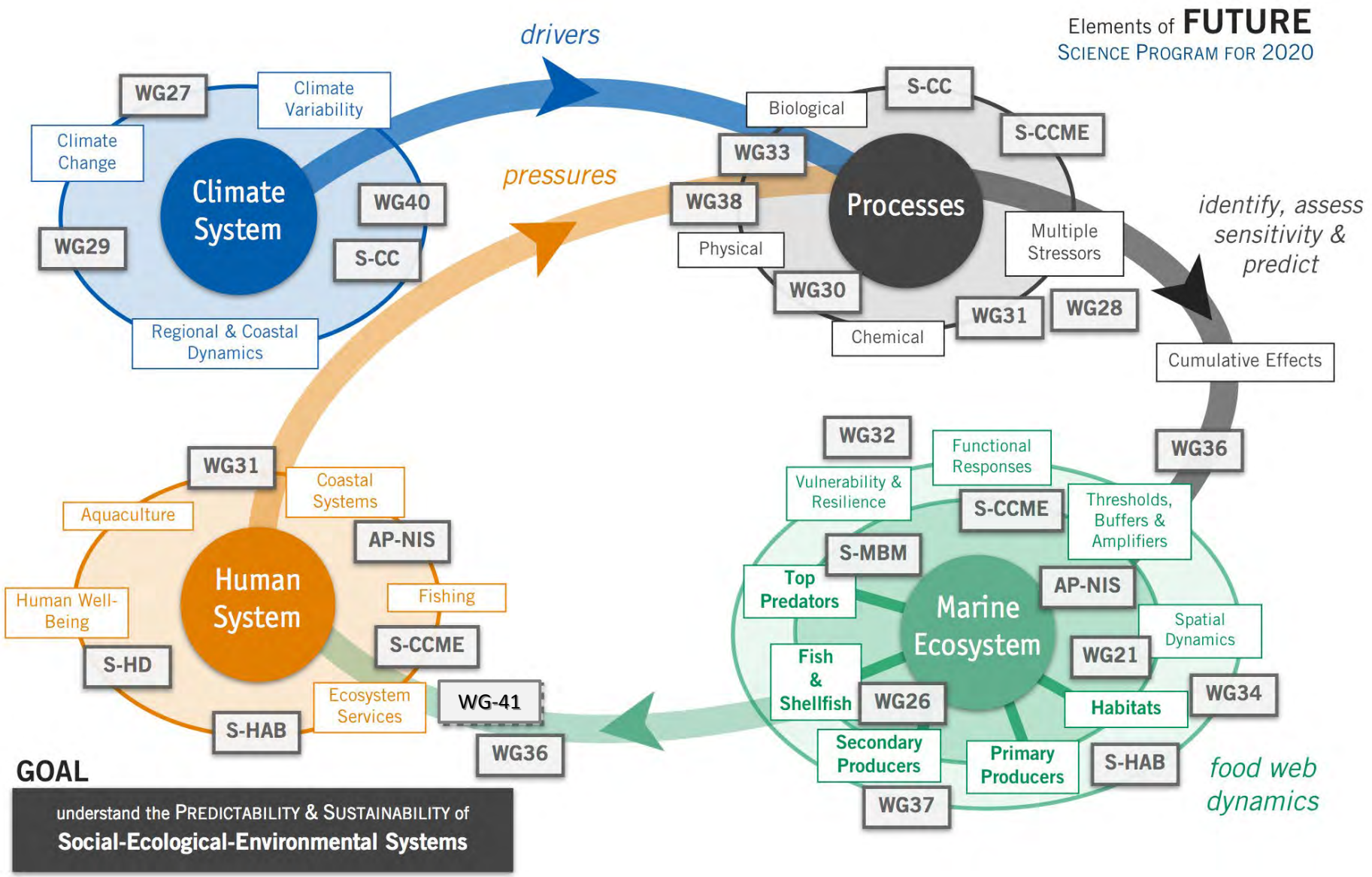
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S-CCME
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WG30
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WG32
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AP-NIS
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WG26
Habitats
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WG37
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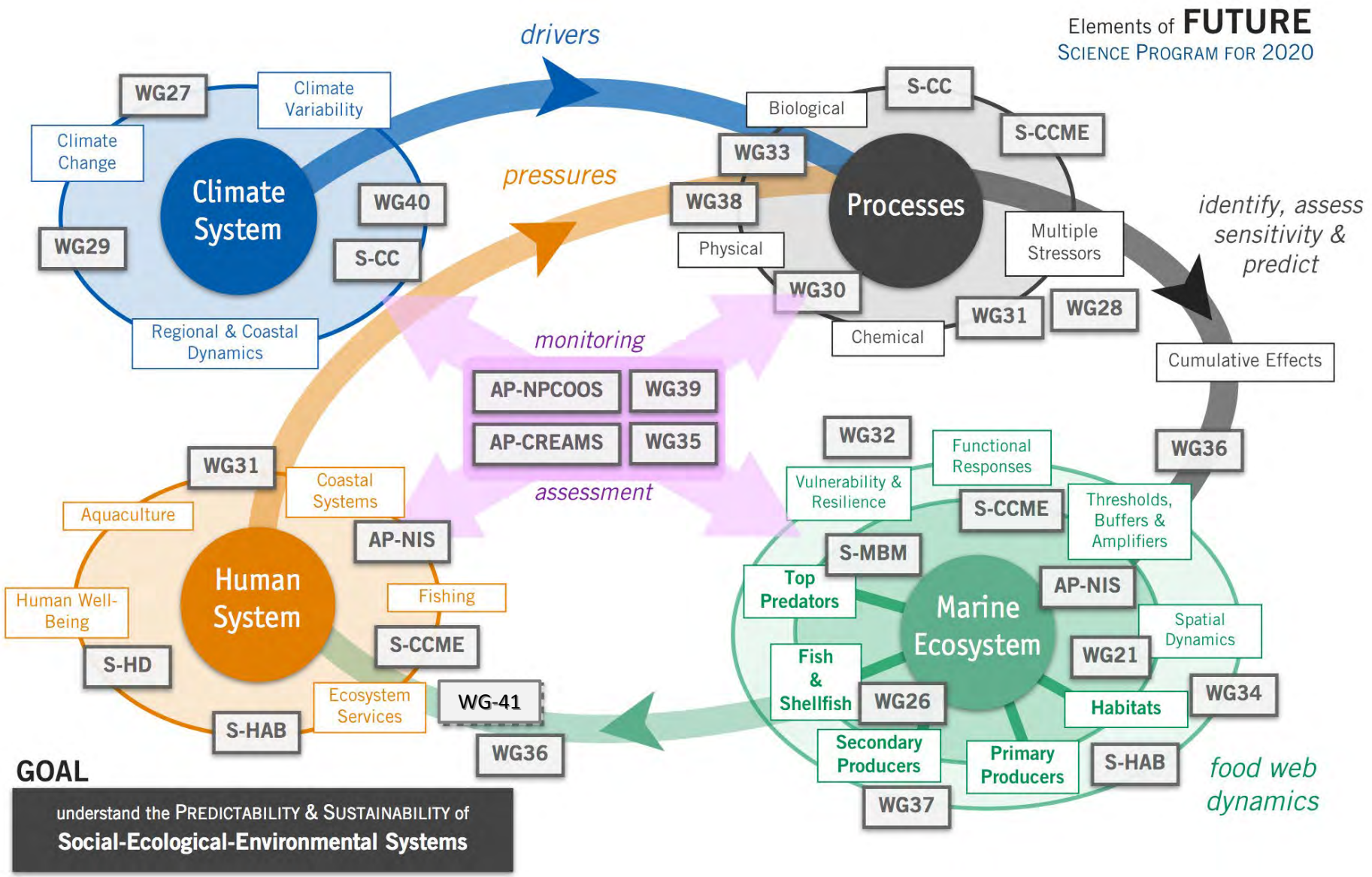
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AP-CREAMS
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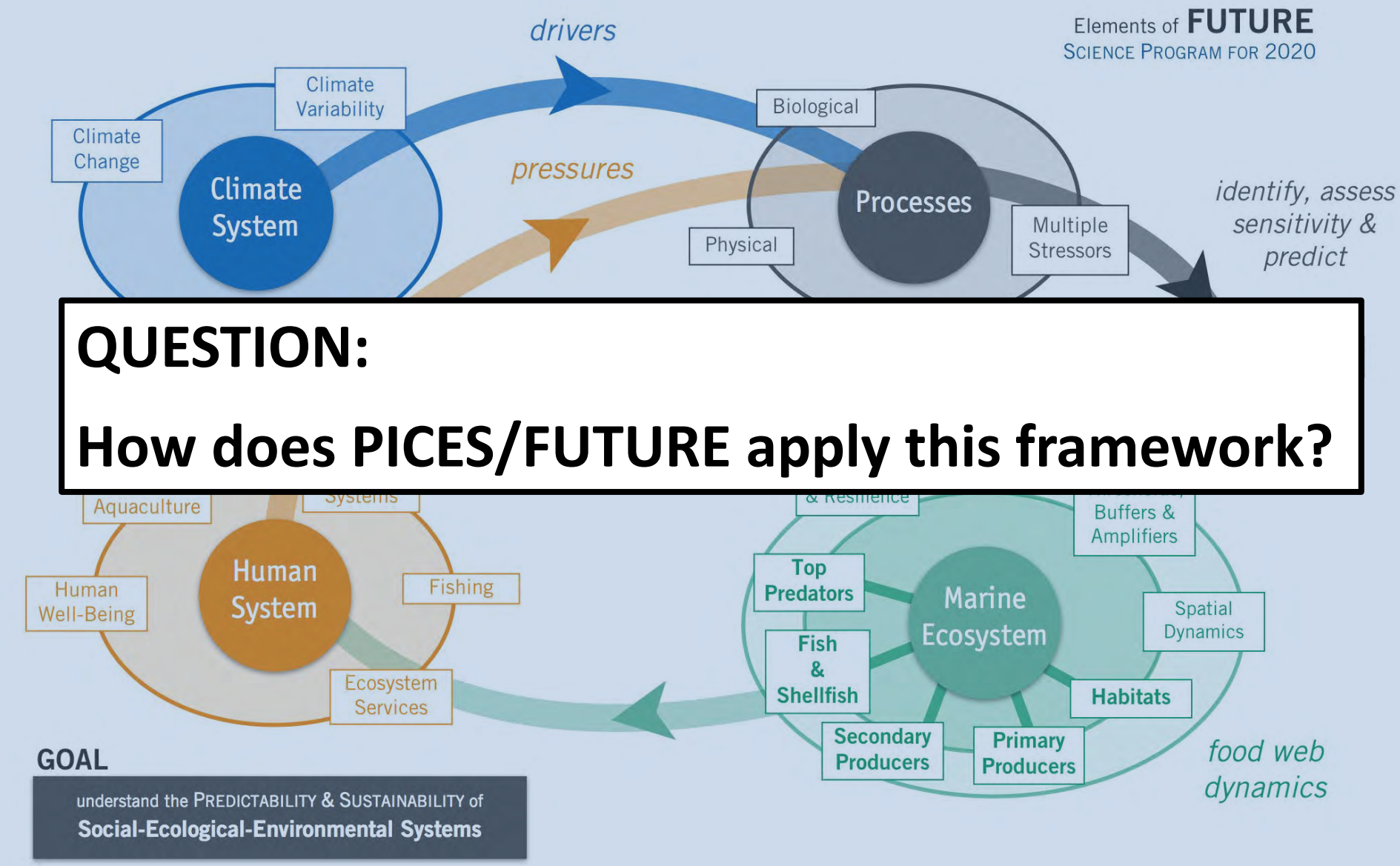
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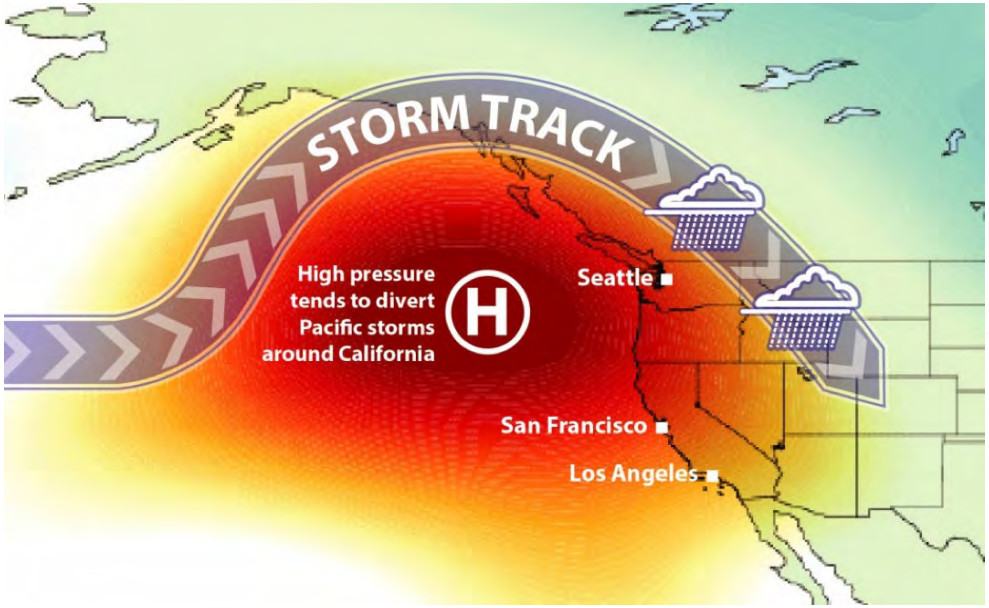
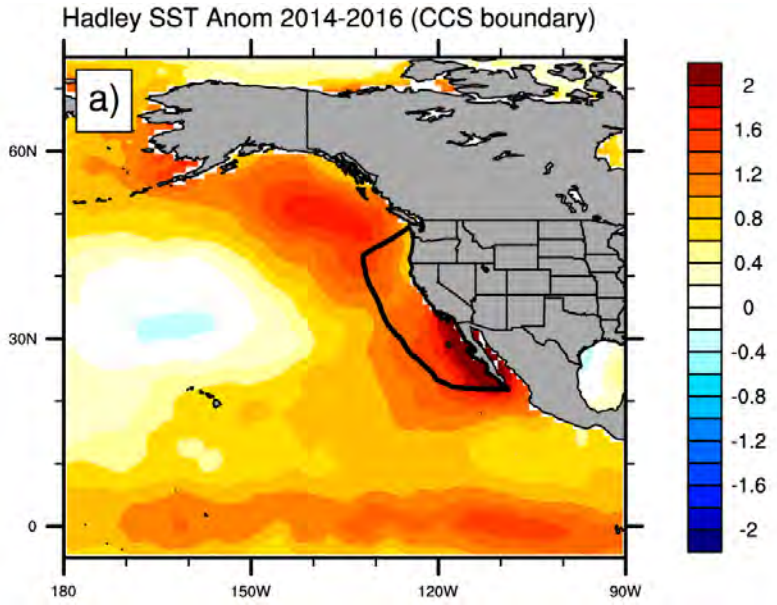
Case Study: Northeast Pacific Marine Heat Wave, 2014-16





Jacox et al. (2017)

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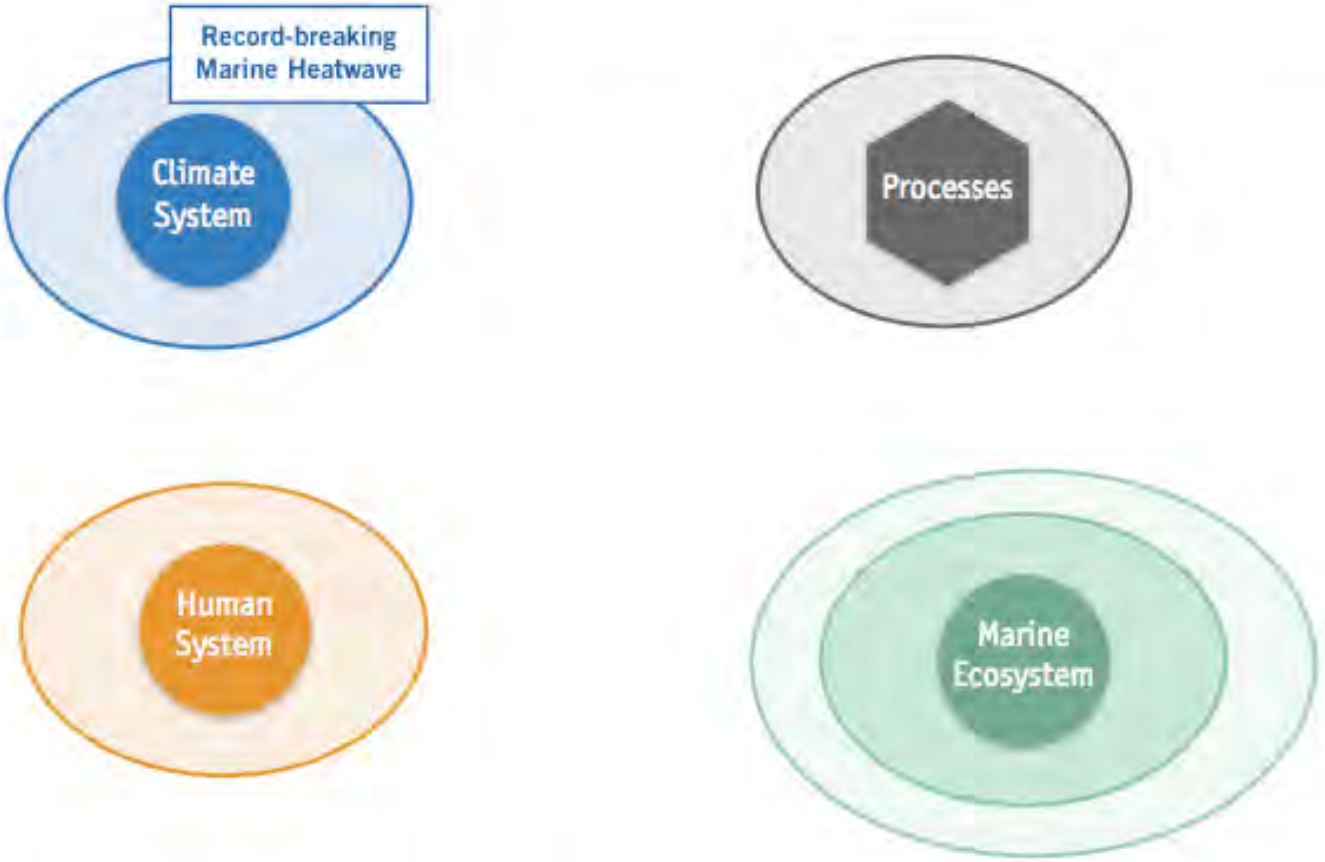

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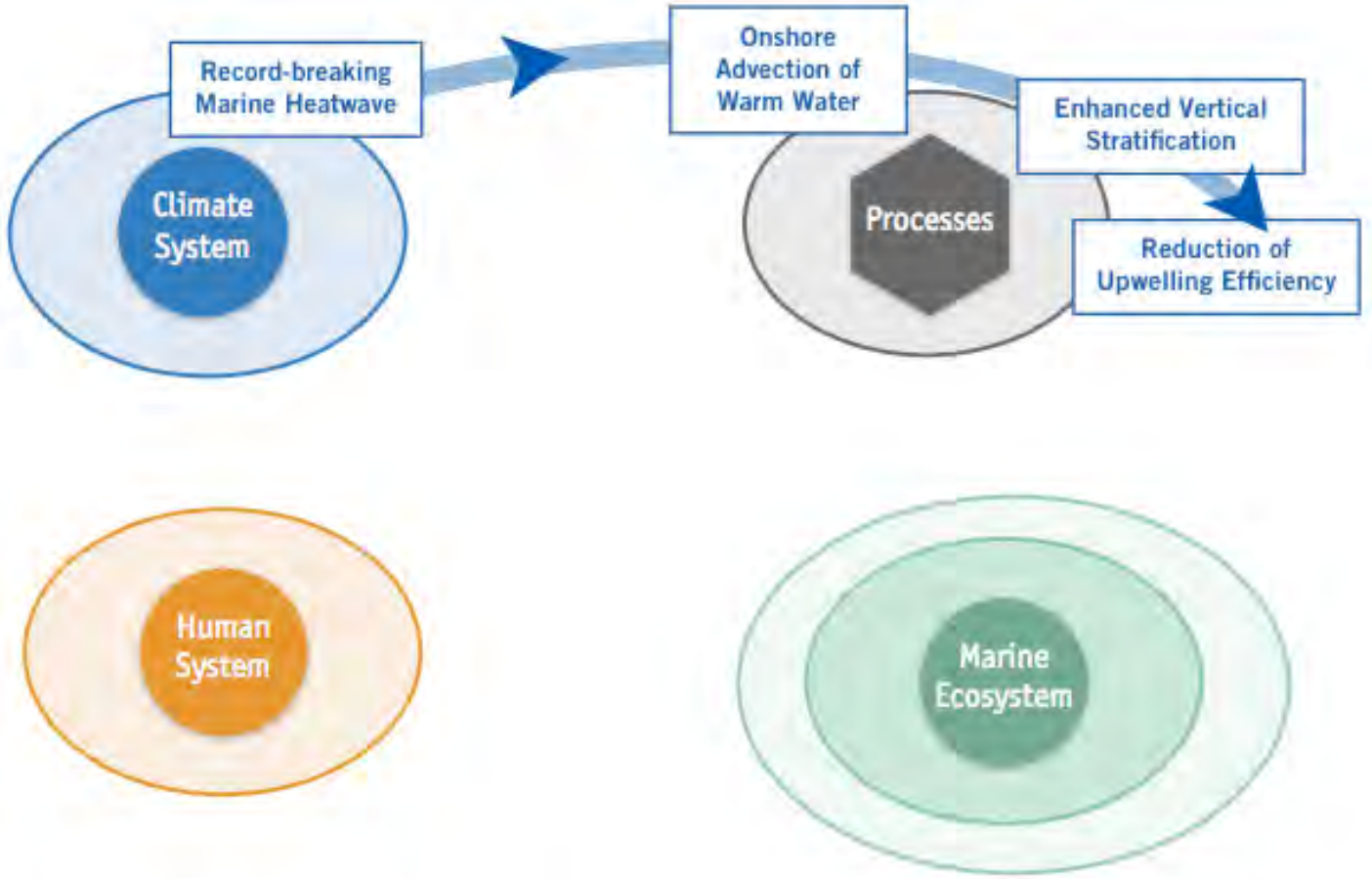

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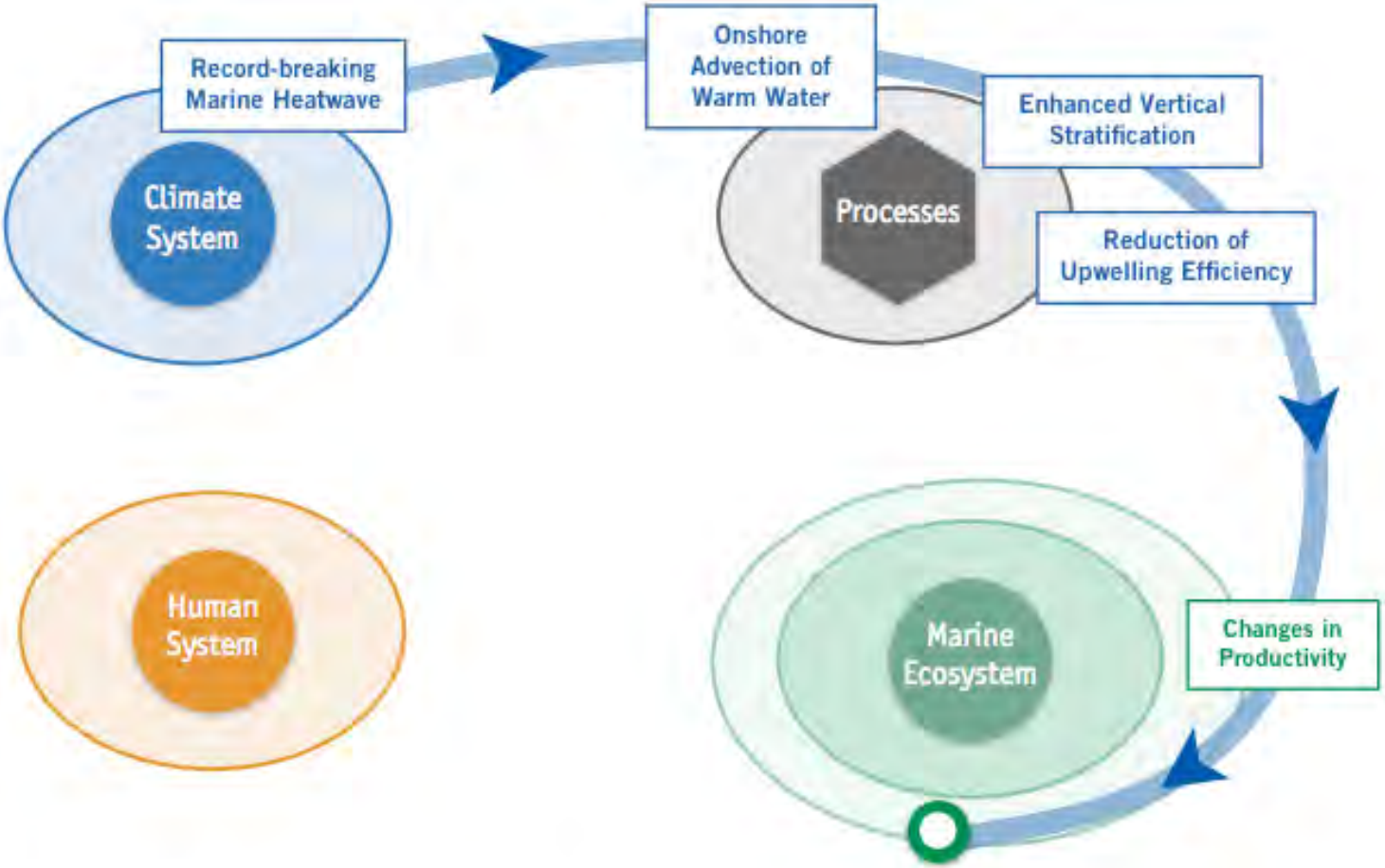

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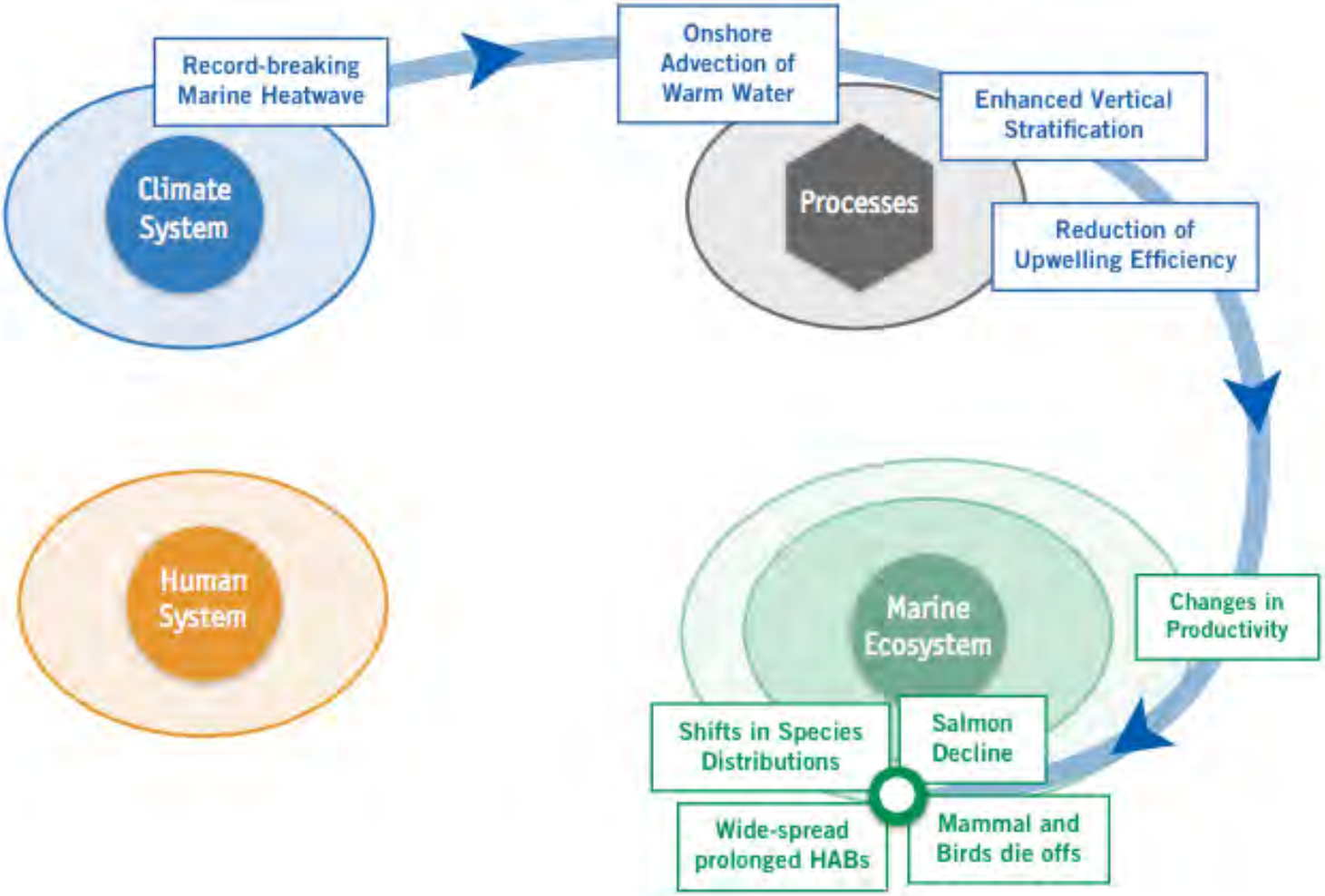

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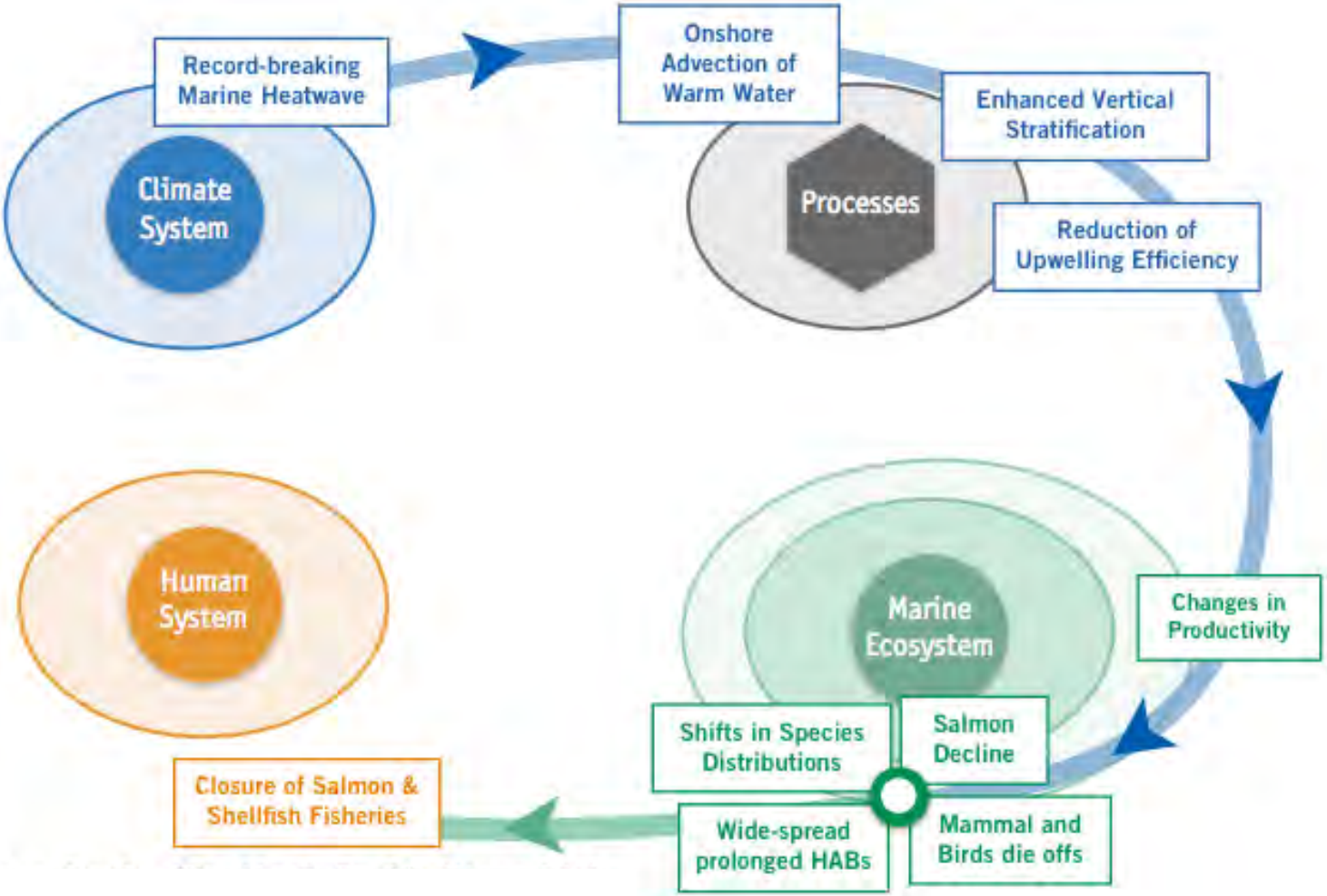

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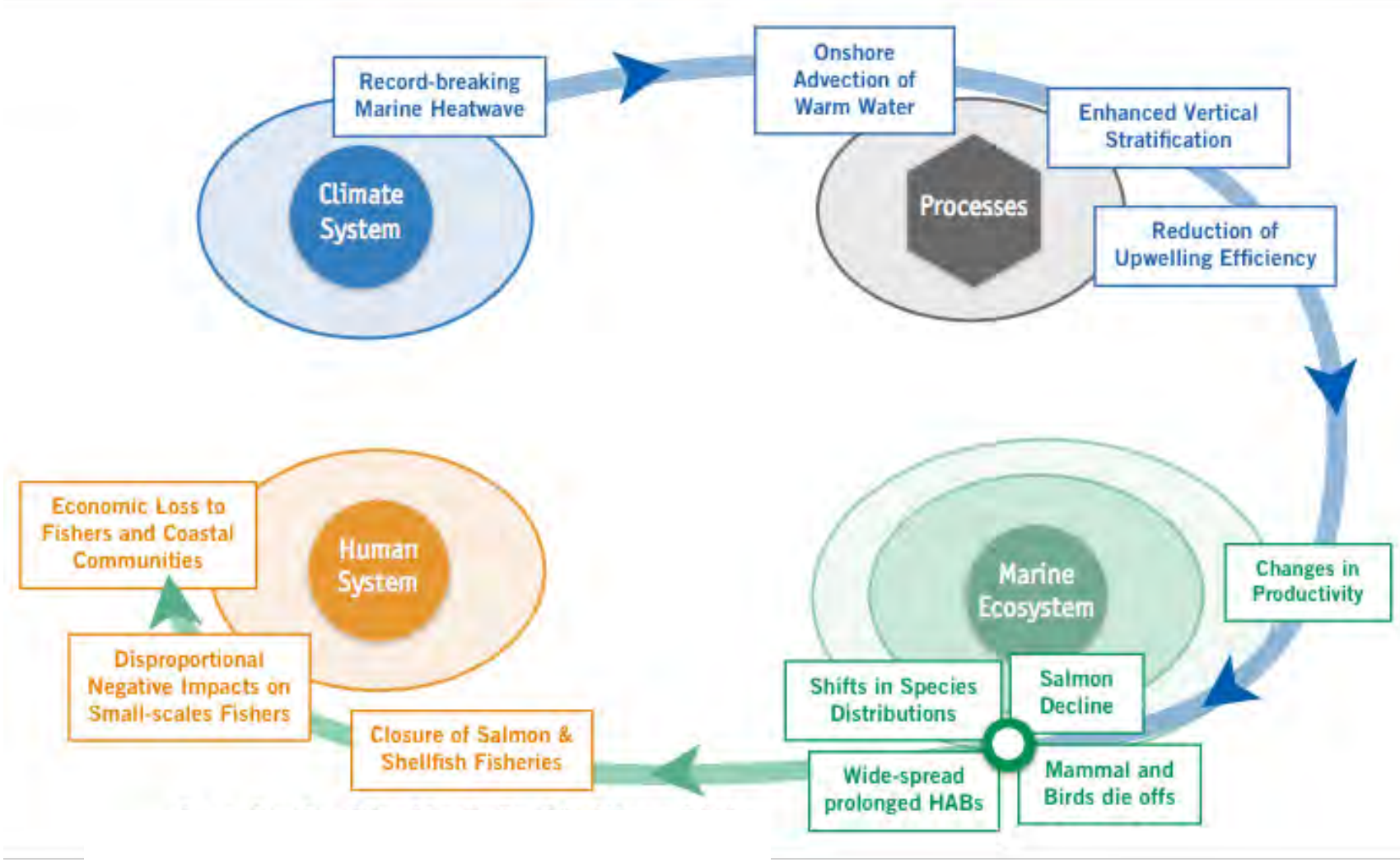

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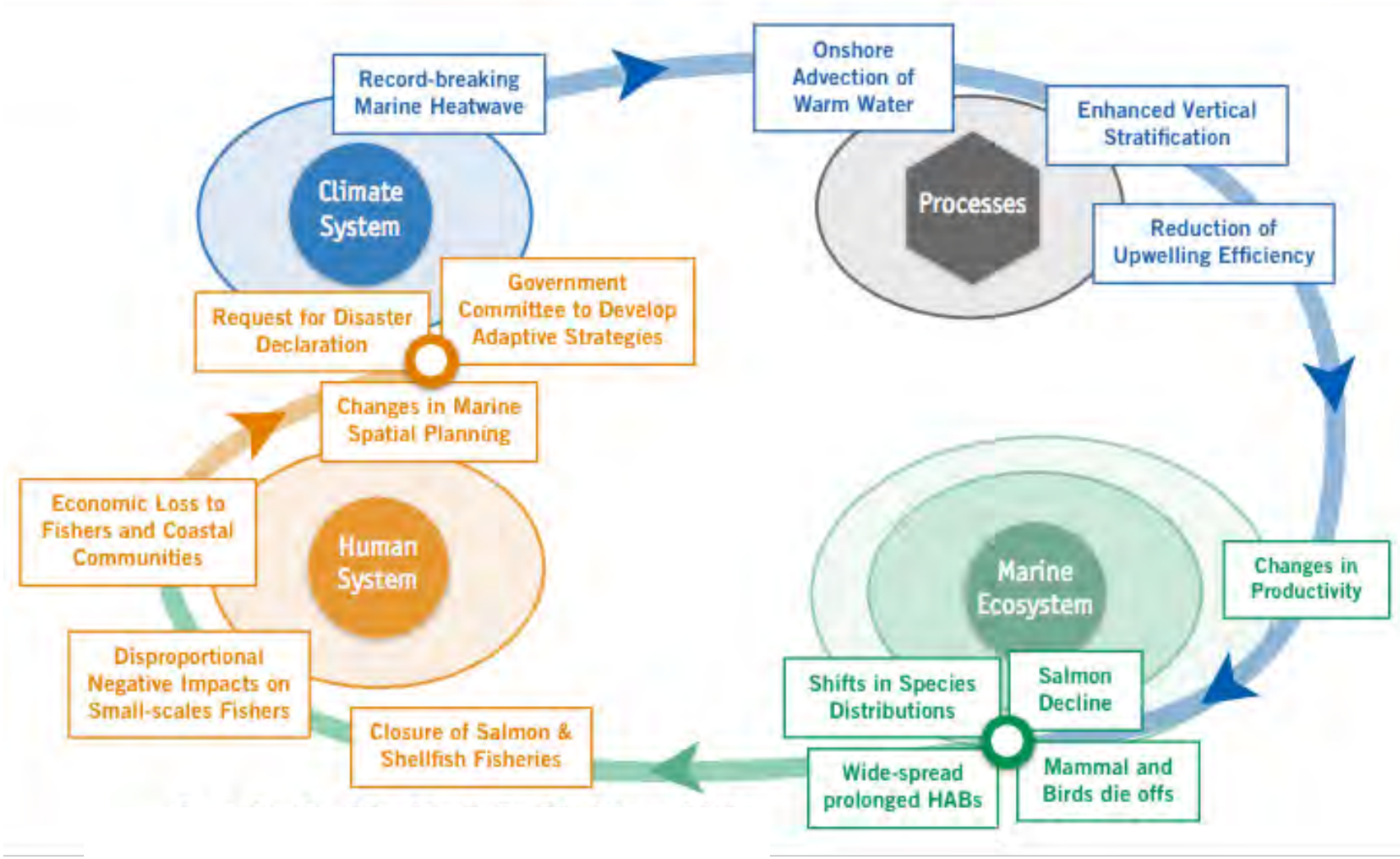

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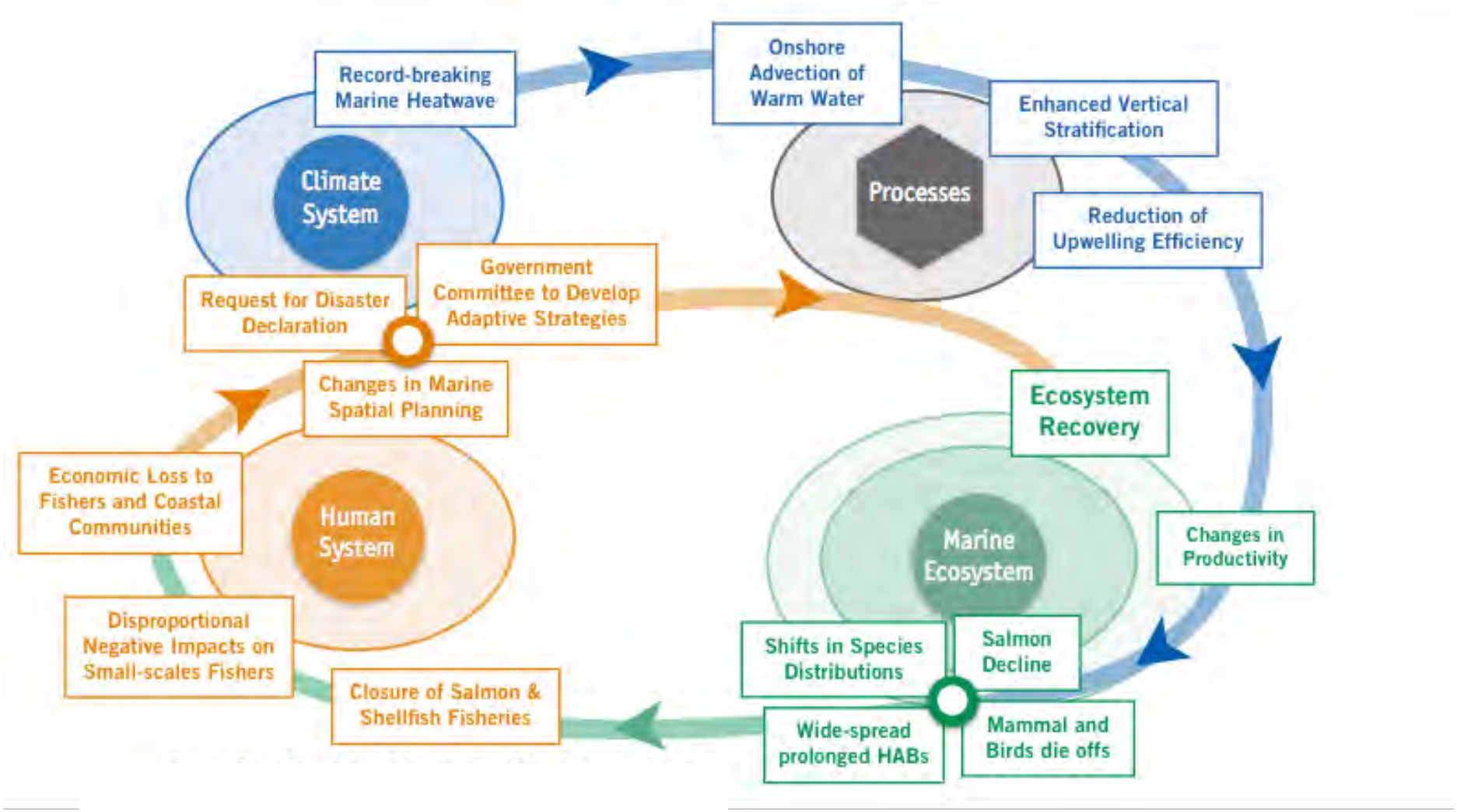

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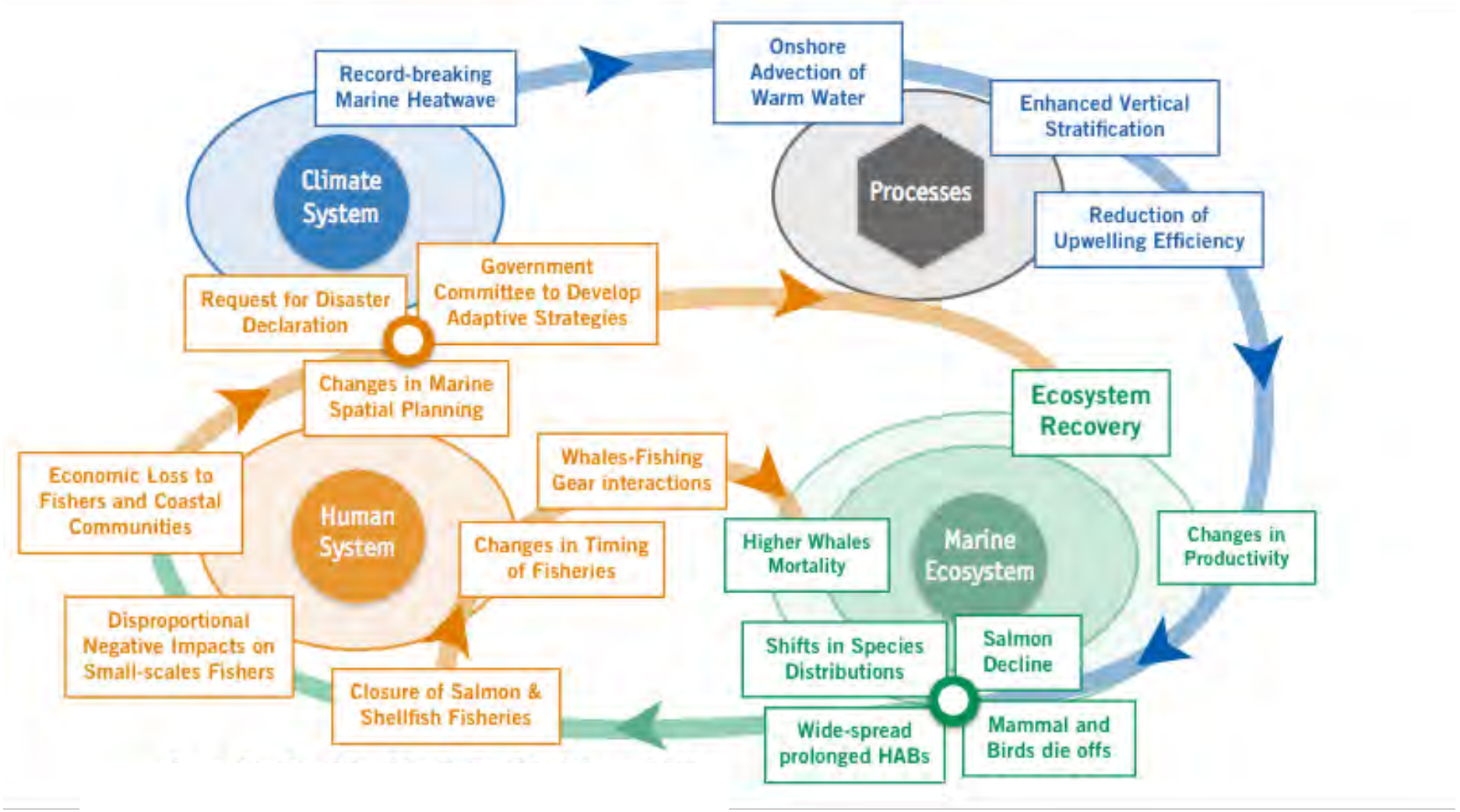

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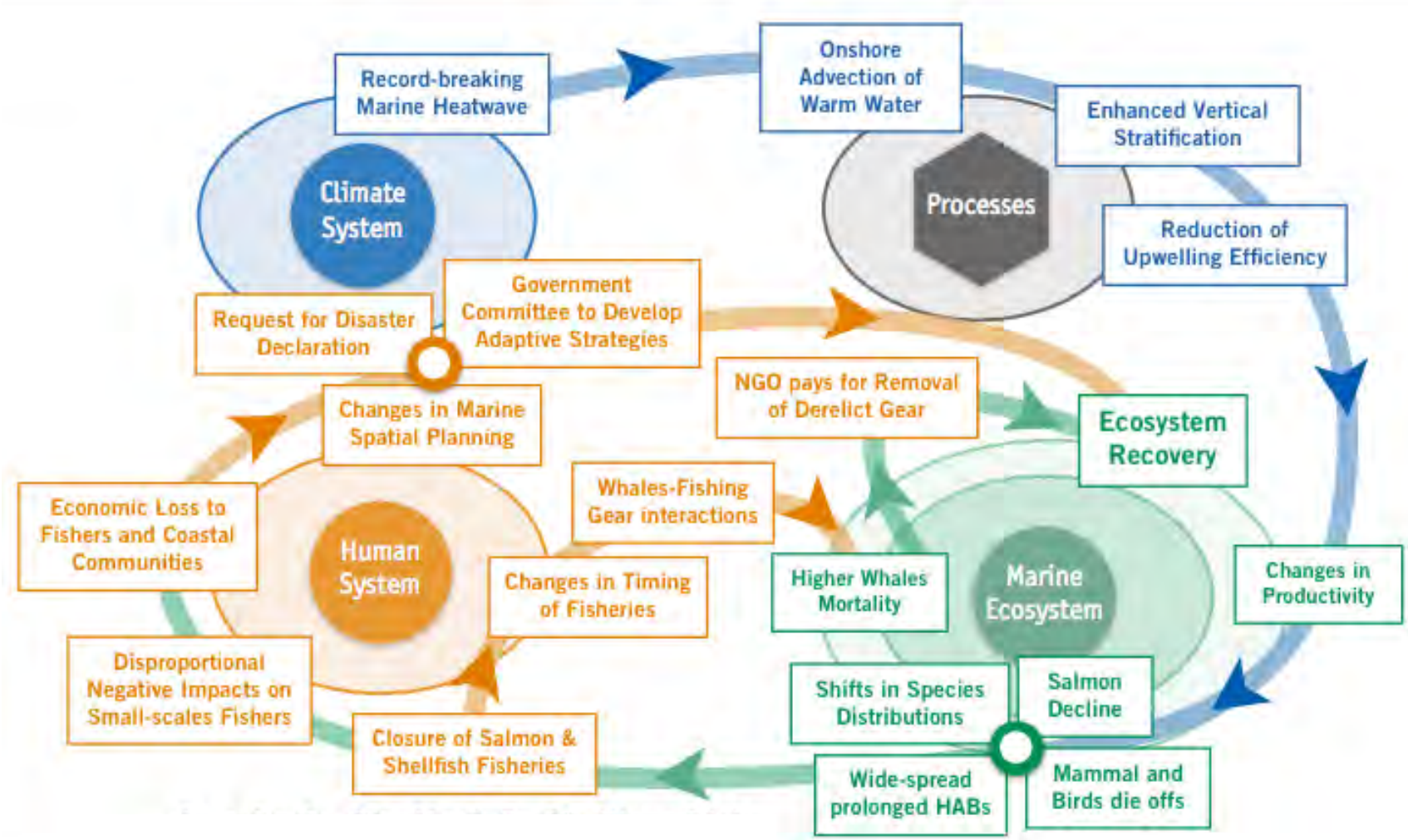

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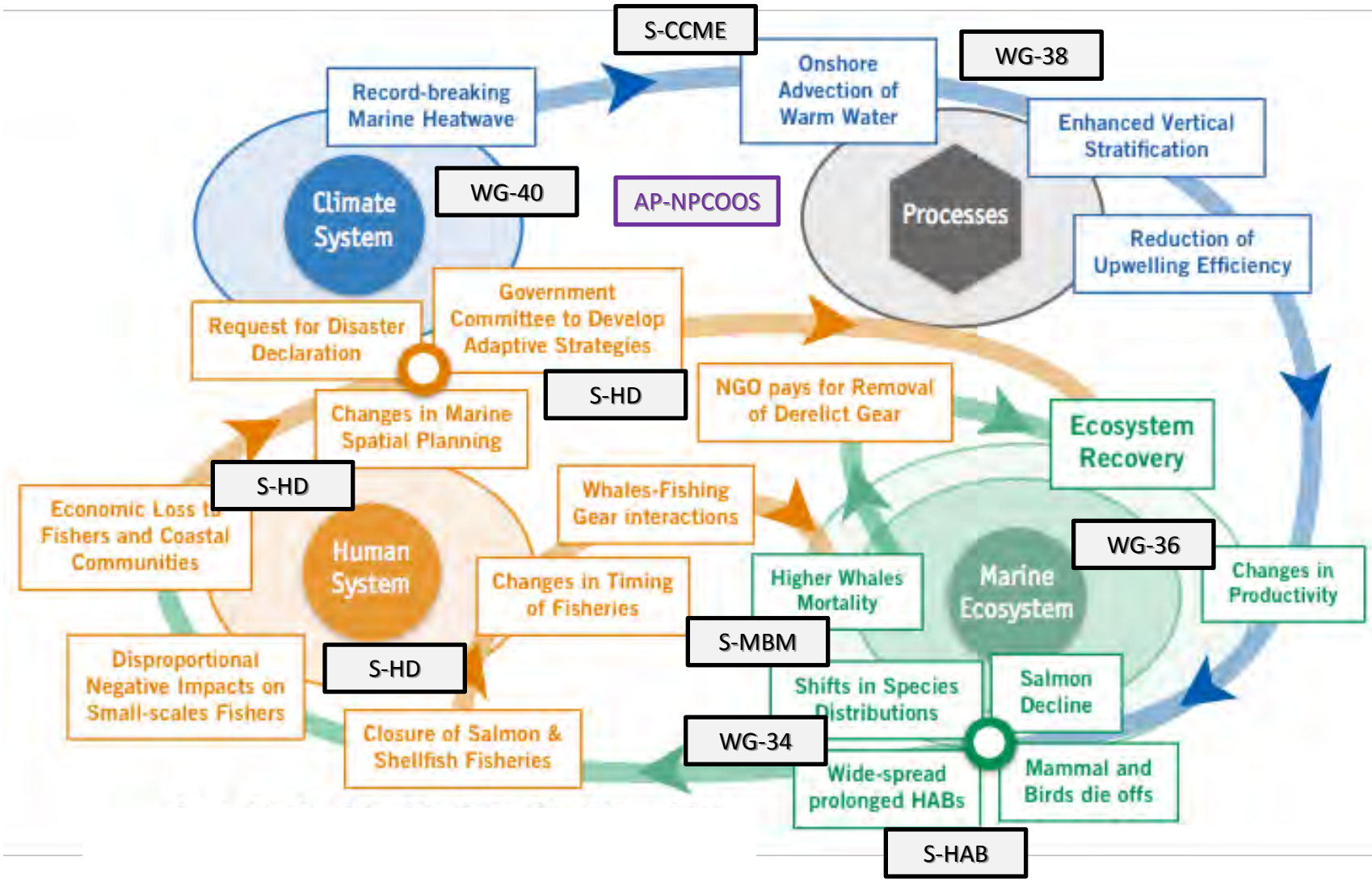
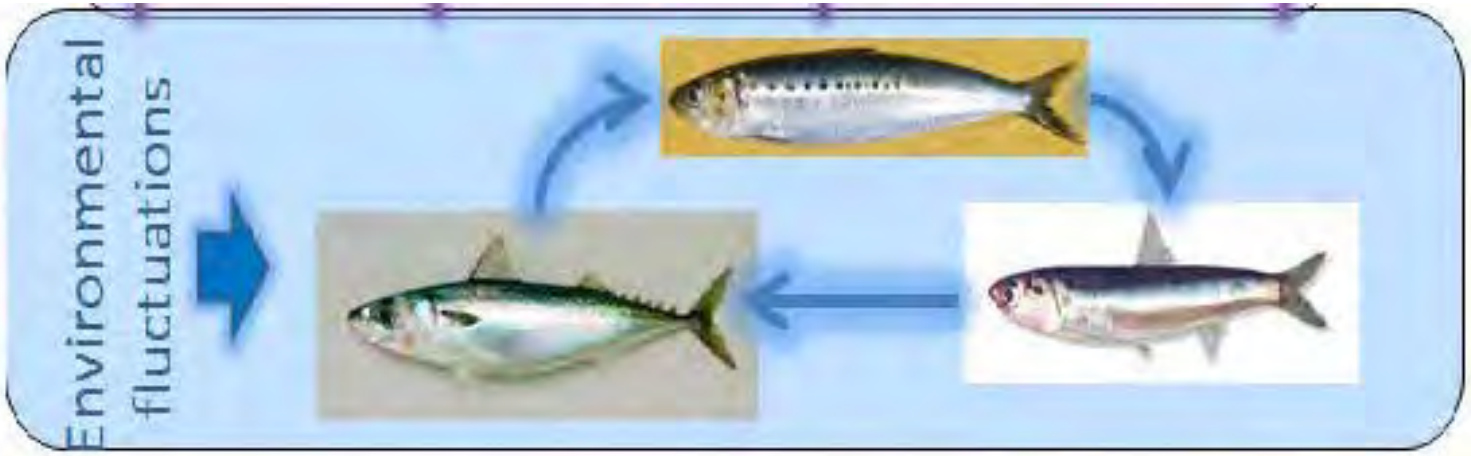


Case Study: Species Alternation in the Western Pacific



Saito, Minobe, Sakurai, Makino (2013)

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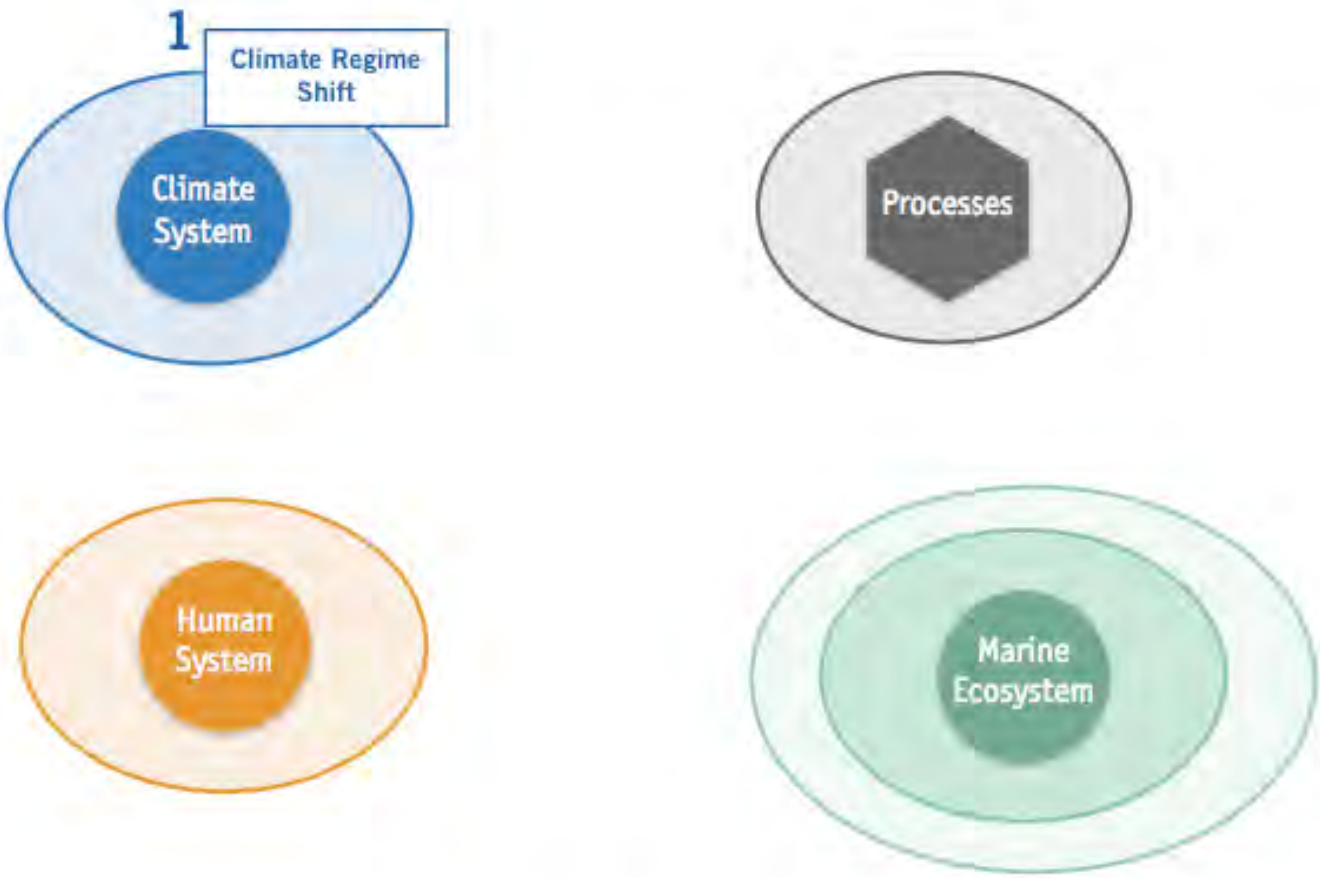

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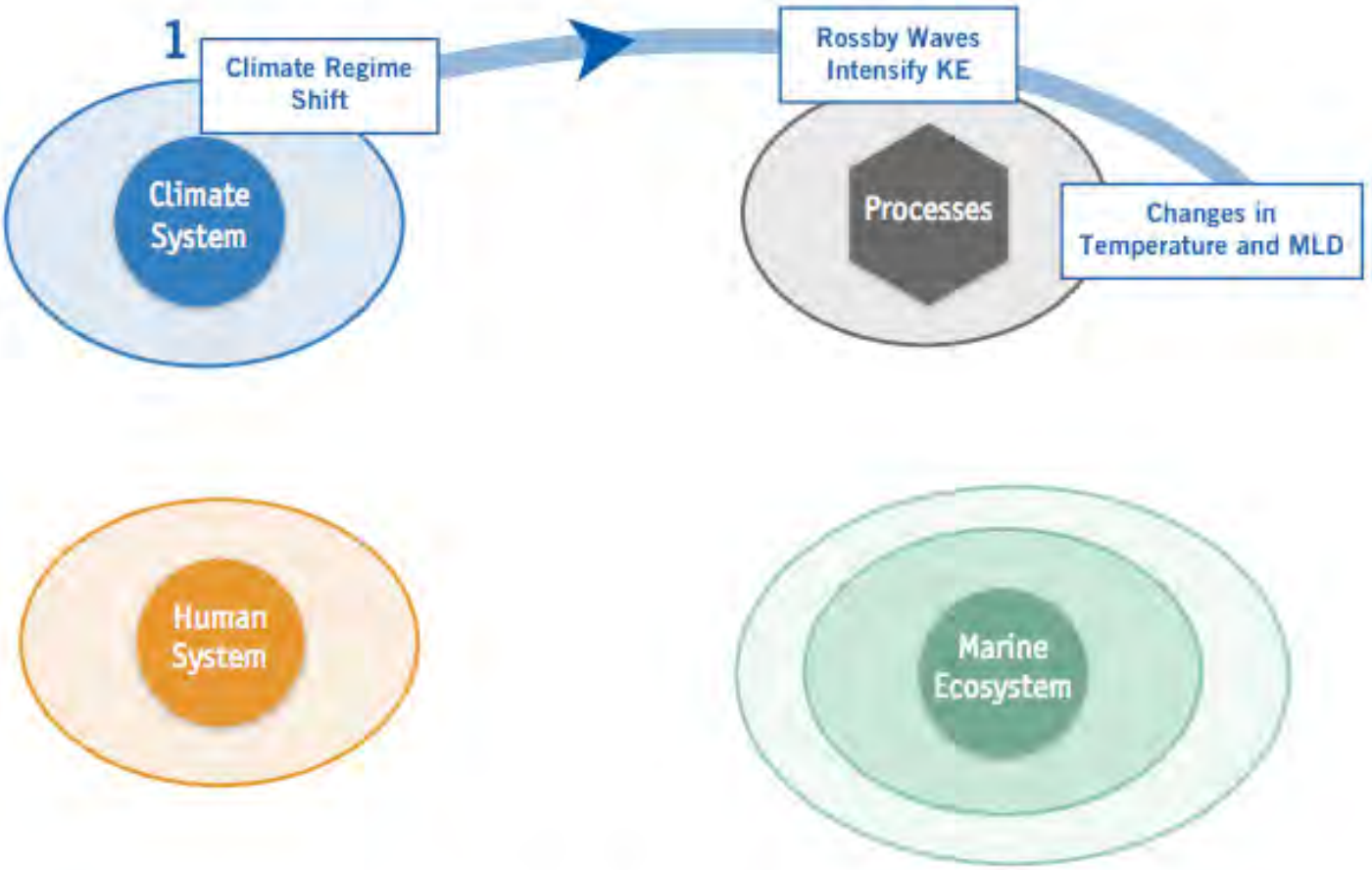

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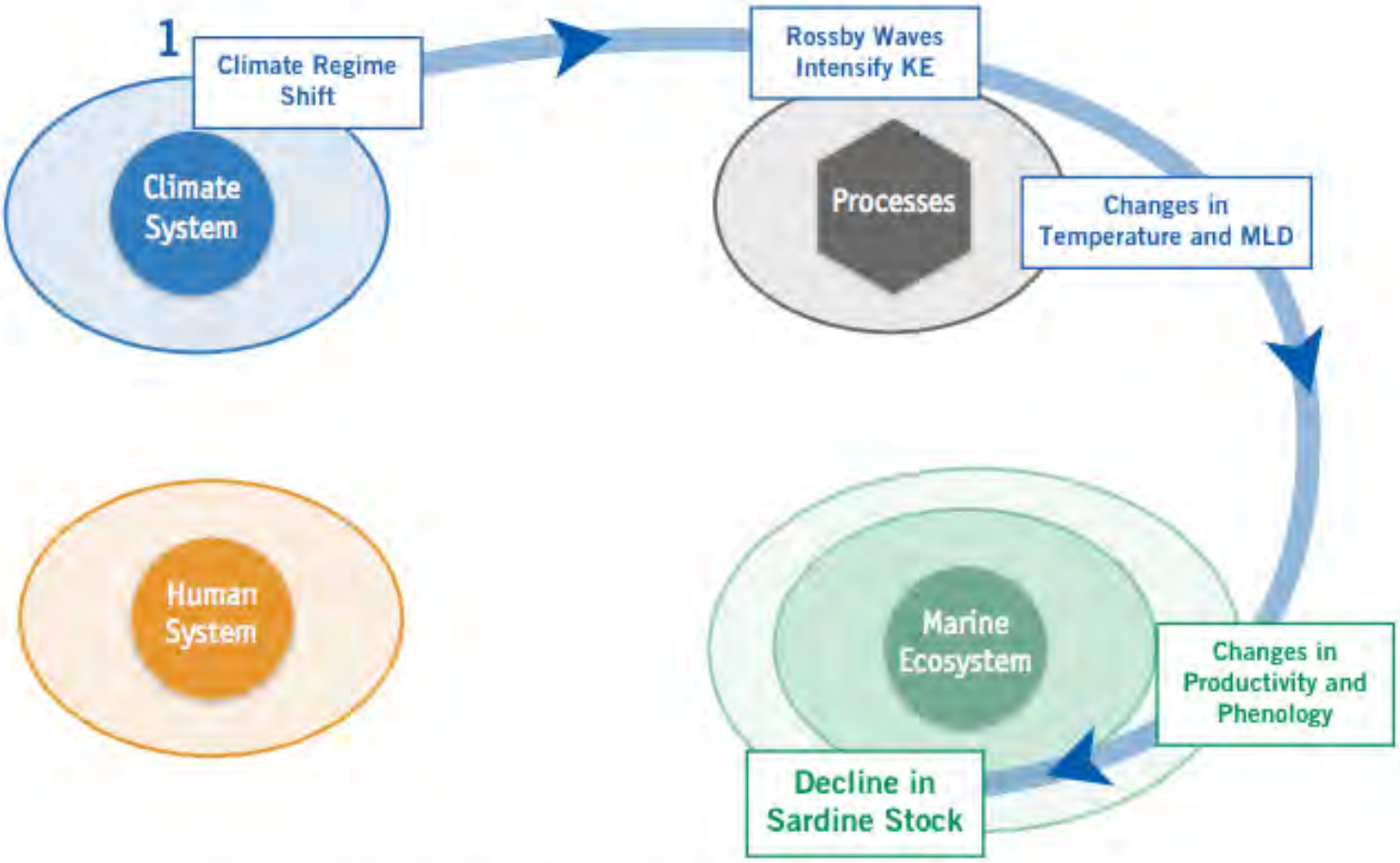
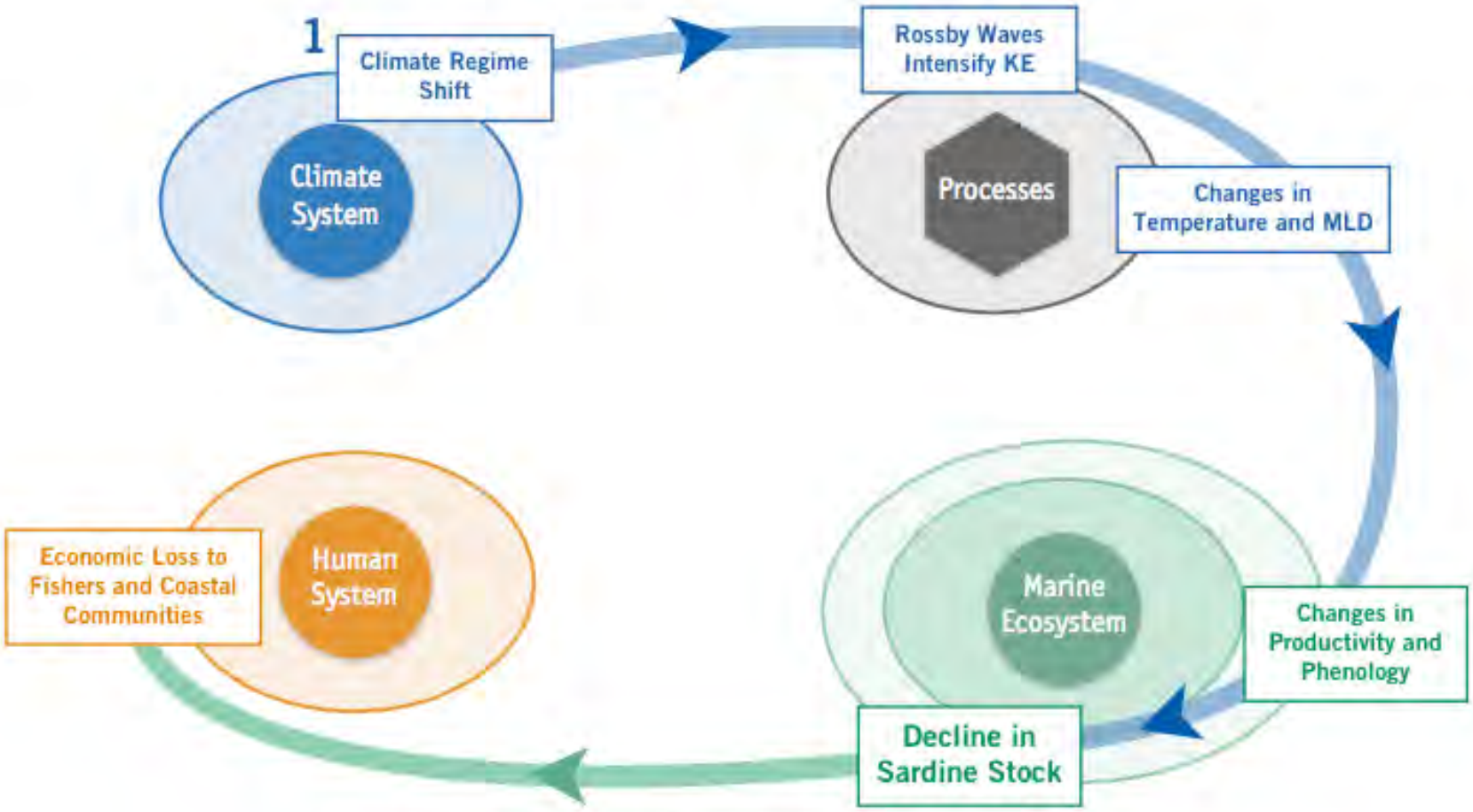


Case Study: Species Alternation in the Western Pacific



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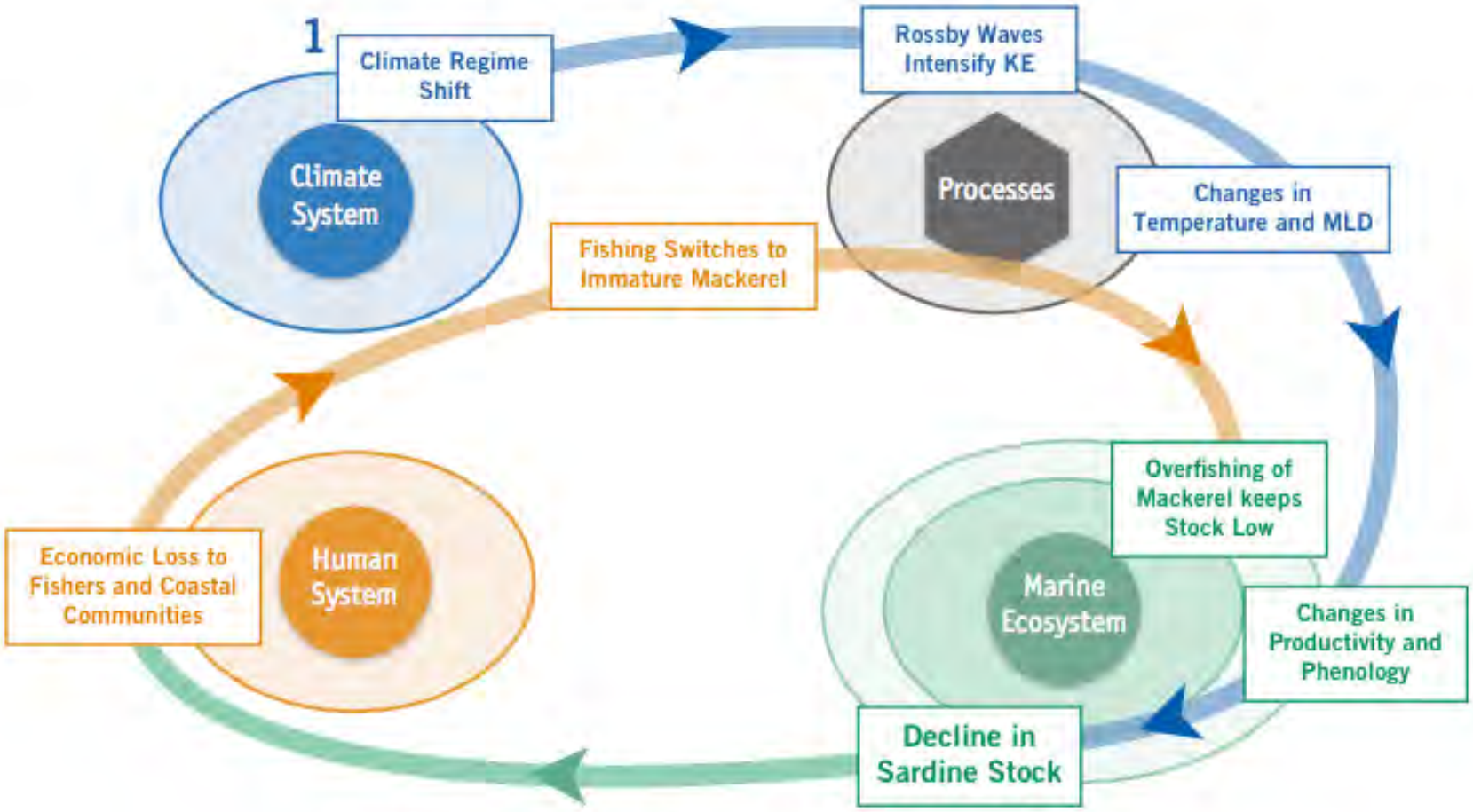

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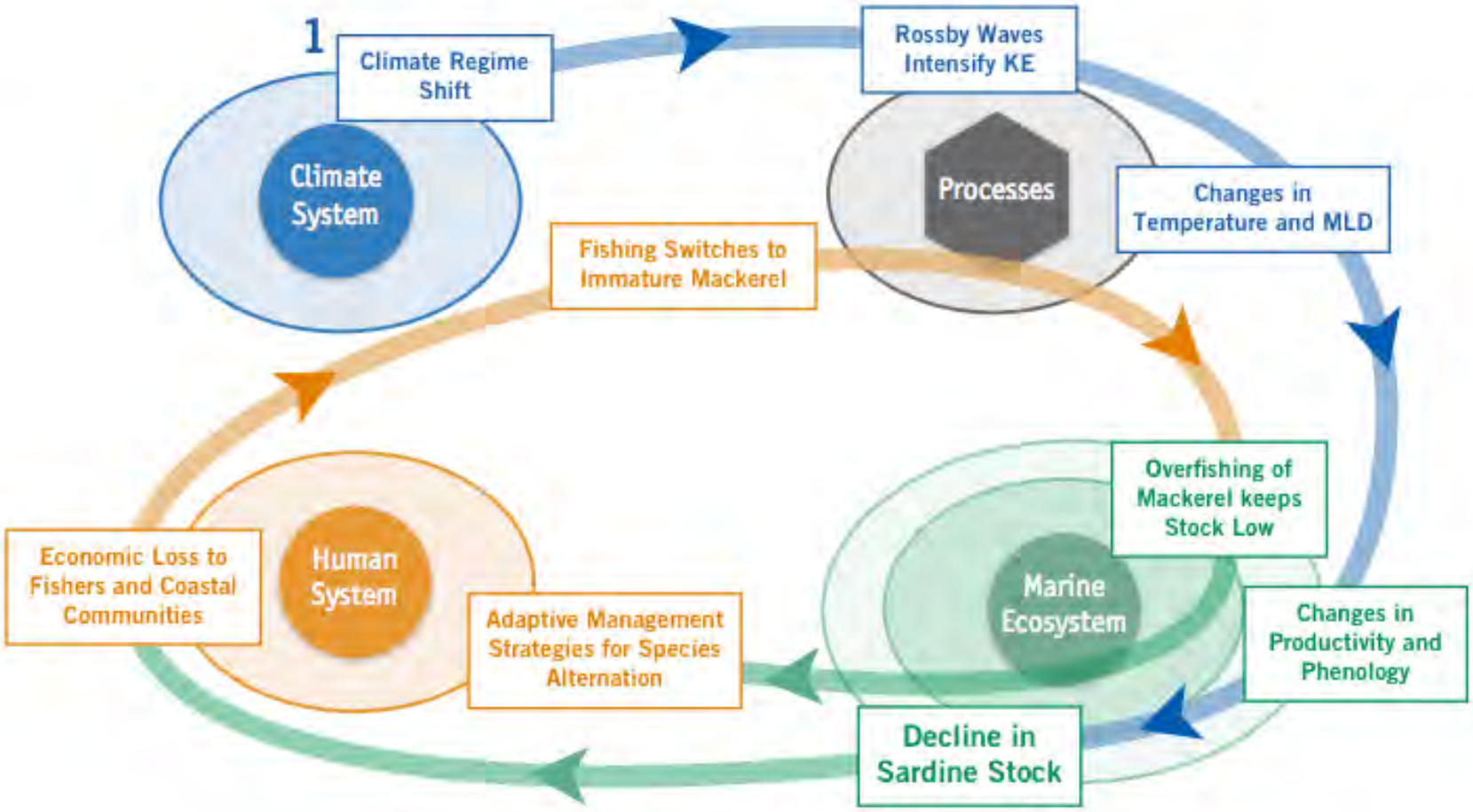

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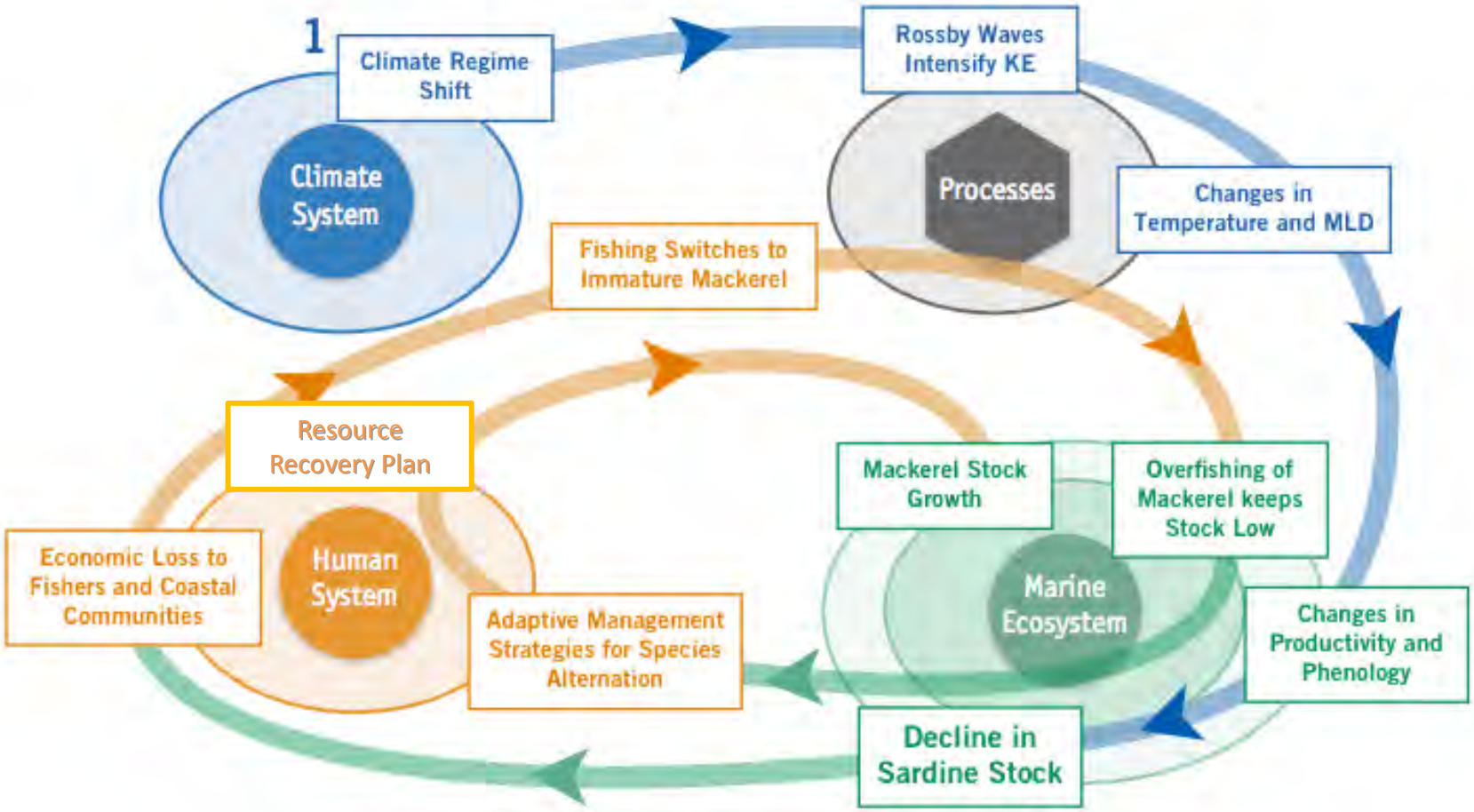

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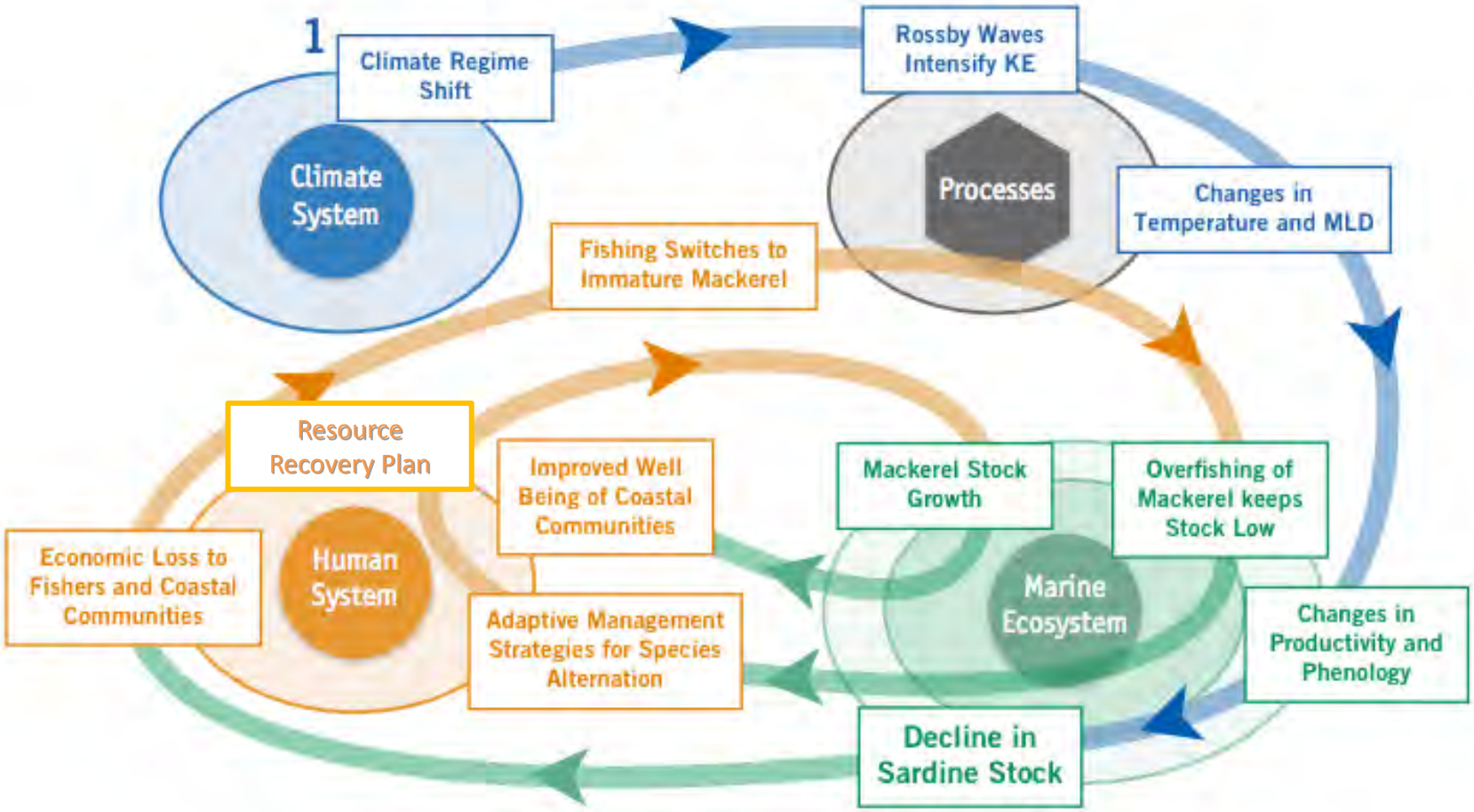

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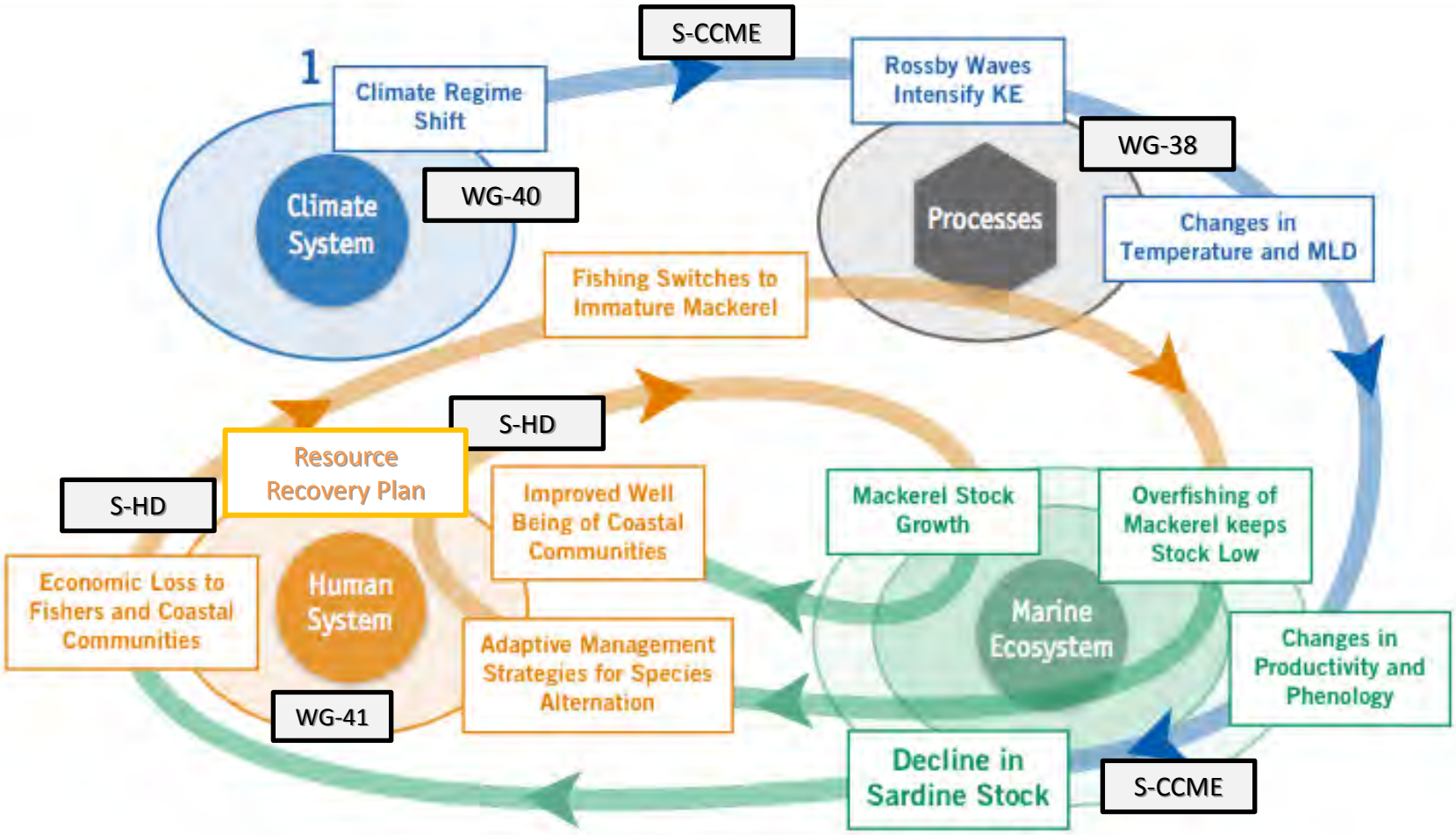
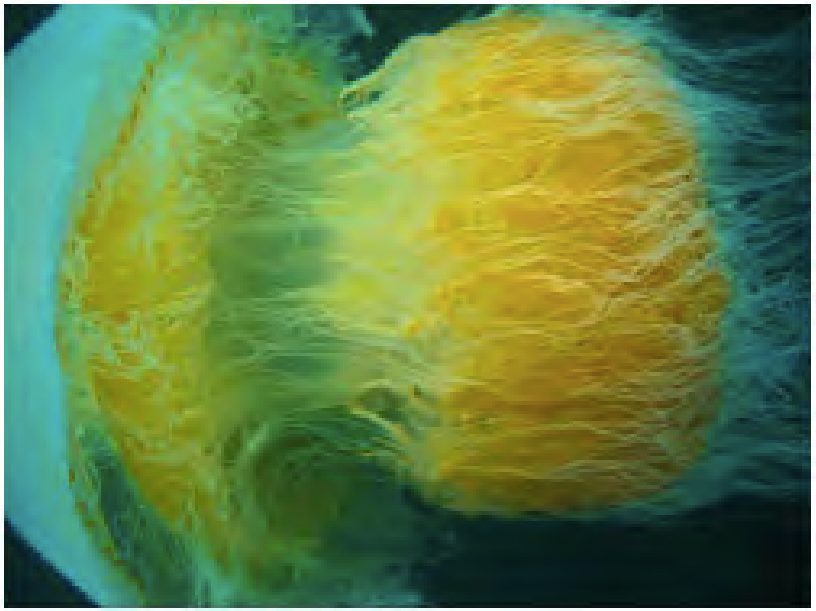


Case Study: Jellyfish Blooms in the Western Pacific



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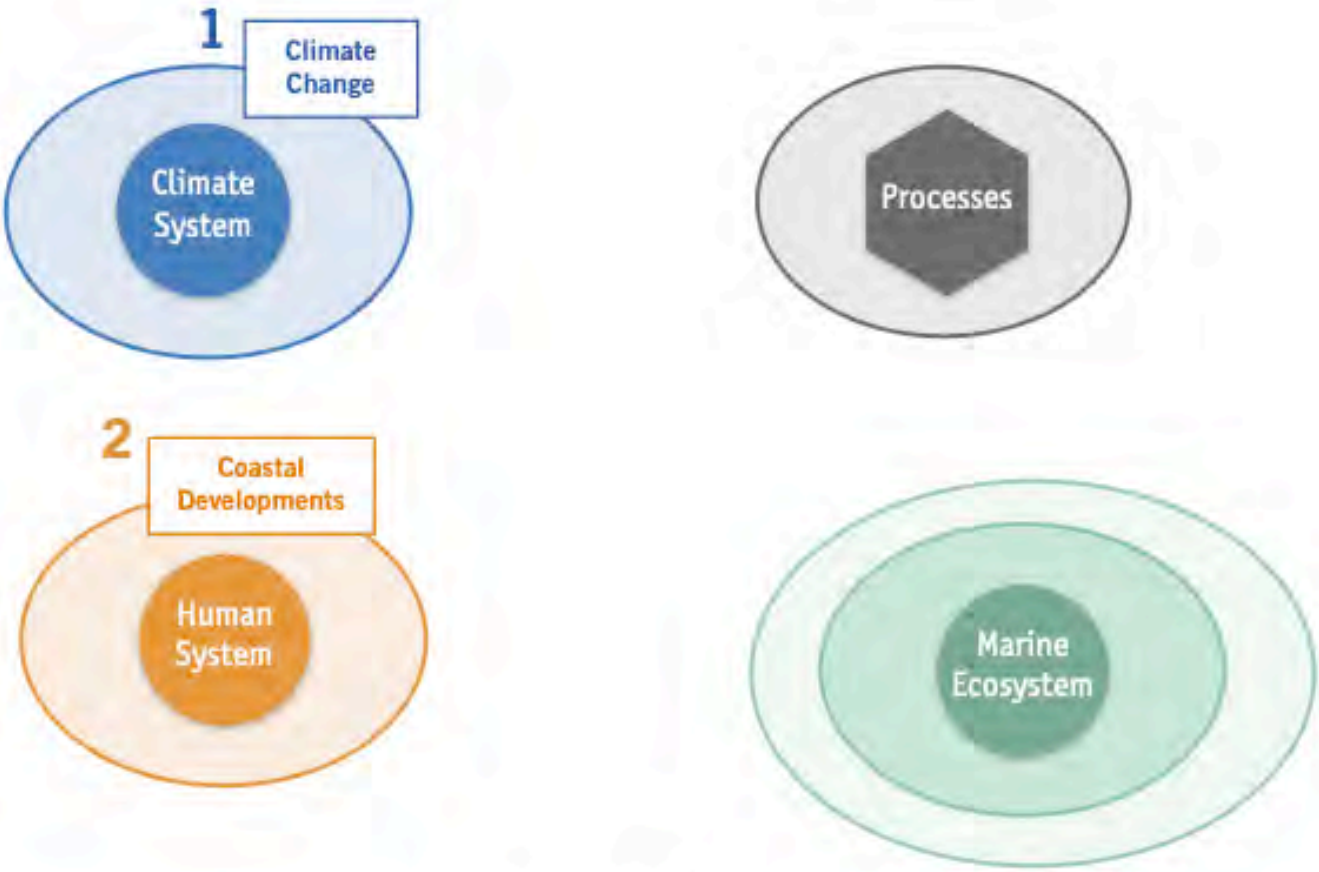

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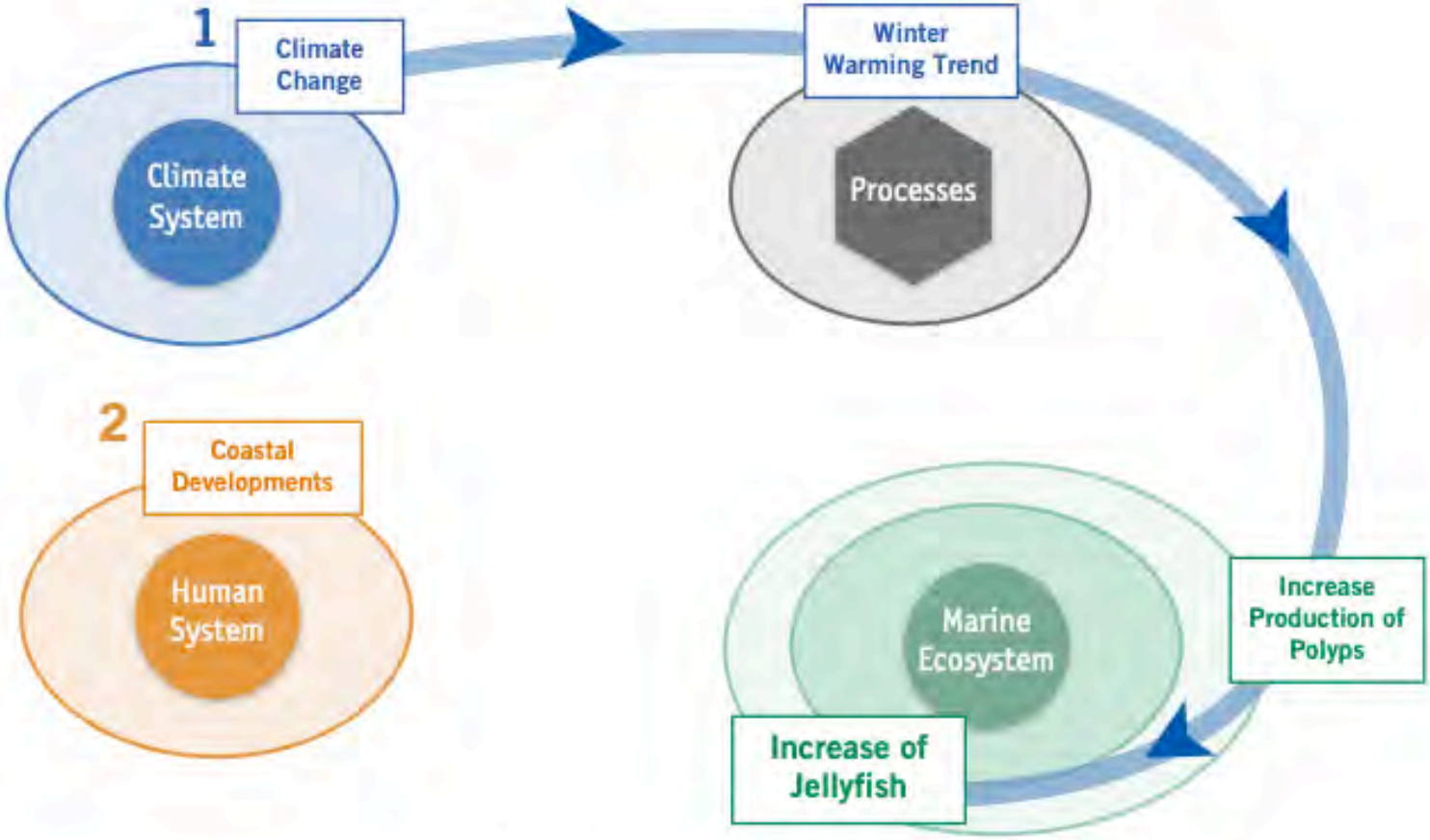

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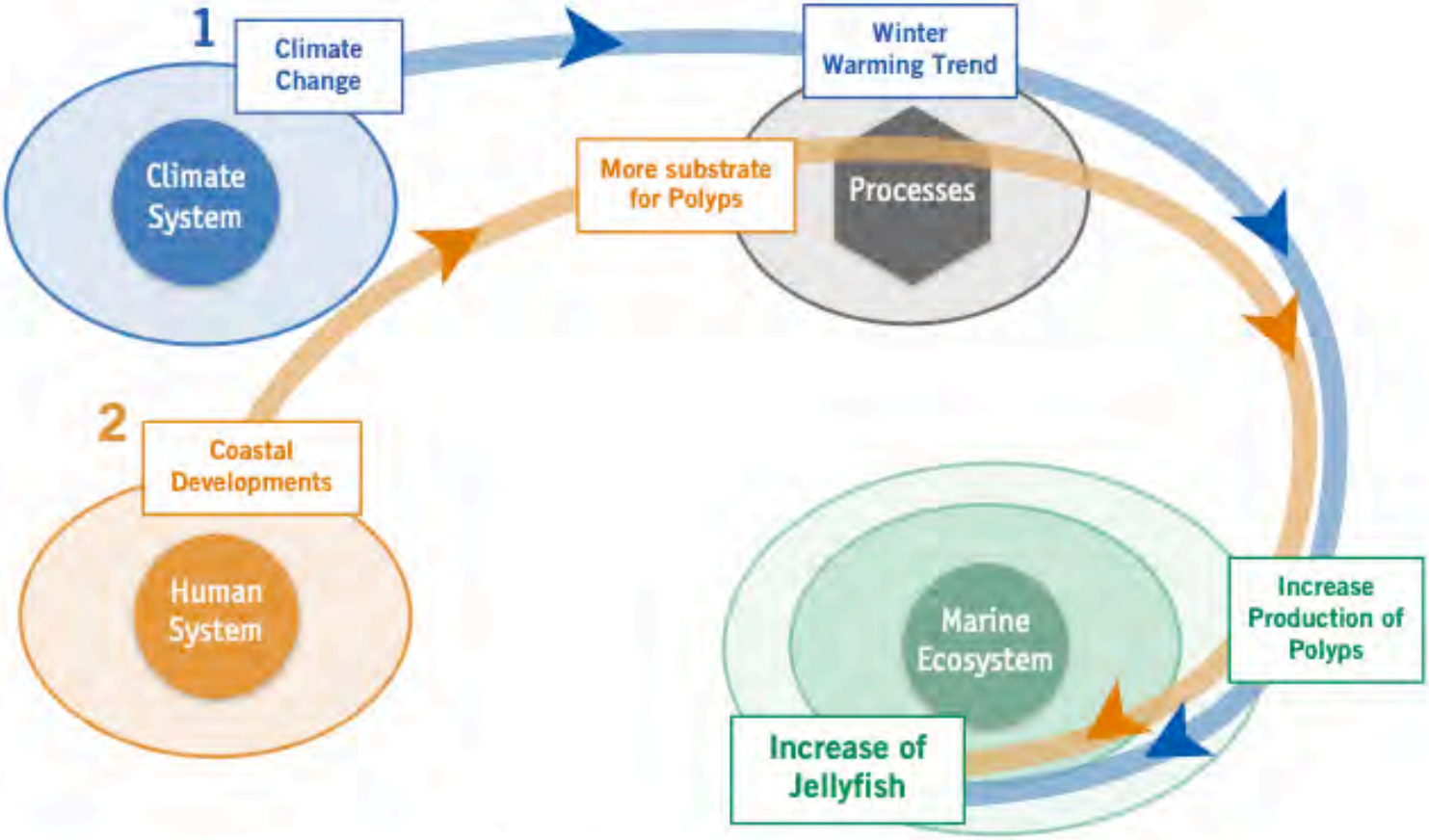

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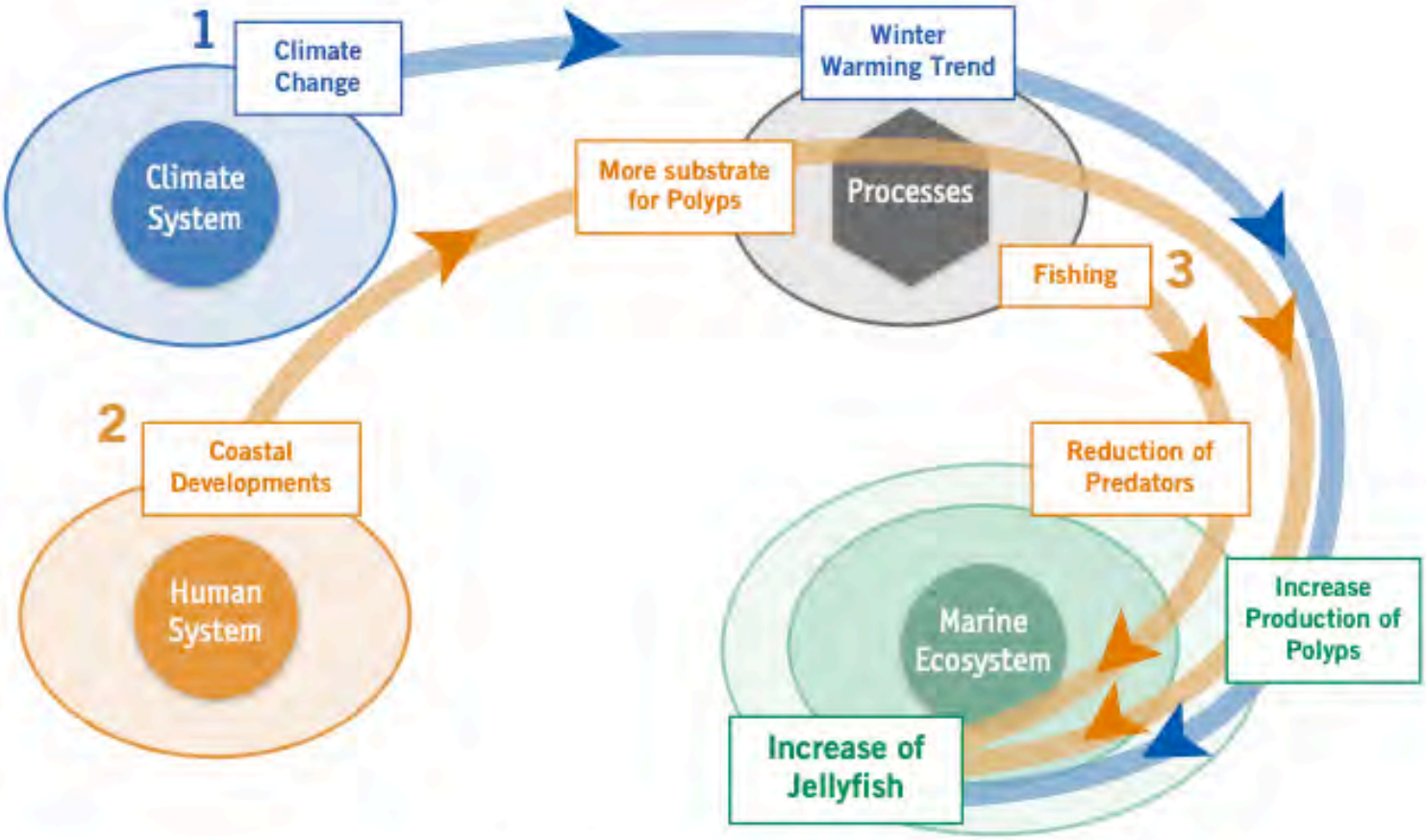

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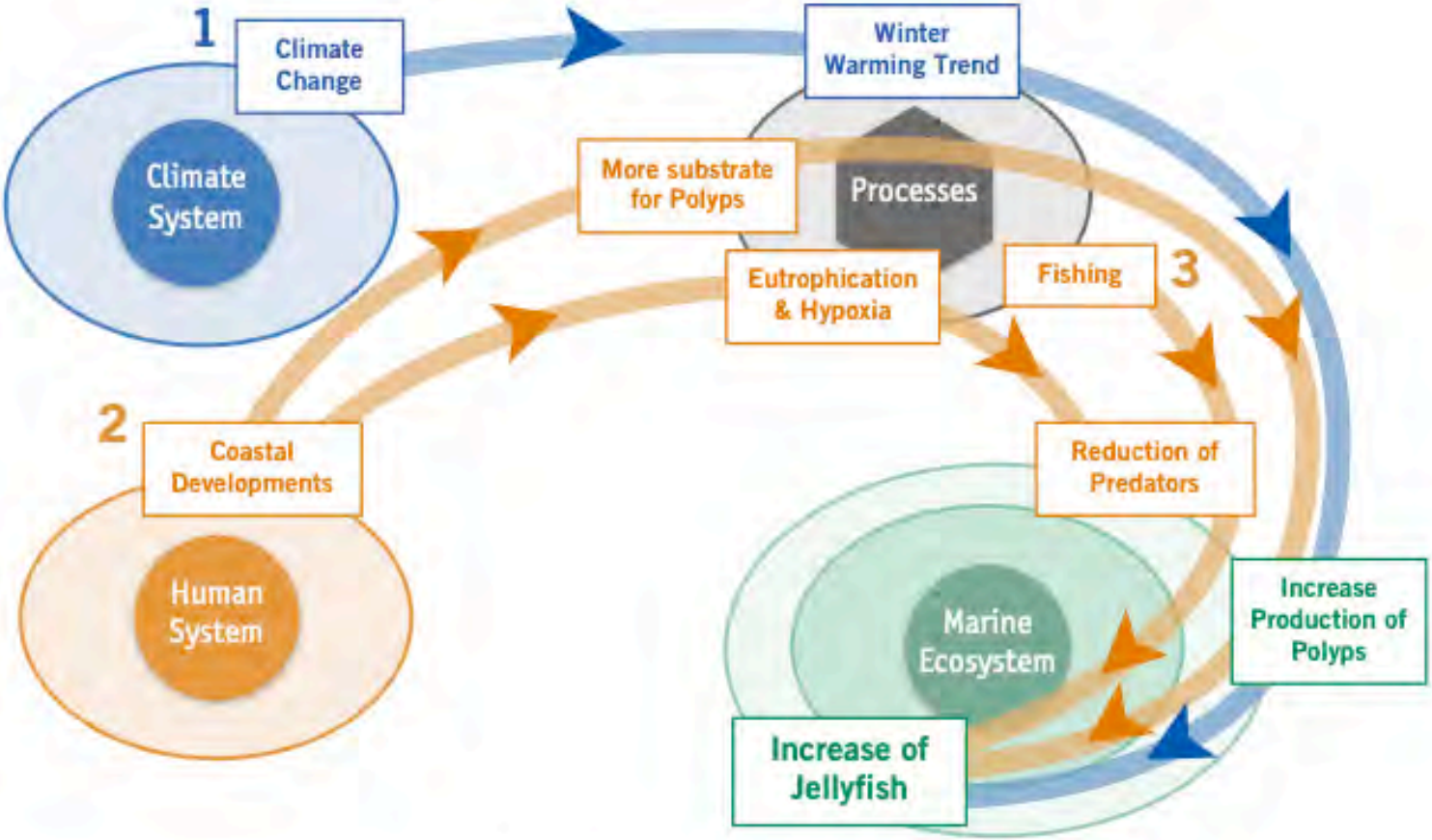

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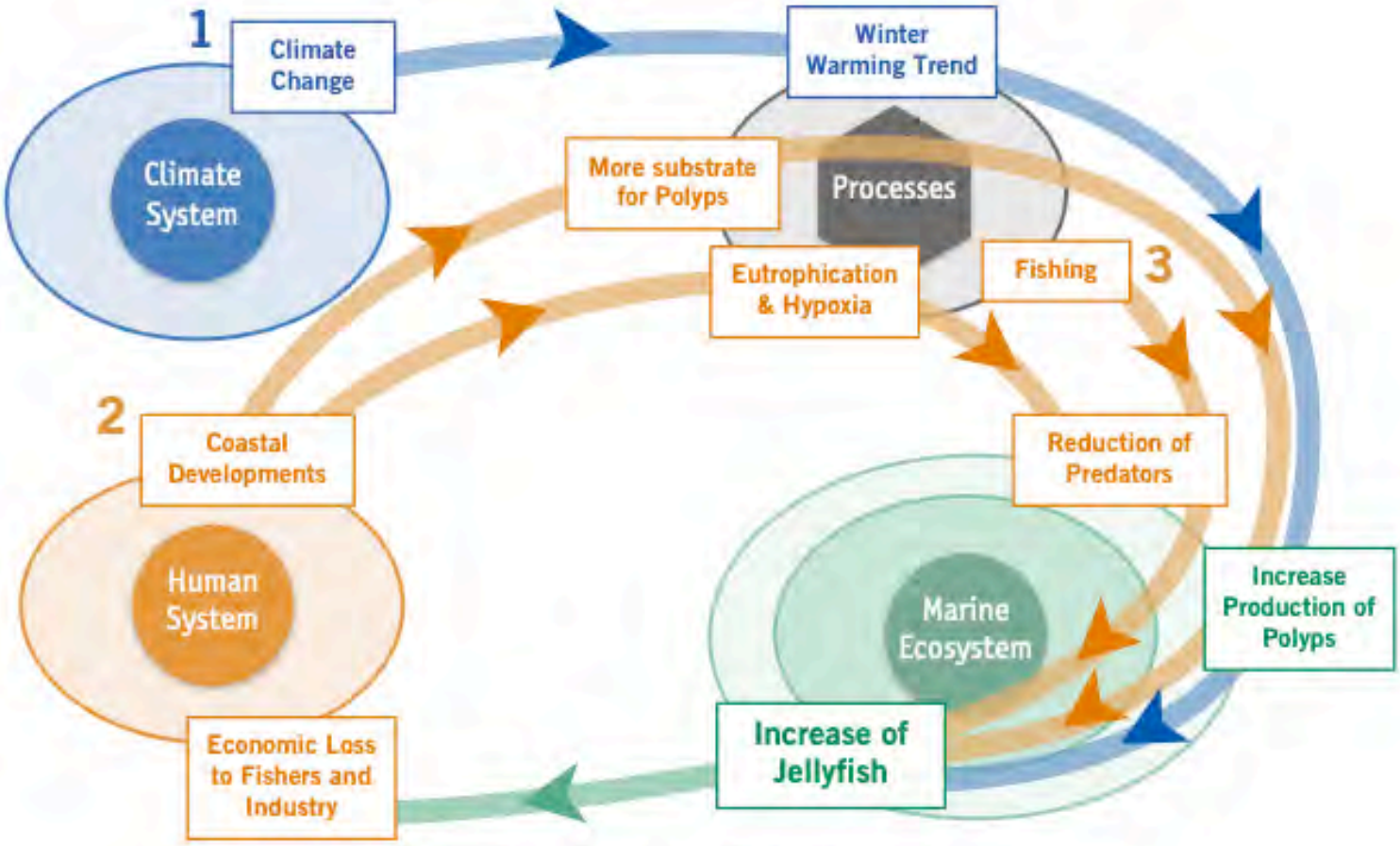

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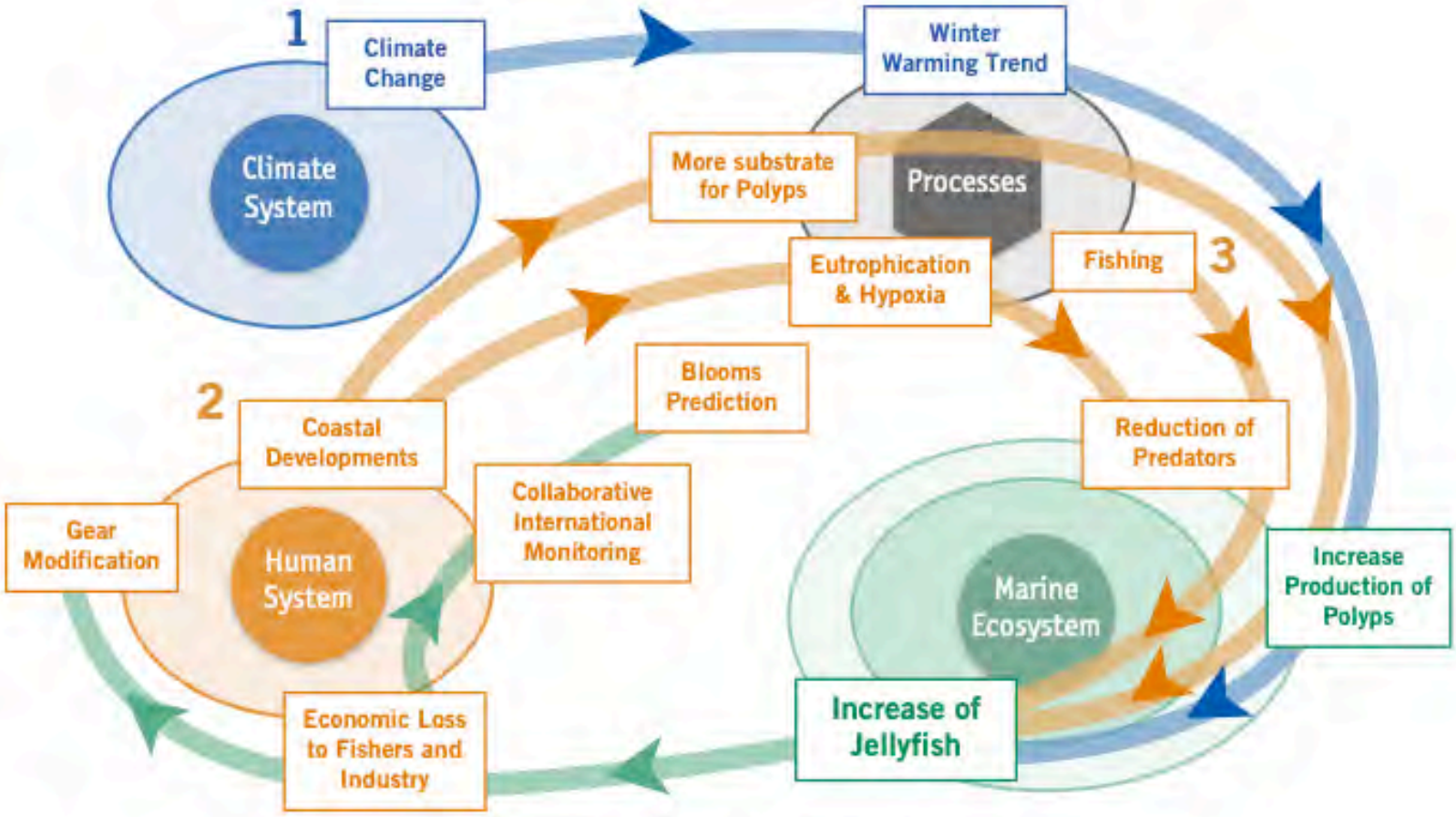

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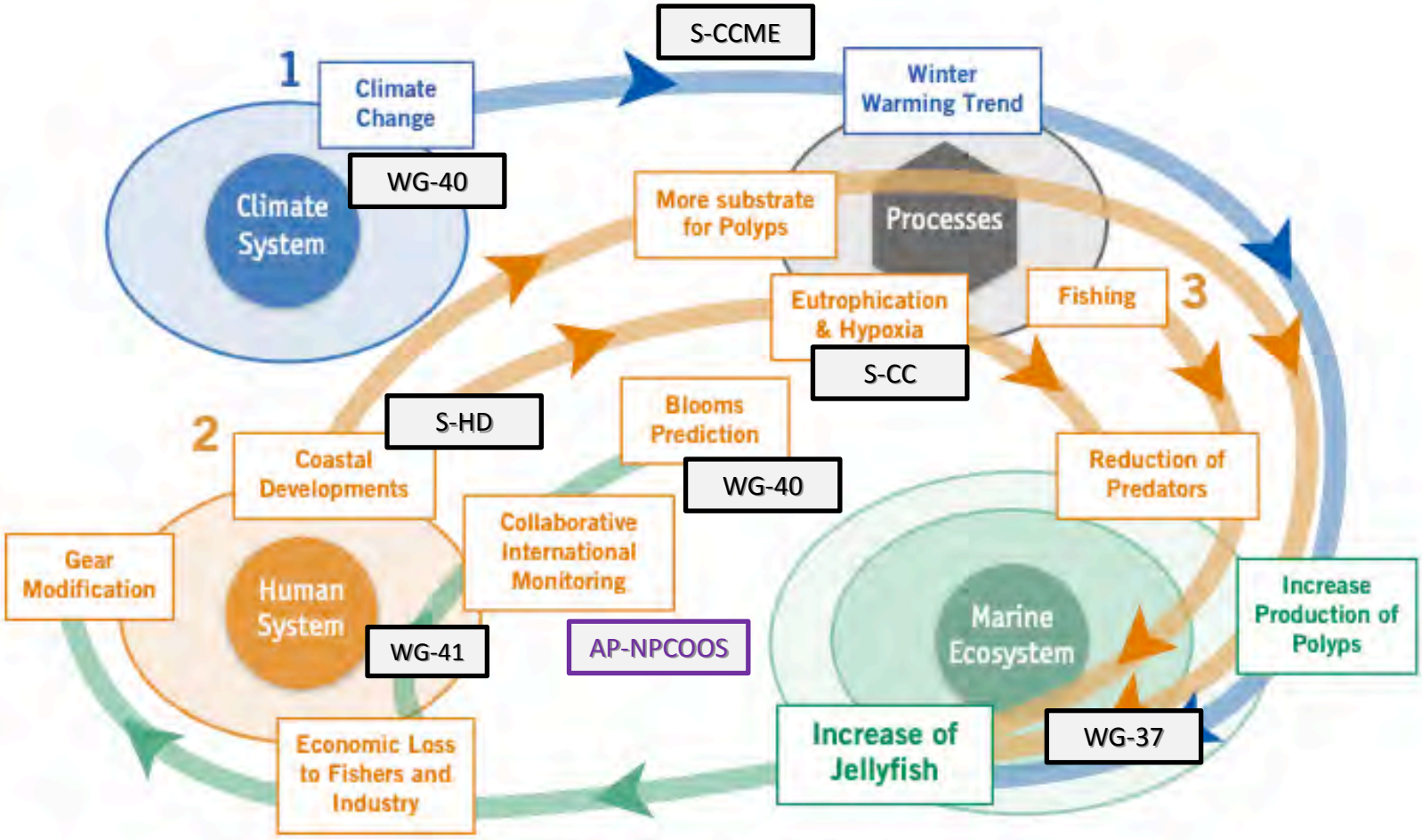
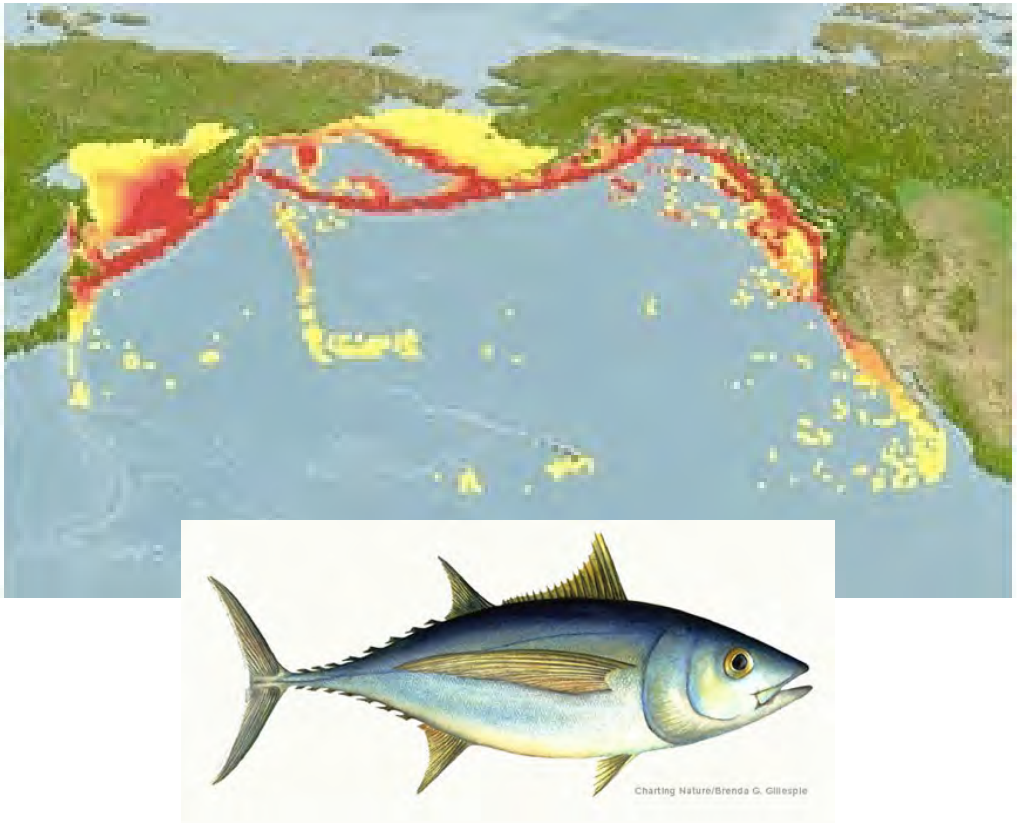


Case Study: Transboundary Fisheries Management under Climate Change



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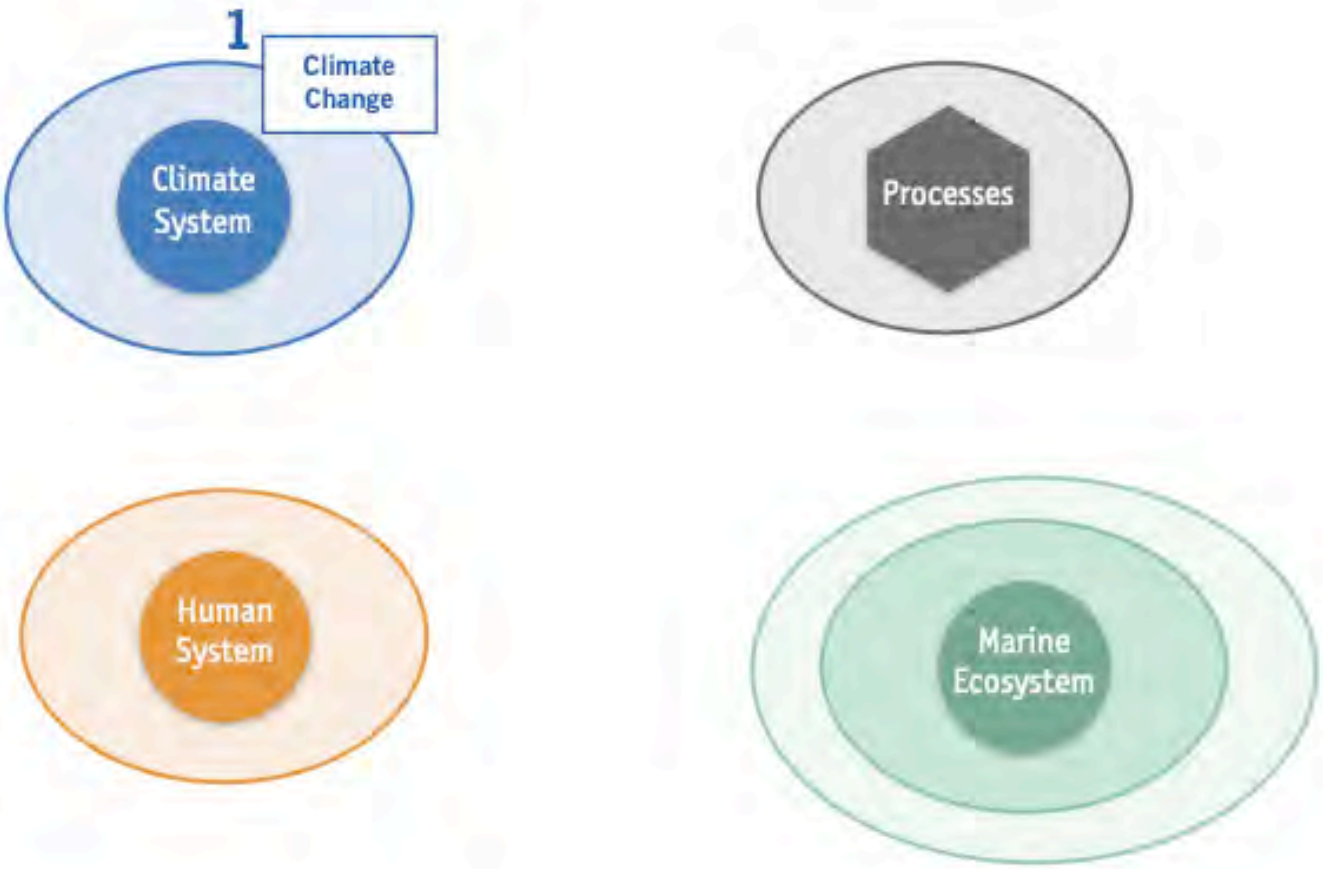

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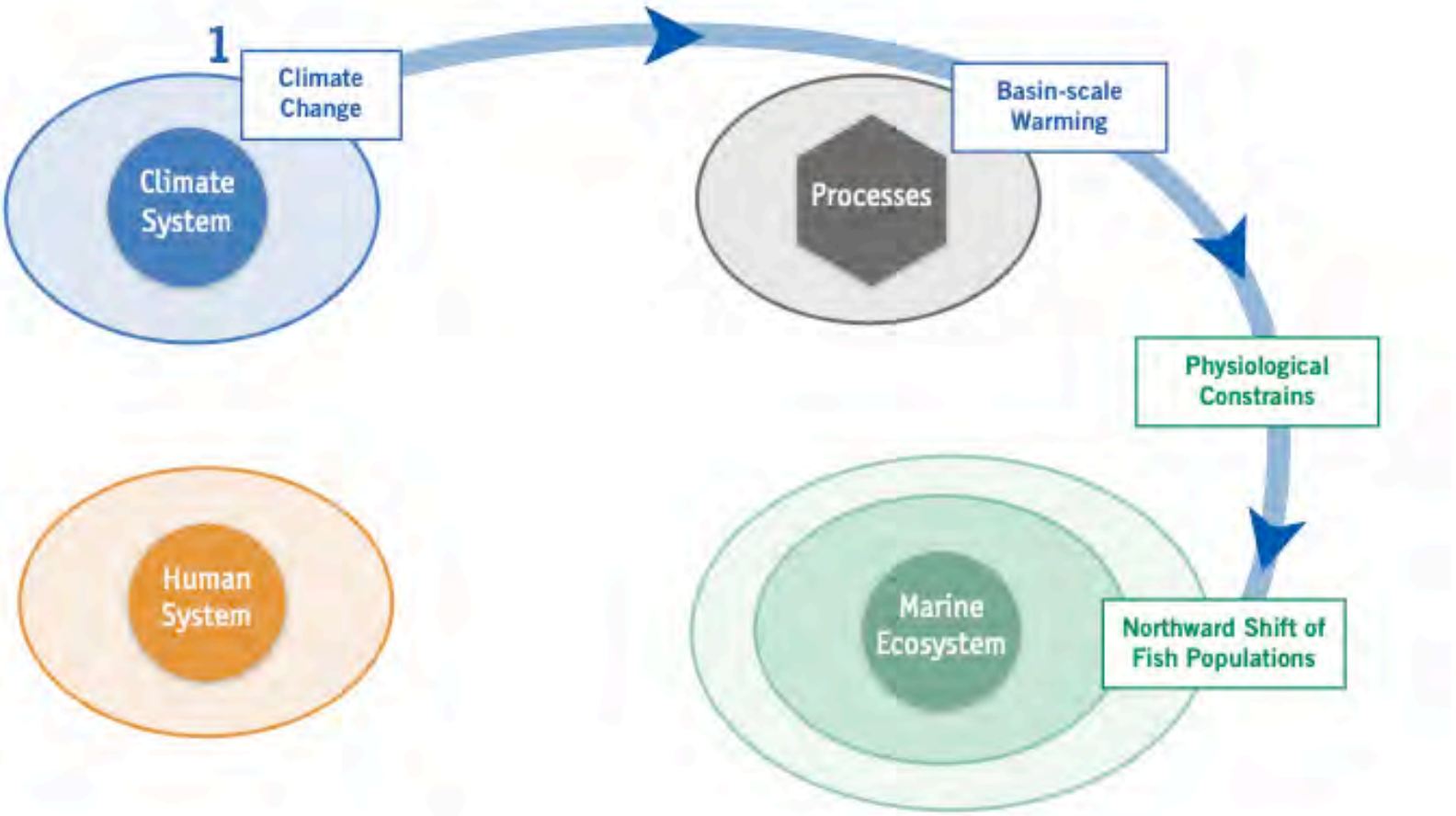

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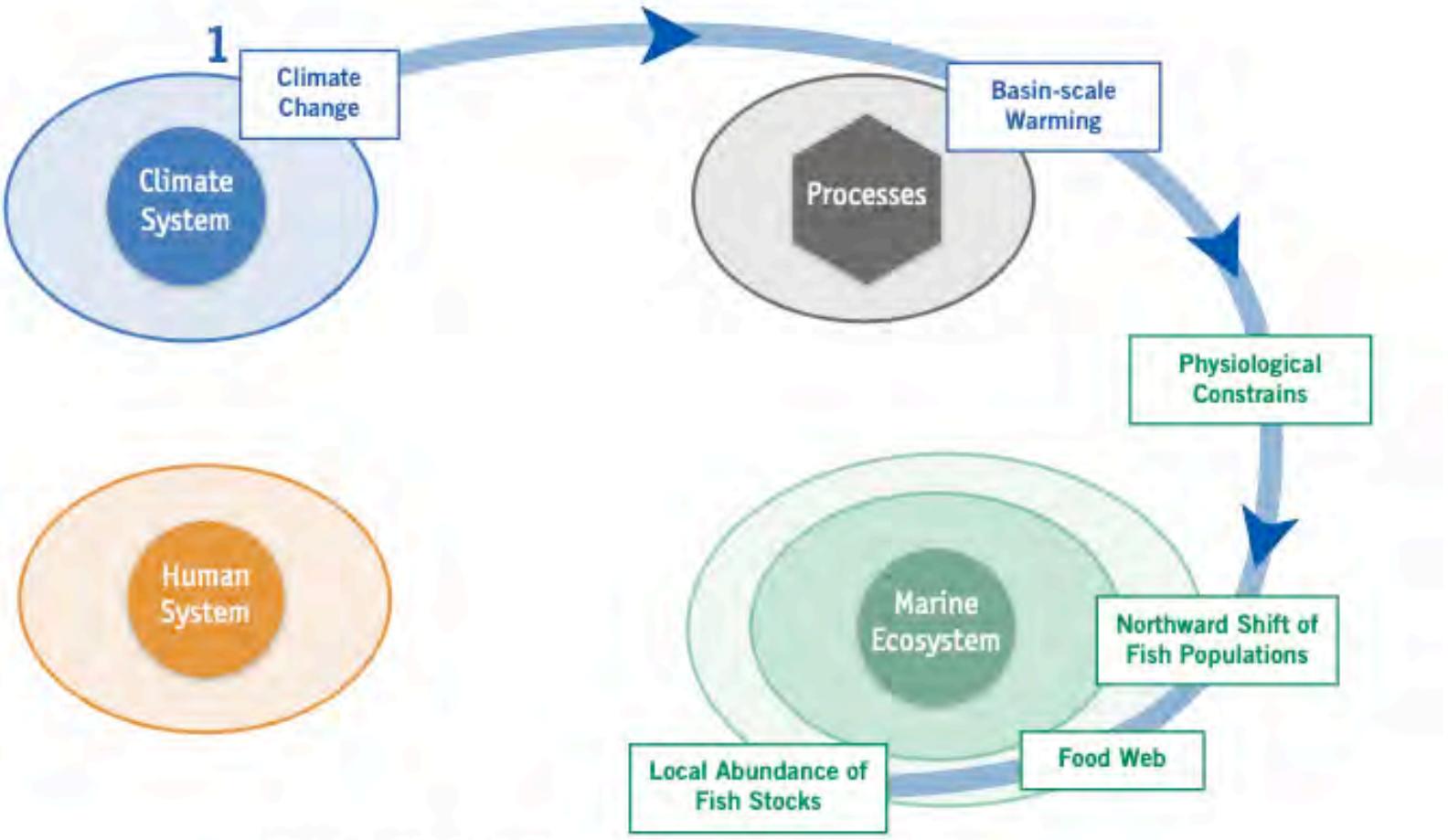

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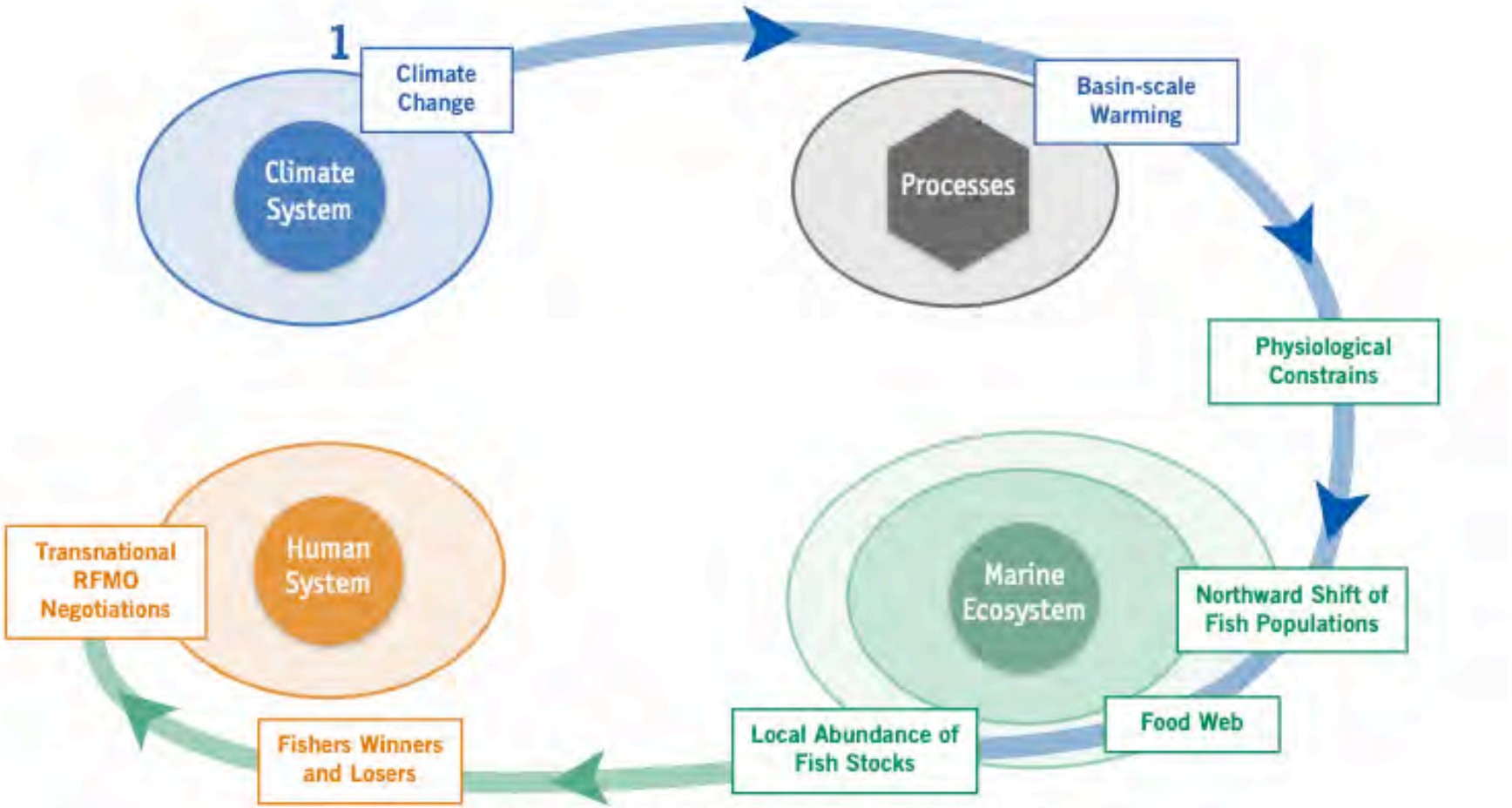

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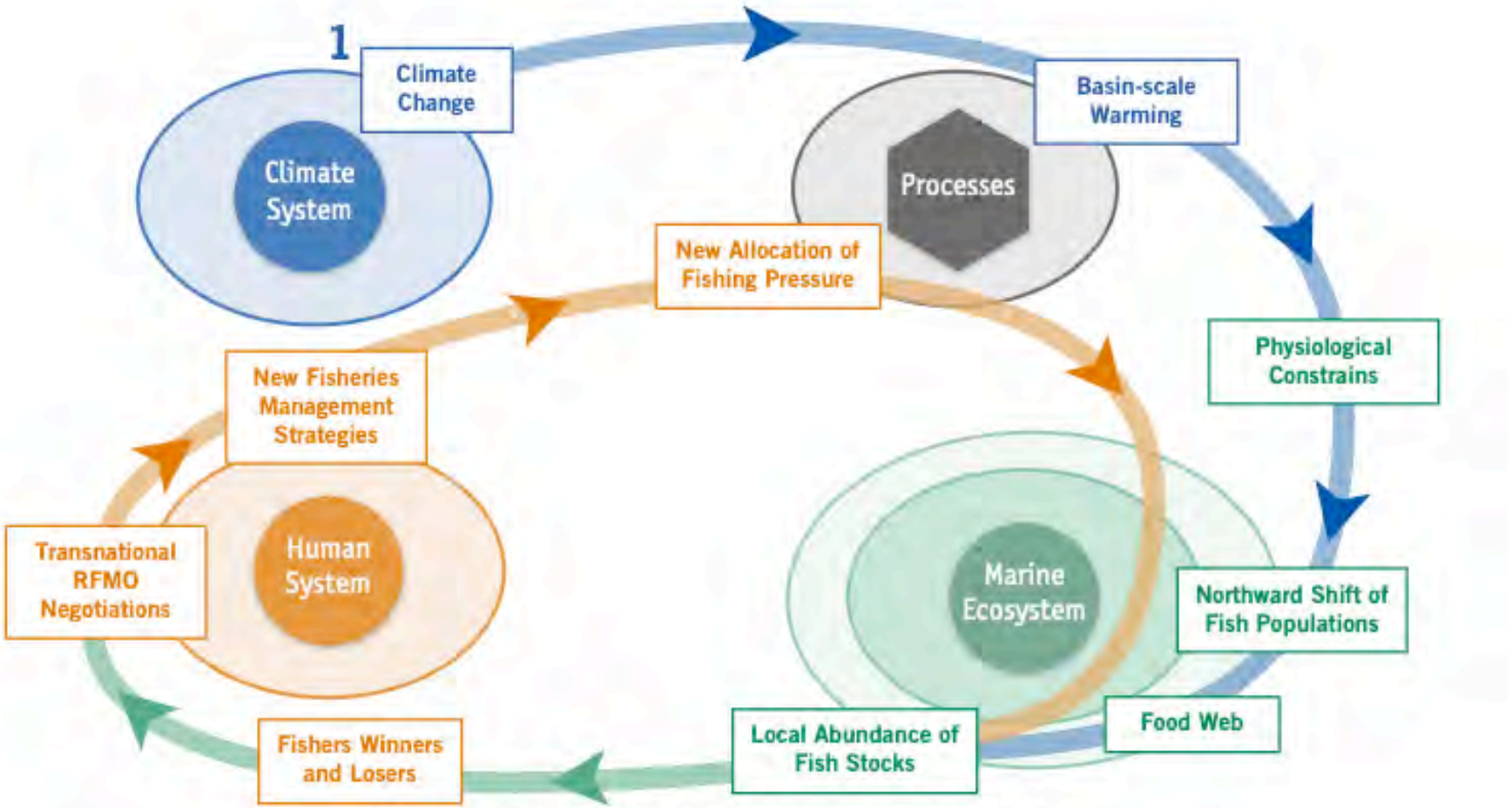

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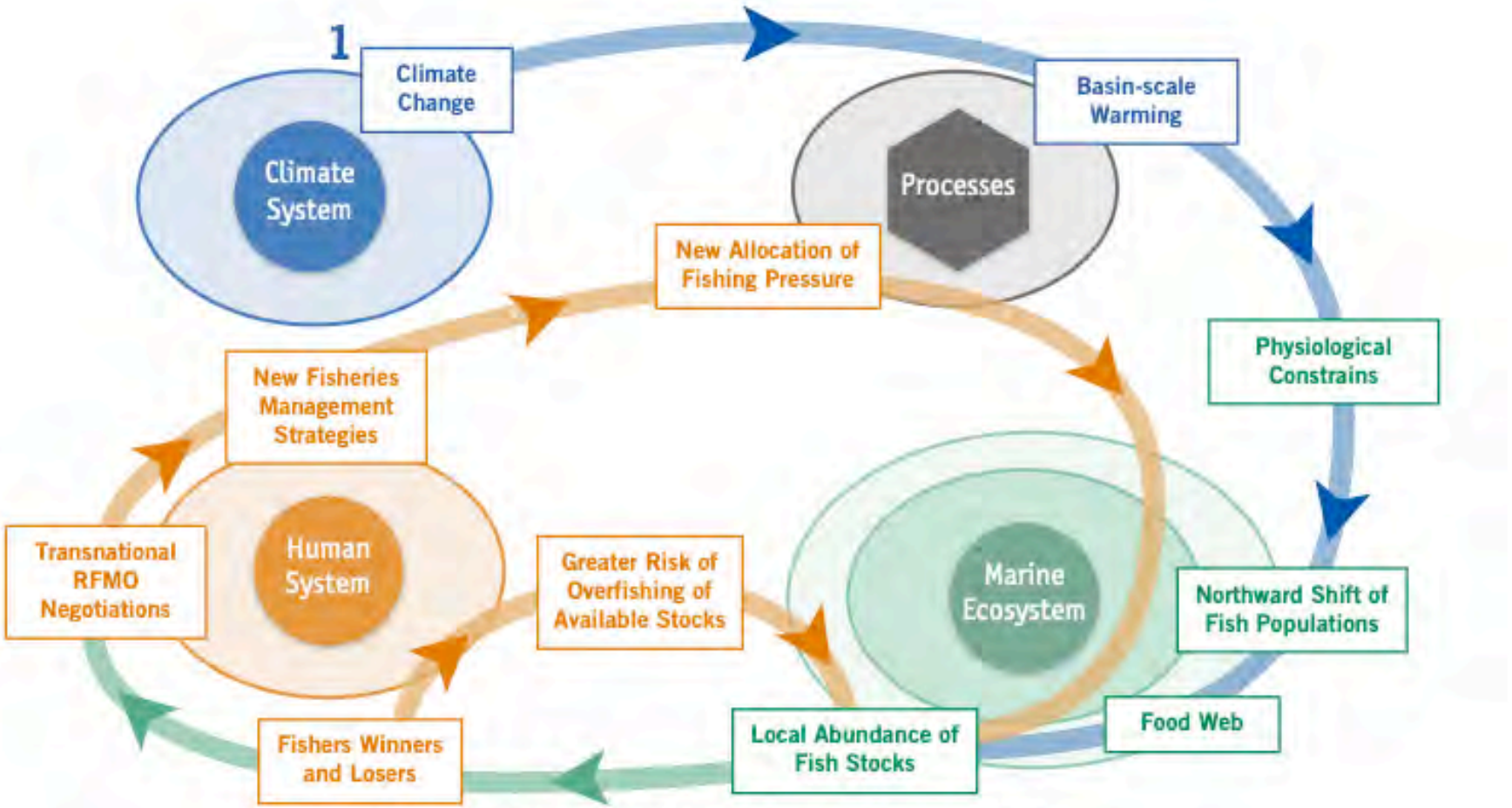

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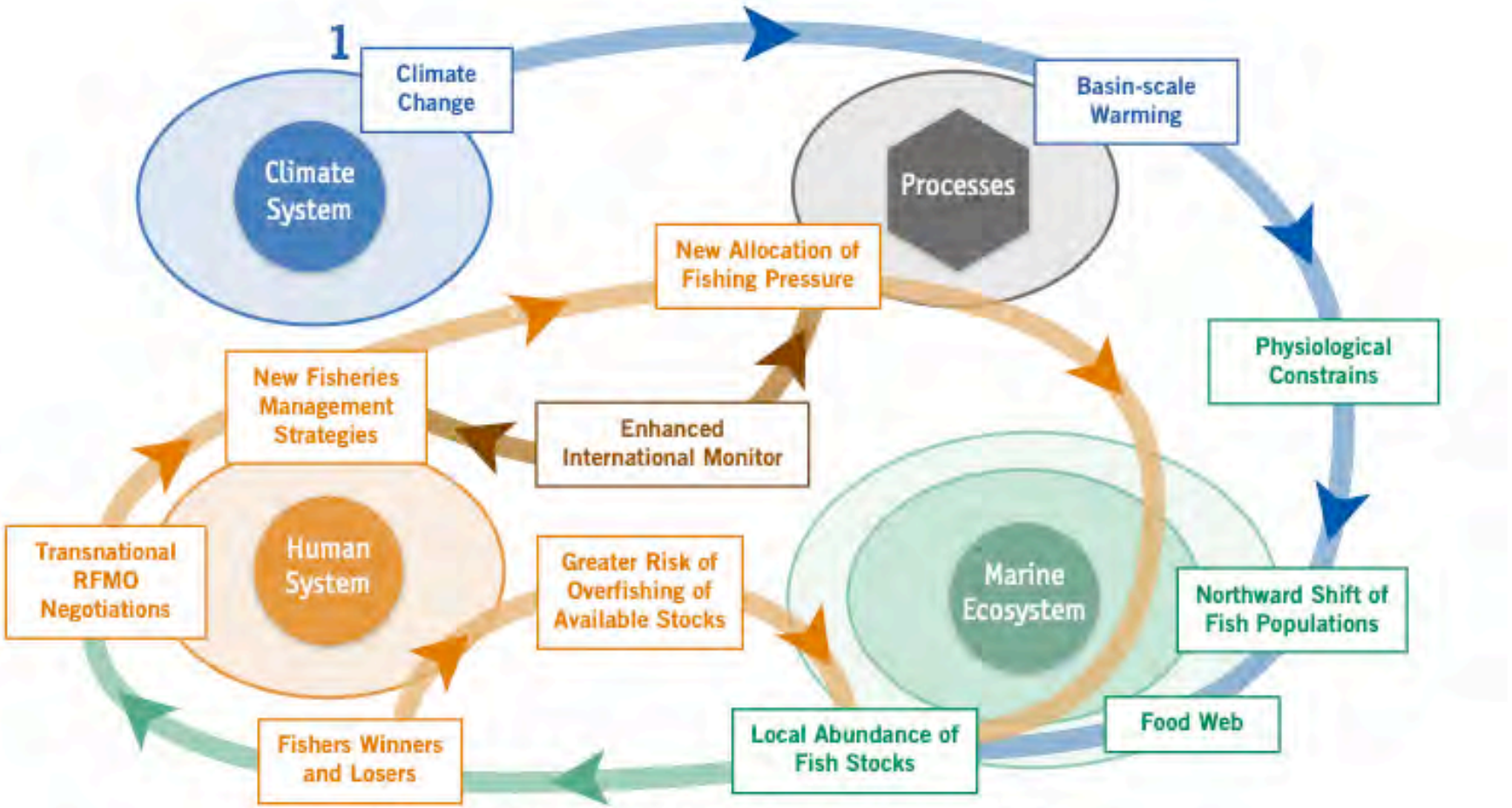

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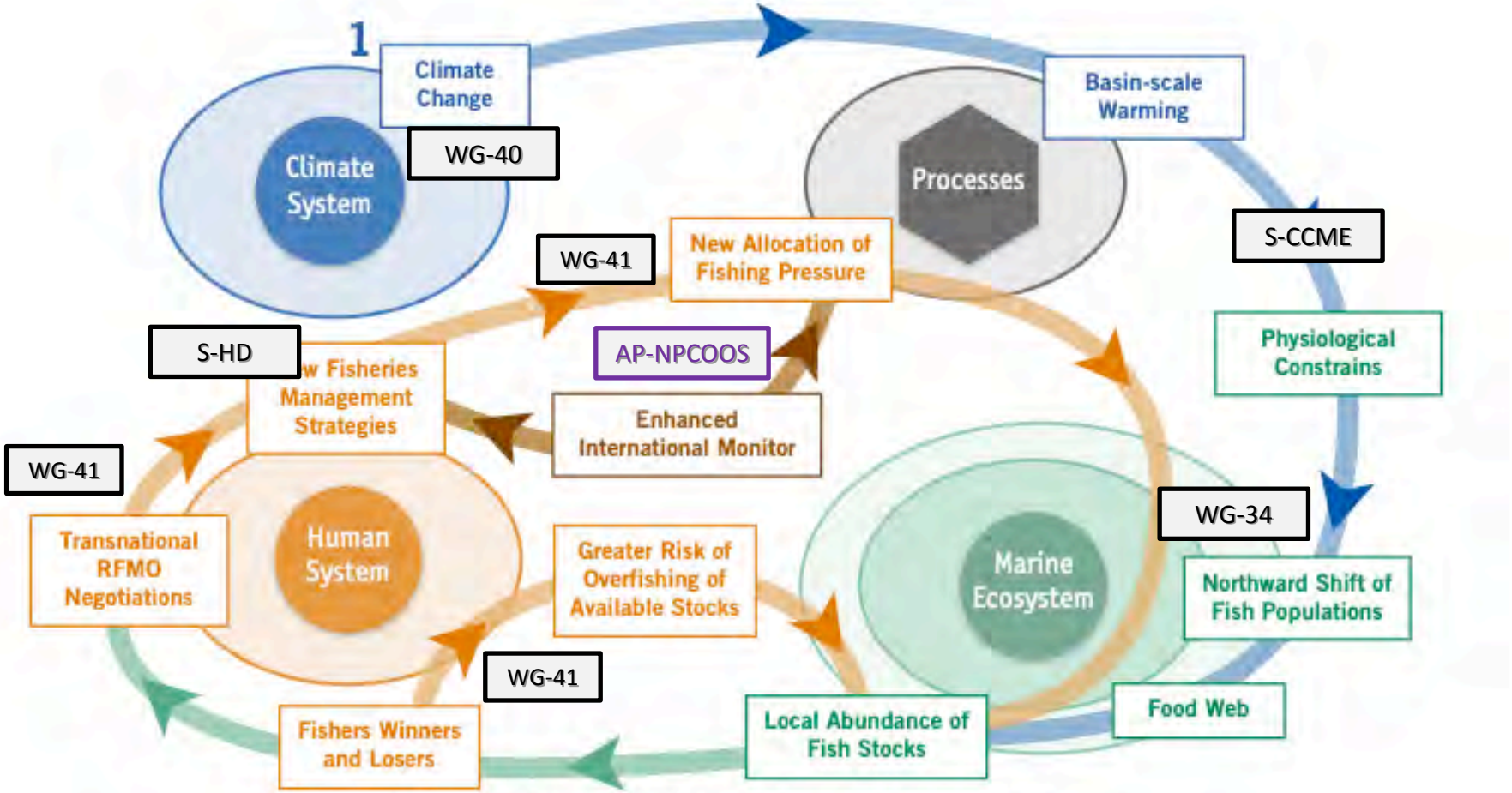

ADDRESSING **FUTURE** RESEARCH GAPS

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1. **What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?**

- **How might changes in ecosystem structure and function affect an ecosystem's resilience or vulnerability to natural and anthropogenic forcing?**
- **What thresholds, buffers and amplifiers are associated with maintaining ecosystem resilience?**

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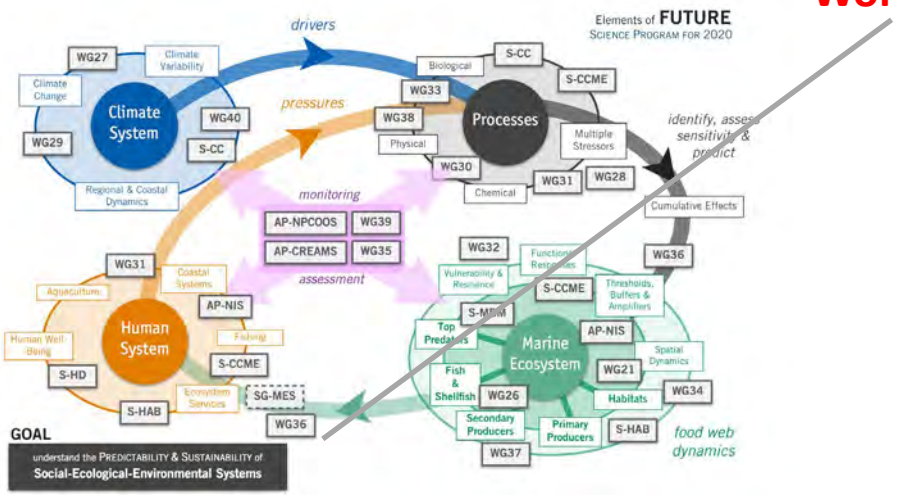

Working Group 36: COMMON ECOSYSTEM REFERENCE POINTS ACROSS PICES COUNTRIES

ADDRESSING **FUTURE** RESEARCH GAPS

2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?

- How does physical forcing, including climate variability and climate change, affect the processes underlying ecosystem structure and function?
- How can understanding of these ecosystem processes and relationships, as addressed in the preceding sub-questions, be used to forecast ecosystem response?

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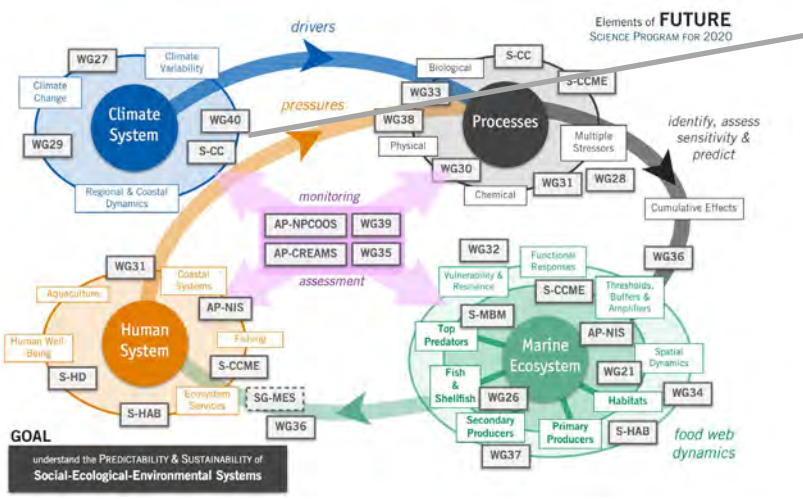
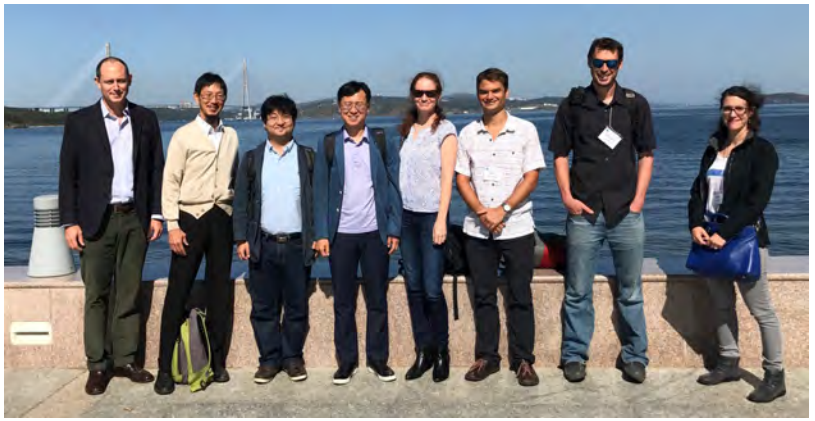


Working Group 40: CLIMATE AND ECOSYSTEM PREDICTABILITY



COMMUNITY INPUT TO **FUTURE**

1. Has PICES created the appropriate structure to accomplish the FUTURE objectives?
2. What are the important remaining gaps in FUTURE research?
3. What are the emerging issues that PICES needs to address?
4. What's next for PICES integrative science …?

FUTURE Science Program

COMMUNITY INPUT TO **FUTURE**

Wednesday, October 31st, 9:00 am – 12:50 pm / Oshidori + Kujaku

S6: FUTURE Topic Session
The FUTURE of PICES: Next steps in understanding, forecasting and communicating climate impacts on North Pacific marine ecosystems

Convenors:
Sukyung Kang (Korea) *corresponding*, Steven Bograd (USA)

'Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems' (FUTURE) is the flagship integrative Scientific Program undertaken by the member nations and affiliates of PICES. Since its inception in 2009, FUTURE has contributed to guiding PICES science to understand how marine ecosystems in the North Pacific respond to climate change and human activities, to forecast ecosystem status based on a contemporary understanding of how nature functions, and to communicate new insights to its members, governments, stakeholders and the public. FUTURE is scheduled to conclude in 2019, so this is a good time to reflect on its accomplishments, to identify remaining gaps in fulfilling its research objectives, and to contemplate new directions for PICES science. In this session, we will conduct a FUTURE 'Mini-Symposium' to update the PICES community on FUTURE progress and to coordinate activities amongst the PICES Expert Groups. Each Expert Group will provide a brief review of their past, current and planned activities as they relate to the FUTURE Science Program, which will be followed by a plenary discussion on the future path of PICES science in the coming years.

QUESTIONS?

"Towards an integrated understanding of human and natural changes in the North Pacific social-ecological marine systems"