Risk Retirement for Marine Renewable Energy

OES-Environmental Public Webinar
September 24, 2020

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PNNL is operated by Battelle for the U.S. Department of Energy

Agenda

- Introduction
- Background
- Risk Retirement
- Data Transferability
- Outreach & Engagement
- Overview of Feedback
  - Underwater Noise
  - Electromagnetic Fields
  - Habitat Changes
- Next Steps

Objective

- Concept of risk retirement
  - Process developed by OES-Environmental
  - As applied to specific stressors
- Build on previous OES-Environmental webinars
  - Present latest developments
- Engage the marine renewable energy (MRE) community
  - To better understand environmental effects of MRE
- Receive feedback on risk retirement

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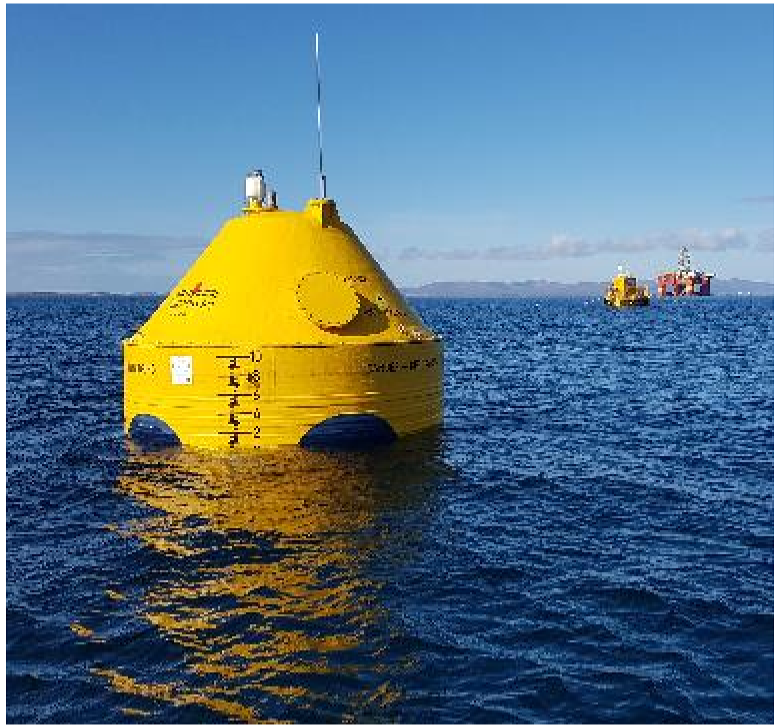
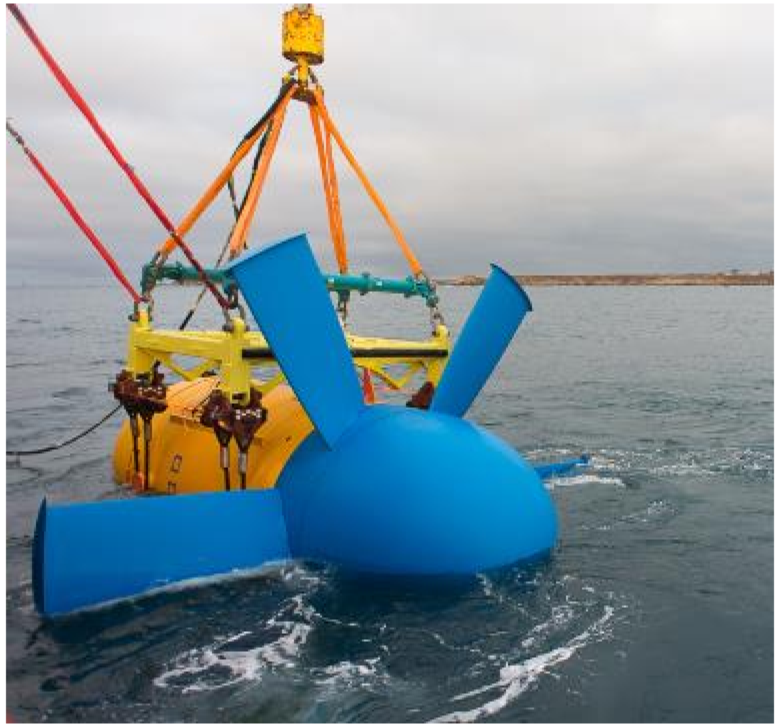
Marine Renewable Energy (MRE)

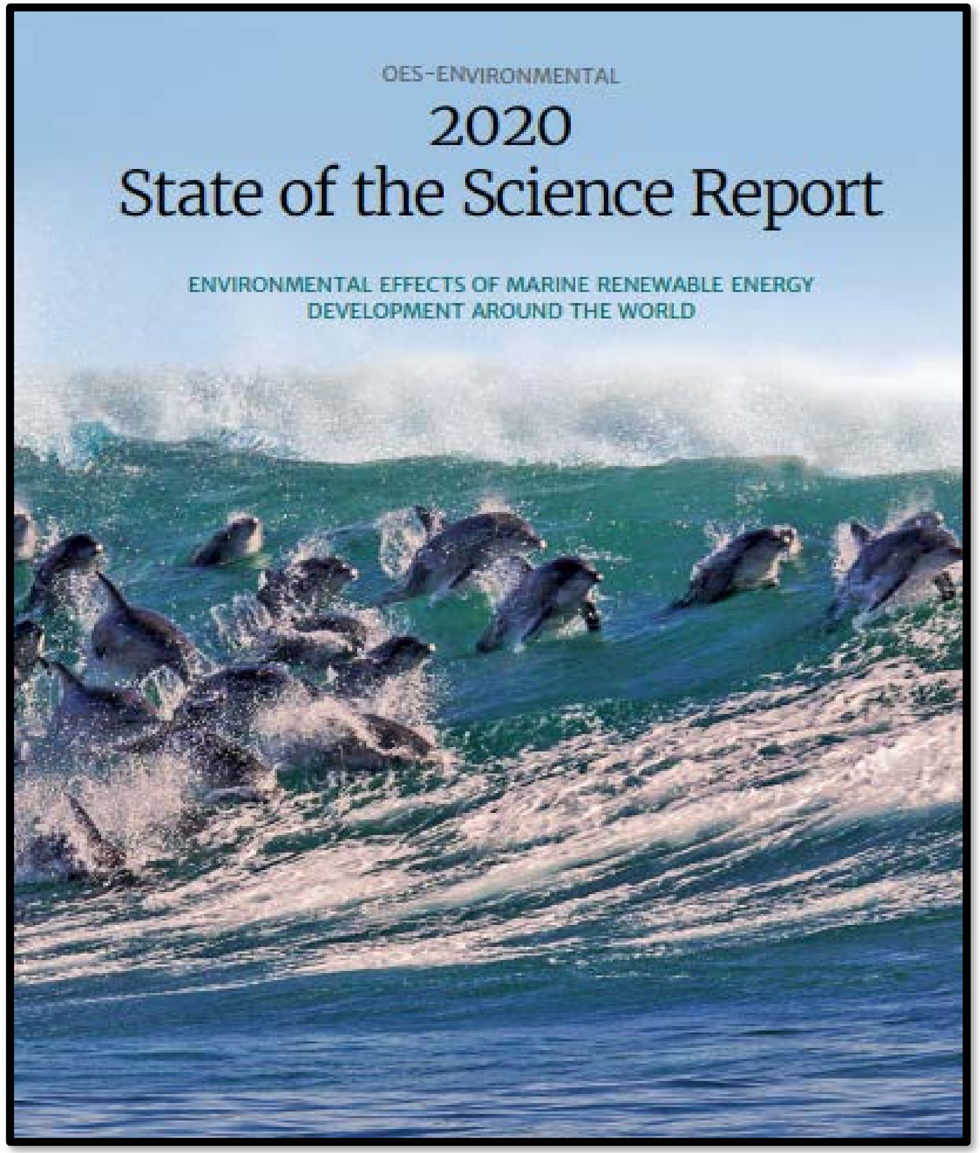
- Energy harnessed from waves and tides
- Early stages of development, deployment, and commercialization
- Environmental concerns continue to slow consenting/permitting worldwide





OES-Environmental

- Established by the International Energy Agency (IEA) Ocean Energy Systems (OES)
- Led by the U.S. Department of Energy's Pacific Northwest National Laboratory
- 15 countries currently involved
- Examines the environmental effects of MRE
- Focusing on risk retirement and data transferability
- Activities coordinated and recorded on *Tethys* (*https://tethys.pnnl.gov/*)



Final 2020 State of the Science Report available in September!

Collision Risk

Underwater Noise

Electromagnetic Fields

Habitat Change

Stressors

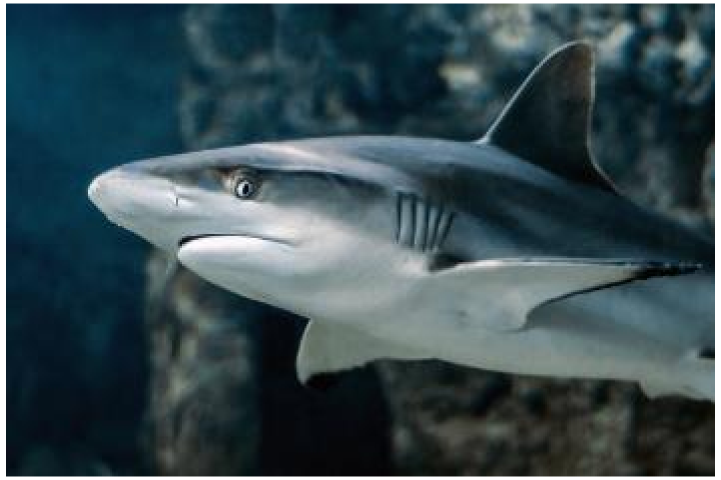
Oceanographic Systems

Entanglement

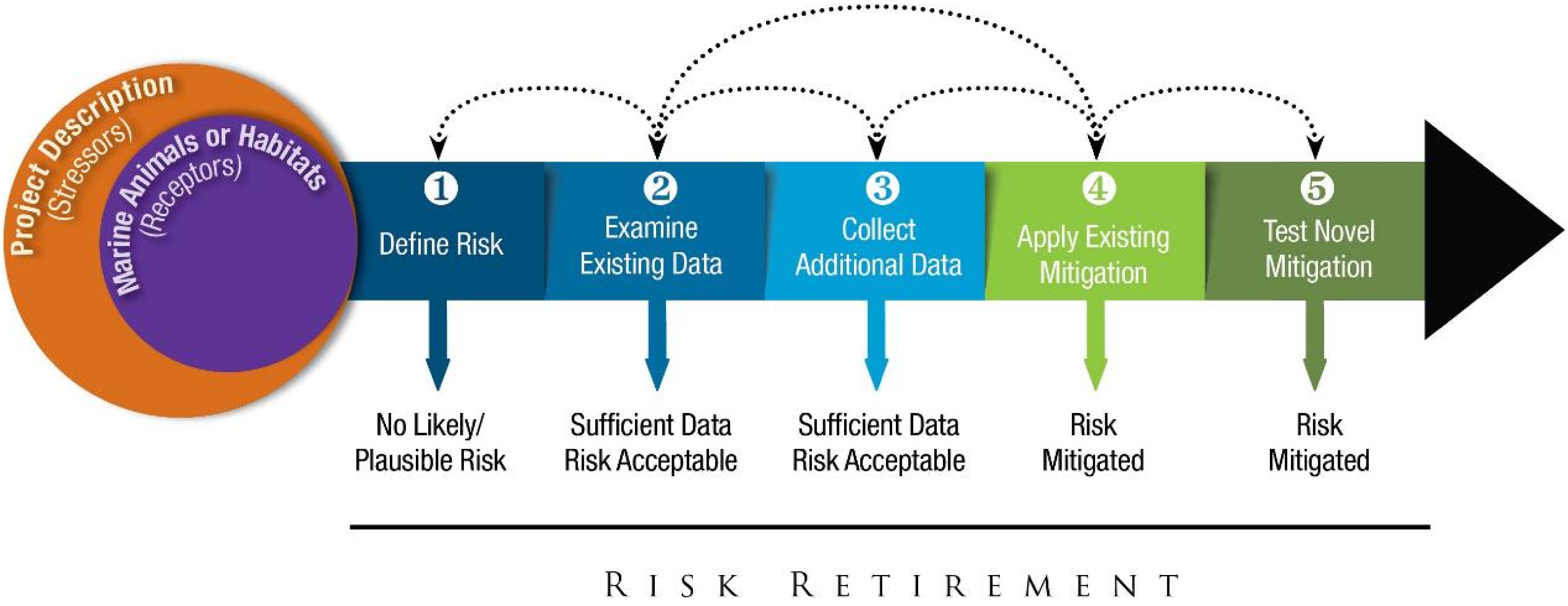
Displacement

What is "risk retirement"?

- For certain interactions, potential risks need not be fully investigated for every project for small developments (1-2 devices)
- Rely on what is already known – already consented/permitted projects, research, or analogous industries
- A "retired risk" is not dead and can be revived in the future as more information becomes available for larger arrays
- Risk retirement does not replace or contradict any regulatory processes



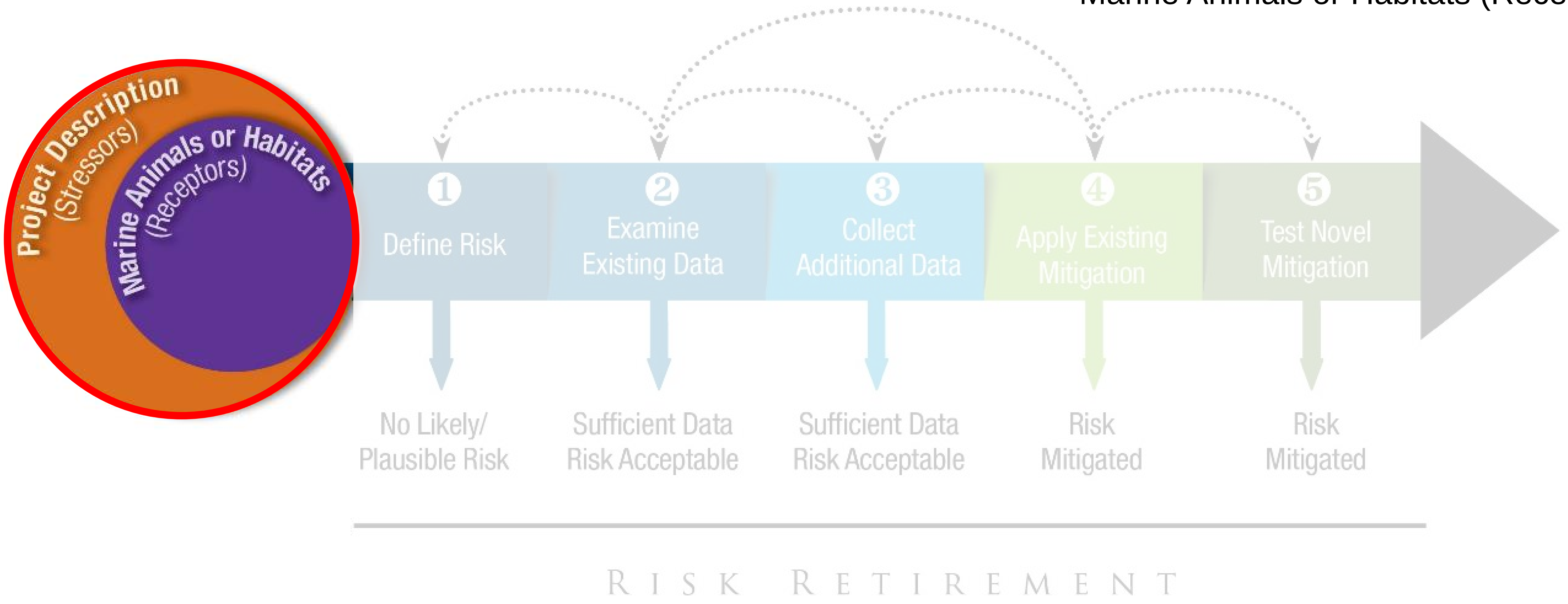
Pathway to Risk Retirement



Pathway to Risk Retirement

Define Interaction

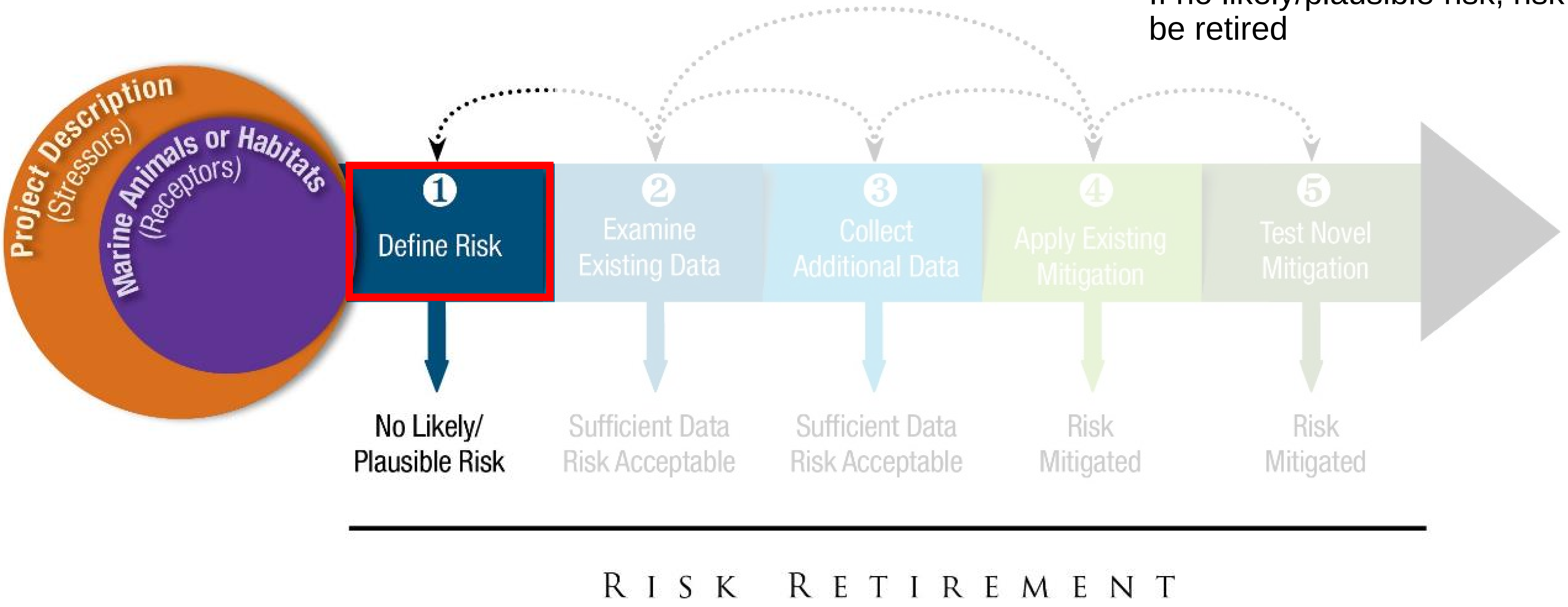
- Project Description (Stressors)
- Marine Animals or Habitats (Receptors)



Pathway to Risk Retirement

Stage Gate 1

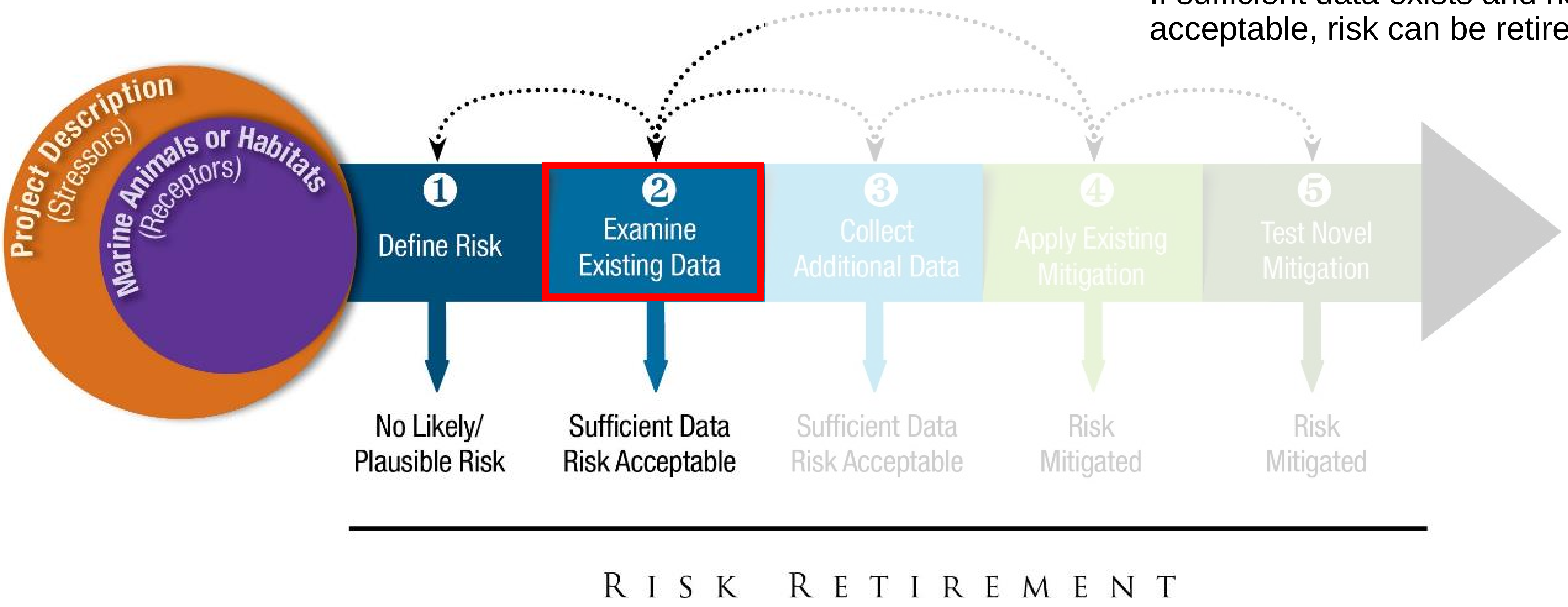
- Define Risk
  - If no likely/plausible risk, risk can be retired



Pathway to Risk Retirement

Stage Gate 2

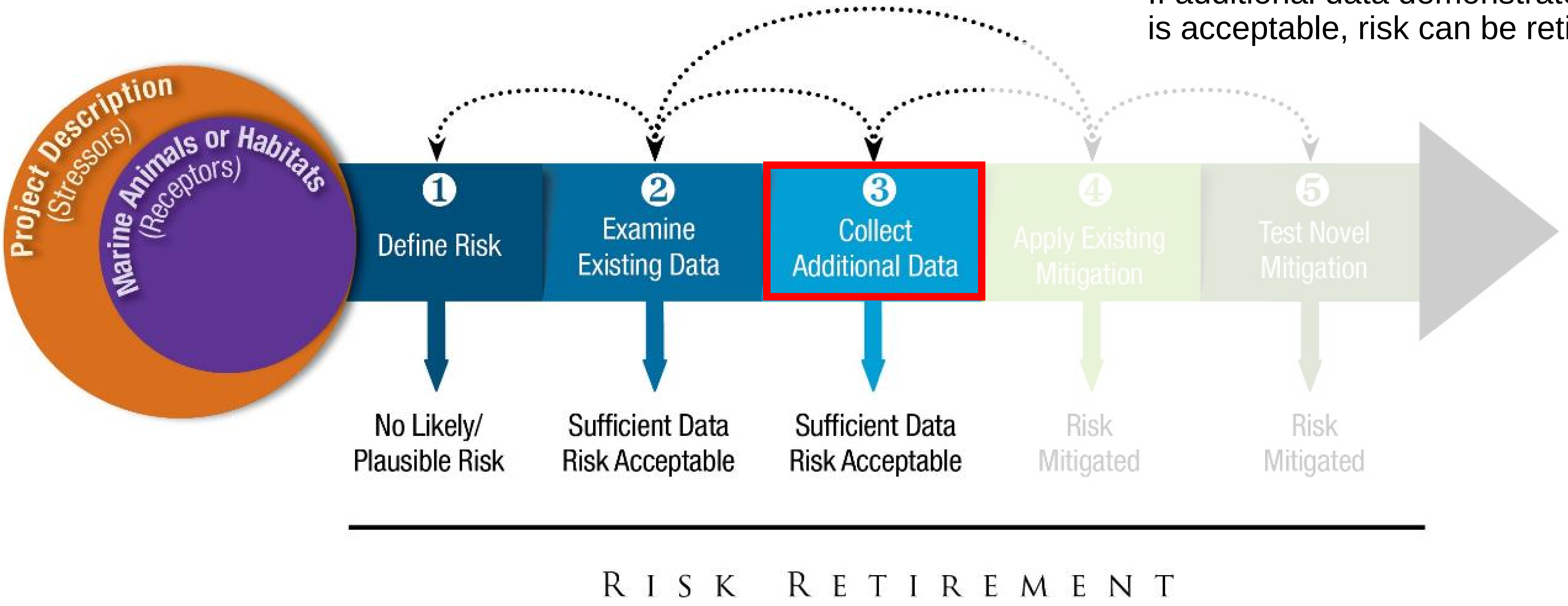
- Examine Existing Data
  - If sufficient data exists and risk is acceptable, risk can be retired



Pathway to Risk Retirement

Stage Gate 3

- Collect Additional Data
  - If additional data demonstrates risk is acceptable, risk can be retired



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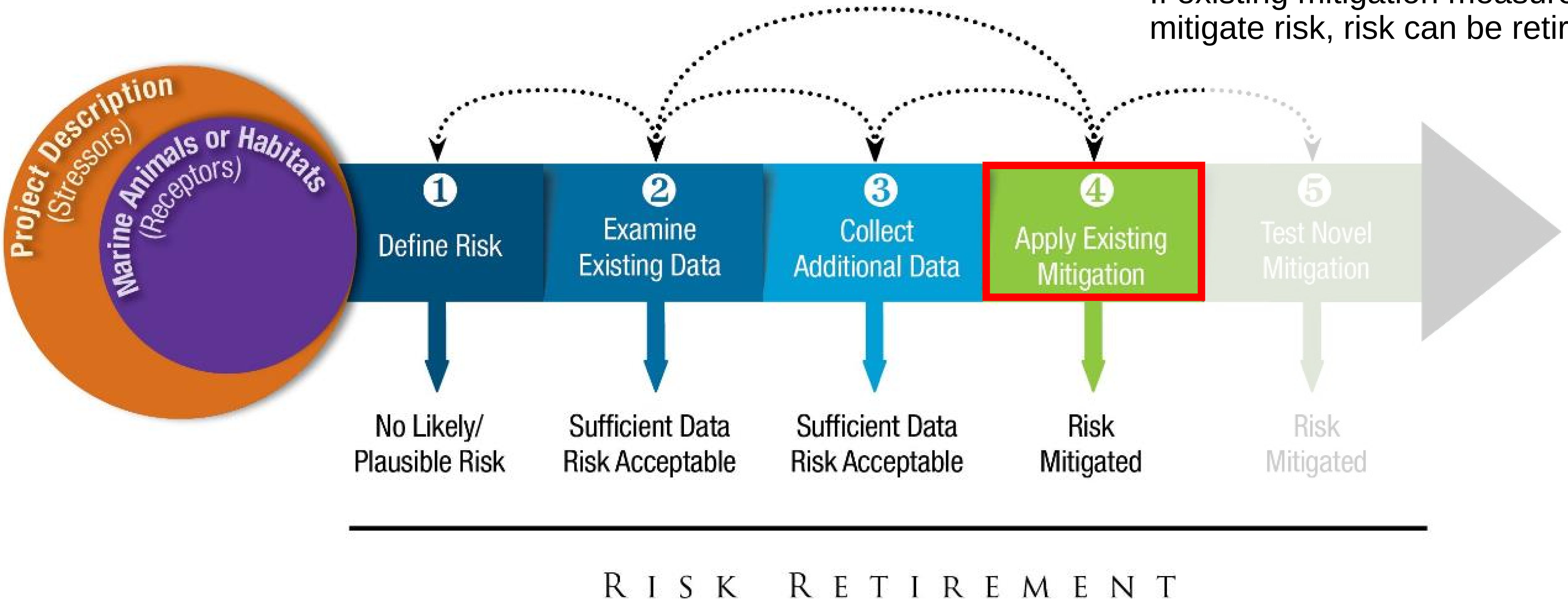
Pathway to Risk Retirement

Stage Gate 4

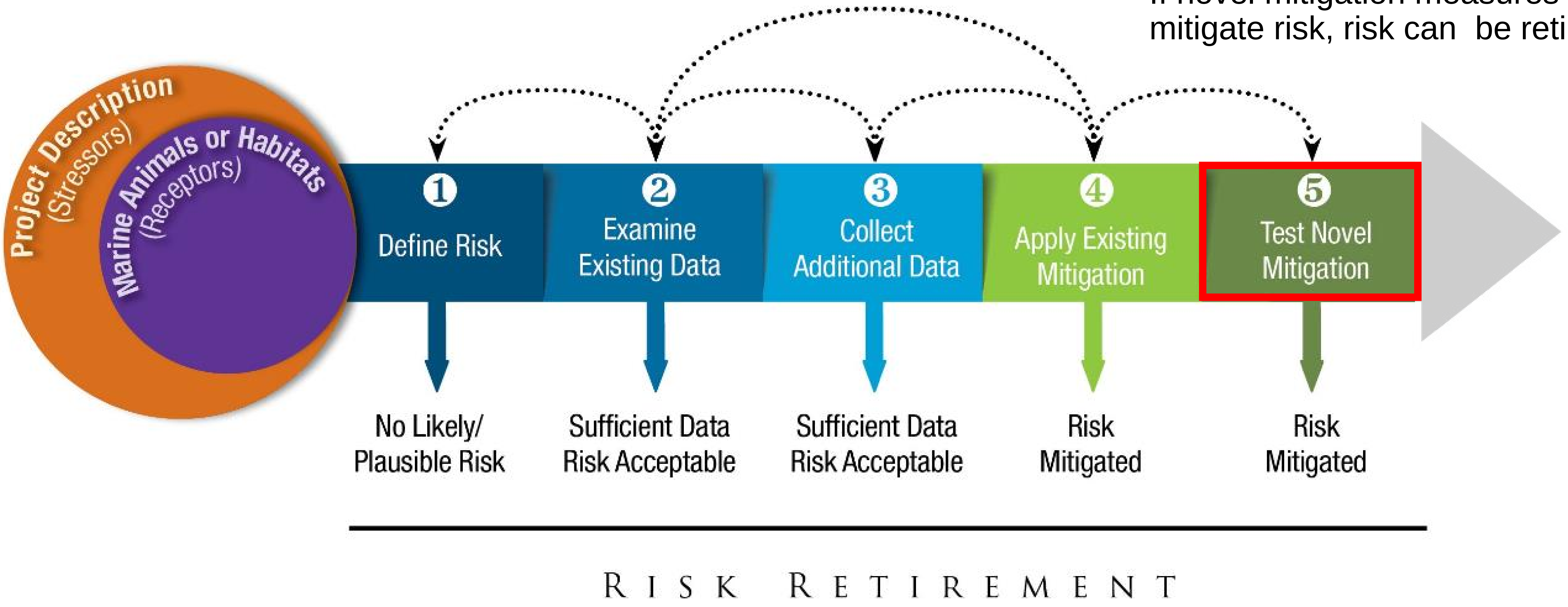
- Apply Existing Mitigation
  - If existing mitigation measures mitigate risk, risk can be retired



Pathway to Risk Retirement

Stage Gate 5

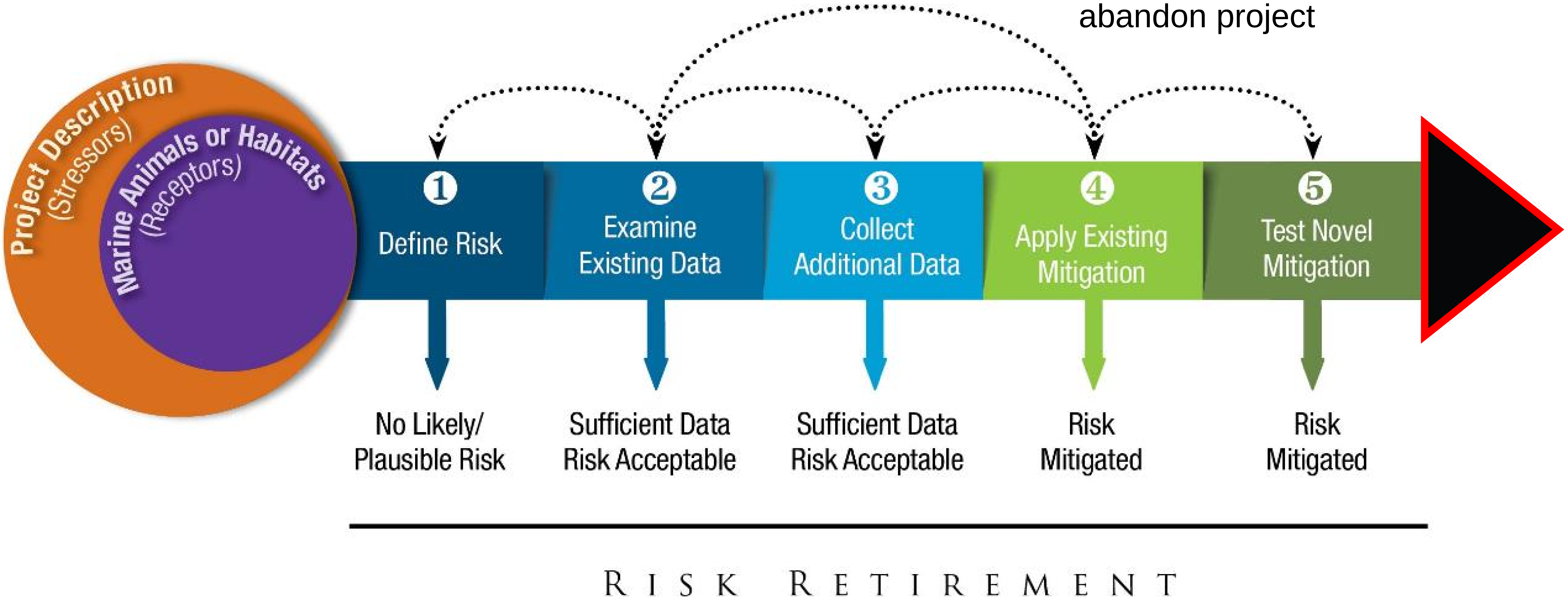
- Test Novel Mitigation
  - If novel mitigation measures mitigate risk, risk can be retired



Pathway to Risk Retirement

End of Pathway

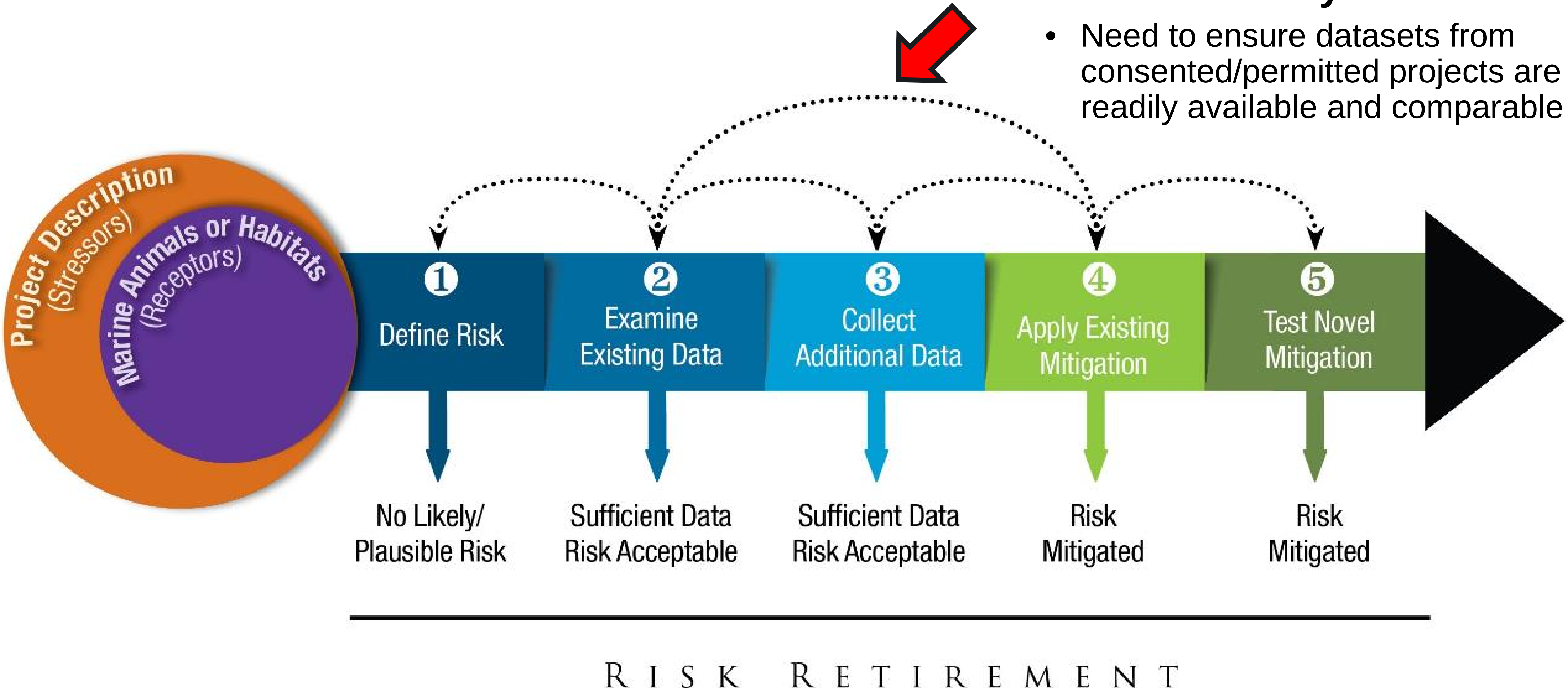
- If risk is significant and cannot be mitigated, redesign or possibly abandon project



Pathway to Risk Retirement

Data Transferability Process

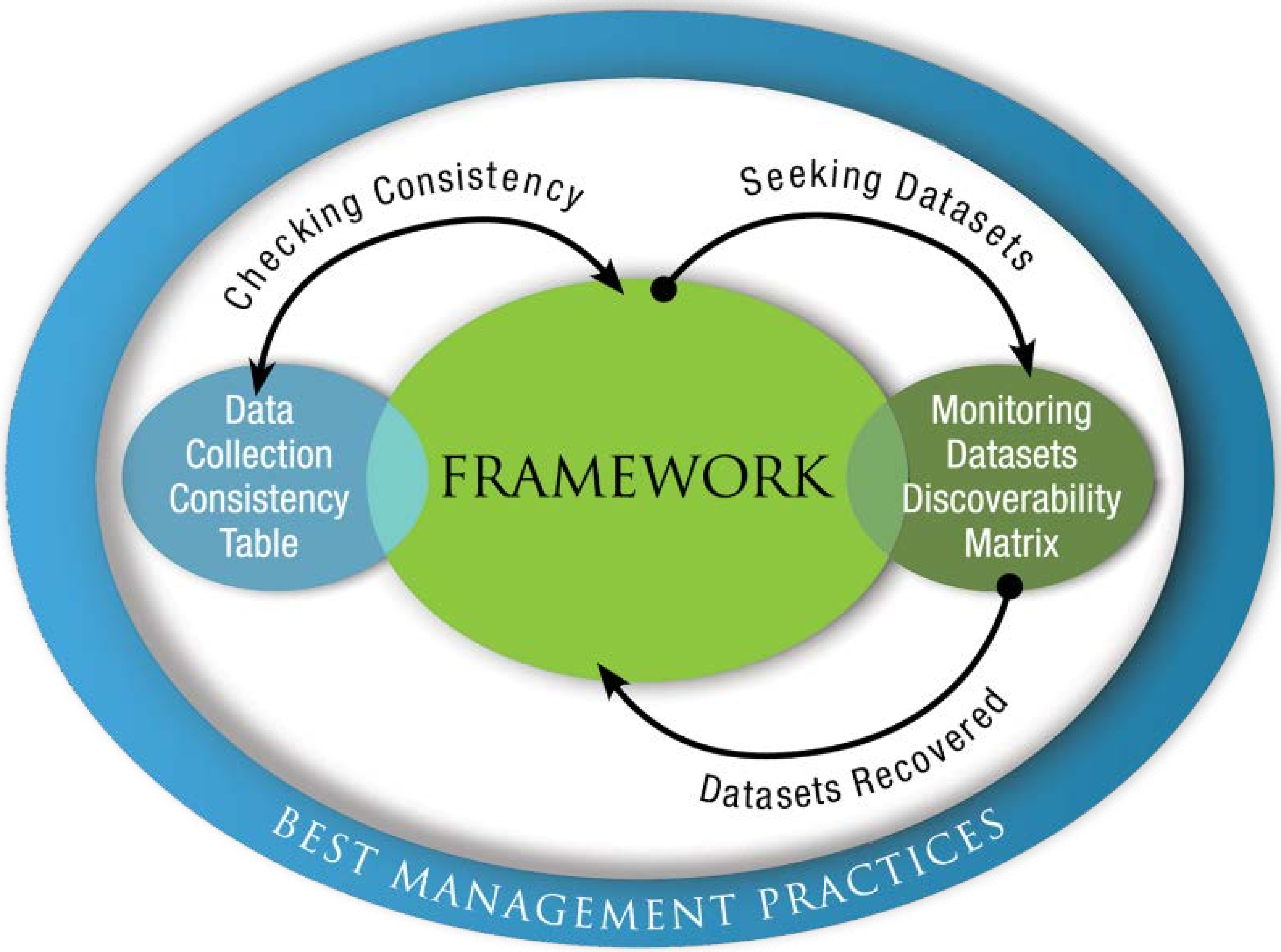
- Need to ensure datasets from consented/permitted projects are readily available and comparable



What do we mean by "data transferability"?

- Data/information collected through research studies and monitoring from other projects should inform new projects
- Site-specific data will be needed for all new projects
- Data from established projects may reduce site-specific data collection needs
- Similarities to other industries may inform new MRE projects
- These data sets that might be "transferred" need to be collected consistently for comparison

Data Transferability Process



https://tethys.pnnl.gov/data-transferability
https://tethys.pnnl.gov/monitoring-datasets-discoverability-matrix

Outreach & Engagement

Workshops for U.S. Regulators

- Two online workshops focused on overall process of risk retirement and gathering feedback on the pathway (May 2019): 10 U.S. state and federal regulators

International Workshops

- Three workshops focused on risk retirement for impacts from underwater noise and/or EMF
  - European Wave and Tidal Energy Conference (EWTEC) (Sep. 2019): 34 attendees from 11 countries
  - Ocean Renewable Energy Conference (Sep. 2019): 60 attendees from 3 countries
  - Sydney workshop (Dec. 2019): 16 attendees from 4 countries
- One online workshop focused on risk retirement for impacts from habitat change
  - Expert workshop (Aug. 2020): 18 attendees from 8 countries

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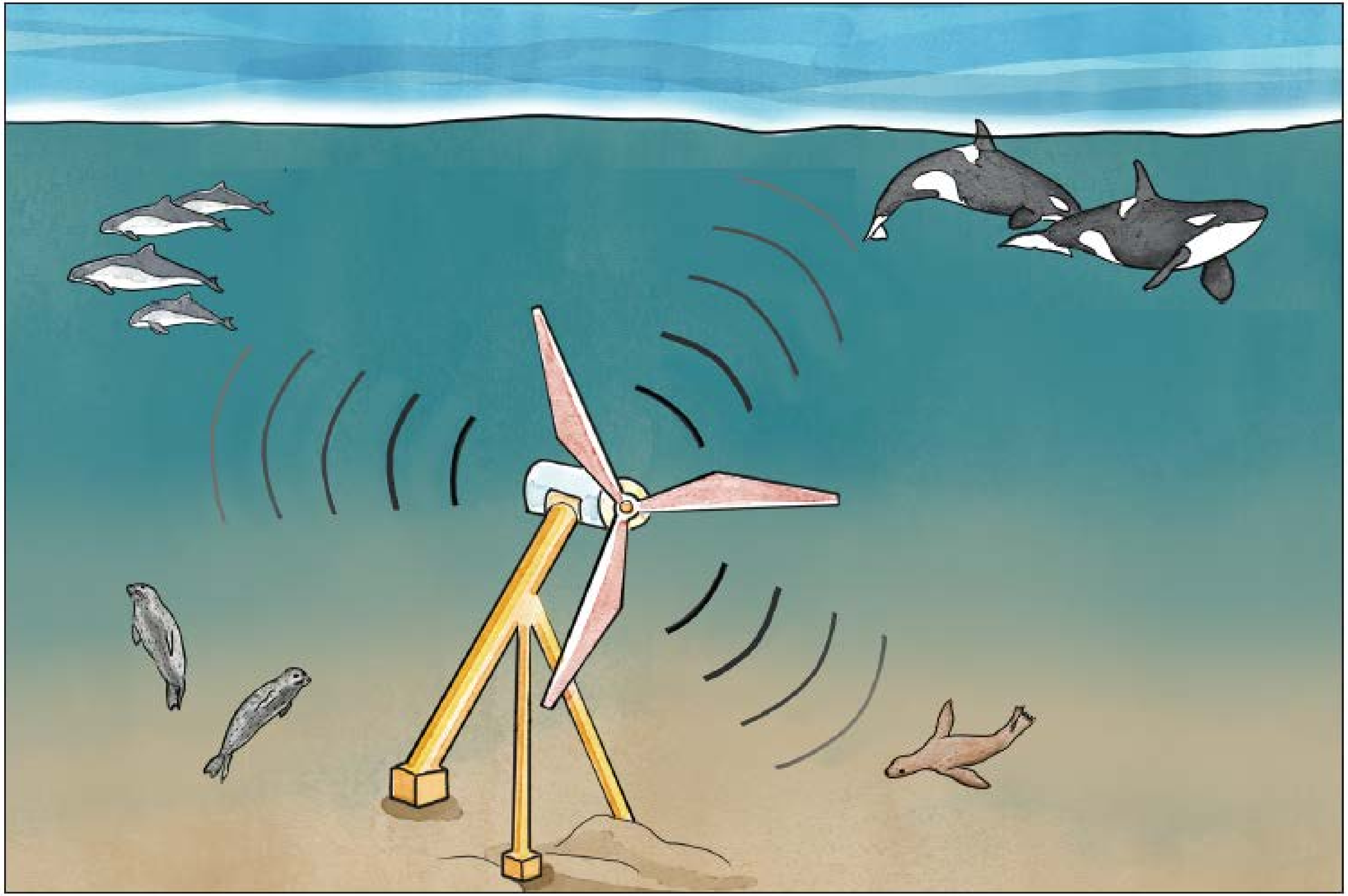
Risk Retirement:

Underwater Noise

https://tethys.pnnl.gov/underwater-noise-evidence-base

Underwater Noise



Regulatory Thresholds and Measurements

U.S. Thresholds

- Marine Mammals: NOAA Technical Guidance (2018)
  - Temporary and permanent impacts to hearing found from noise 153 db and higher, based on the animal
- Fish: NOAA Fisheries and BOEM Underwater Acoustic Modeling Report (2013)
  - Physical and behavioral effects found from noise 150 db and higher

International Specifications

- IEC TC 114 Technical Specification 62600-40:2019 provides methods and instrumentation to characterize sound near MRE devices

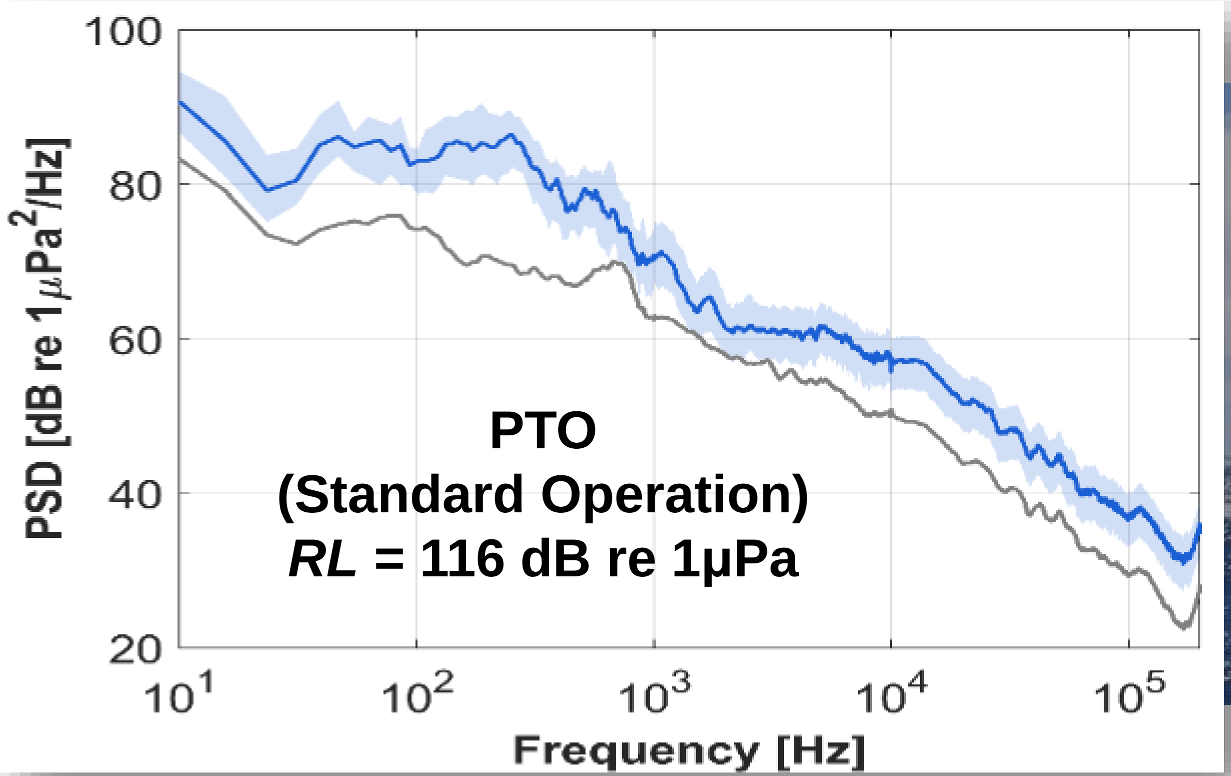
Noise Measurements from MRE Devices

Project	Device	Noise measurements	Conclusion	Relation to U.S. underwater sound threshold	Reference
Verdant Power Roosevelt Island Tidal Energy Project (RITE) (New York, U.S.; 2006-2008)	Tidal turbine array	Operational noise of the array, which included six bottom mounted turbines, was up to 145 re 1 µPa at 1 m from the array.	More noise was output than expected due to a broken blade on one turbine and another failing turbine.	Remains under threshold for broadband sound	Verdant Power (2010)
WaveRoller at WavEc (Peniche, Portugal; 2012- 2014)	WEC	Operational noise of bottom-mounted oscillating wave surge converter prototype peaked at 121 dB re 1µPa. Average broadband sound pressure level (SPL) measured with Hydrophone 2 varied between 115 and 126 dB re 1 µPa rms and with Hydrophone 1 between 115 and 121 dB re 1 µPa rms. SPL values decreased over time. The noise decreased within 300 m of the device.	Calculating the sound exposure level (SEL) of the WaveRoller sound, which is150 dB re 1µPa2 -s, shows that no injury to cetaceans is expected. The results indicate that the frequency ranges at which the device operates overlap those used by some low and midfrequency cetaceans, but only behavioral responses would be expected if the organisms swim near the WaveRoller. Additionally, no cetaceans were around the WaveRoller device, likely due to the low depth where the device was installed.	Remains under threshold for broadband sound	Cruz et al. (2015)
EDF and DCNS Energies OpenHydro (Paimpol Brehat, France; 2013 – 2014)	Tidal turbine	SPL ranged from 118 to 152 dB re1 µPa at 1 m in thirdoctave bands at frequencies between 40 and 8192 Hz, which were measured at distances between 100-2400 m from the turbine. The acoustic footprint of the device corresponds to a 1.5 km radius disk.	Physiological injury of marine mammals, fish, and invertebrates is improbable within the area of greatest potential impact. Permanent threshold shifts (PTS) and temporary threshold shifts (TTS) risks are non-existent for all target species. Behavioral disturbance may occur up to 1 km around the device for harbor porpoises only but is of little concern for a single turbine.	Remains under threshold for broadband sound	Lossent et al. (2018)
Minesto AB Tidal Kite (Strangford Narrows, Northern Ireland; 2016)	Tidal kite	Sound levels for the ¼ scale tidal kite tested at different speeds ranged from 70 dB re µPa at the lowest frequencies up to a peak of around 105 dB re µPa at 500 Hz.	Sound levels remain below thresholds for marine mammals and fish.	Remains under threshold for broadband sound	Schmitt et al. (2018)
Fred. Olsen Bolt Lifesaver at US Navy Wave Energy Test Site (WETS) (O'ahu, U.S.; 2016-2018)	WEC	Operational noise of floating point absorber wave device was 114 dB re 1µPa for median broadband SPL and mean levels as high as 159 dB re 1µPa were infrequently observed. At one point during the study, the WEC had a damaged bearing, which coupled with the operational noise reached 124 dB re 1µPa.	Operational noise levels remained below acceptable thresholds. Received levels exceeded the U.S. regulatory threshold for auditory harassment of marine mammals (broadband level of 120 dB re 1µPa) for only 1% of the deployment. These exceedance events are dominated by nonpropagating flow noise and sources unrelated to the Lifesaver	Operational sounds from device remain under threshold for broadband sound	Polagye et al. (2017)

(Copping et al. 2020)

Fred. Olsen Lifesaver at WETS

- Hawai’i Wave Energy Test Site (WETS), O’ahu, HI, U.S.
- Floating point absorber with a shallow draft (0.5 m)
- Noise measurements (2016):
  - 3 seabed-mounted hydrophones (3 months)
  - 2 drifting hydrophones (3 drifts)



(Polagye et al. 2017, EWTEC)

Underwater Noise Feedback

Consensus

- Participants found the risk retirement pathway intuitive and easy to navigate
- Participants agreed that the risk could be retired for single devices or small arrays

Knowledge Gaps

- Understand how marine animals use the habitat surrounding a device and how they might behave in response to underwater noise from the device
- Verify noise propagation models for large arrays
- Assess cumulative effects

Recommendations

- Need a library of standardized noise measurements produced by MRE
- Test centers could play key role in measuring underwater noise under operation

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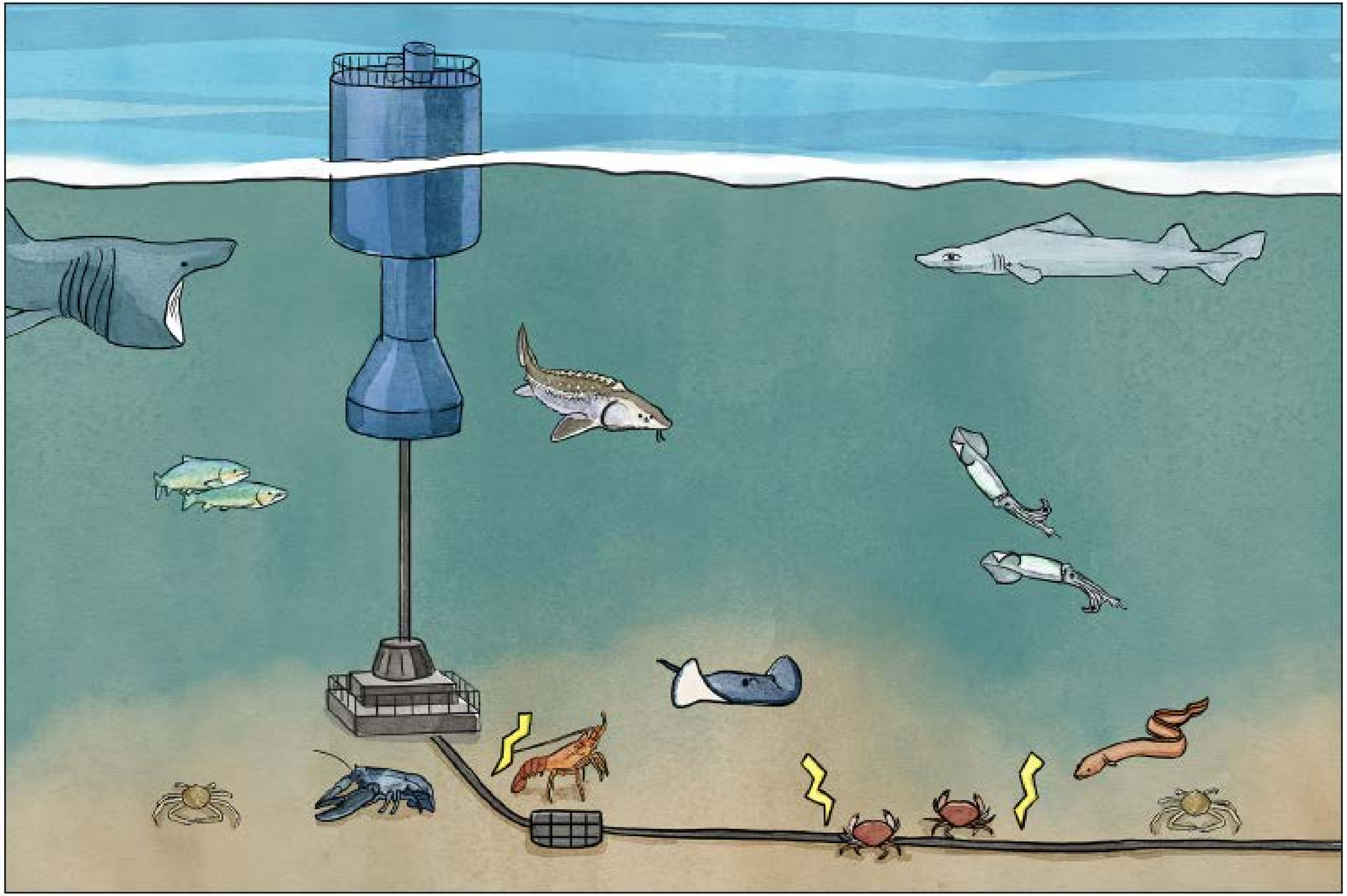
Risk Retirement:

Electromagnetic Fields

https://tethys.pnnl.gov/emf-evidence-base

Electromagnetic Fields (EMFs)



EMF Measurements from Subsea Cables

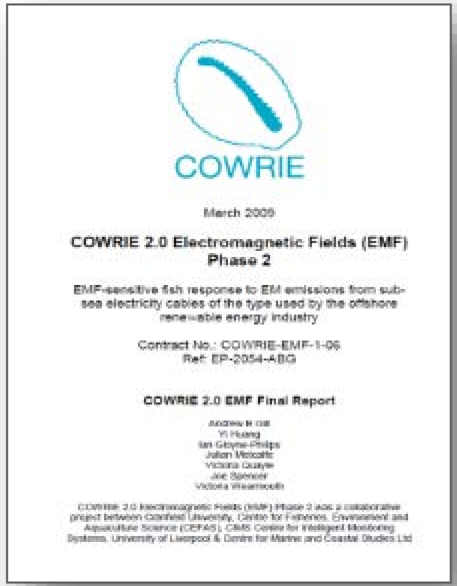
Cable	Current	Location	Magnetic field (B-field)	Electric field (E-field)	Extent EMF	Reference
2 - 2.4 amps 0.98 - 1.59 amps, 60 Hz	DC AC	South Florida (U.S.)	Max: 150 µT Mean: 30 nT 2.2 m above seafloor	Max: 60 µV/m 4 m above cable	10s m (estimated) AC > DC	Dhanak et al. et al. (2016)
Trans Bay Cable (200 kV, 400 MW, 85 km)	DC	San Francisco Bay, California (U.S.)	1.15 - 1.2 µT 3 m above seafloor	n/a	<40 m	Kavet et al. (2016)
Basslink (500 kV, 237 MW, 290 km)	DC	Bass Strait, Tasmania (Australia)	58.3 µT	5.8 µV/m	15 - 20 m	Sherwood et al. (2016)
Cross Sound (300 kV, 330 MW, 40 km)	DC	Connecticut (U.S.)	DC: 0.4 - 18.7 µT AC: max 0.15 µT	AC: max: 0.7 mV/m	AC-DC B-fields: 5 - 10 m	Hutchison et al. (2018)
Neptune (500 kV, 660 MW, 105 km)	DC	New Jersey (U.S.)	DC: 1.3 - 20.7 µT AC: max 0.04 µT	DC: 0.4 mV/m	AC: max: E-fields up to 100 m	Hutchison et al. (2018)
Sea2shore (502 amps, 30 MW, 32 km)	AC	Rhode Island (U.S.)	0.05 - 0.3 µT	1-25 µV/m	AC: B-field up to 10 m AC: E-field up to 50 m (estimated)	Hutchison et al. (2018)

(Copping et al. 2020)

EMF Evidence Base

EMF-sensitive fish response to EM emissions from subsea electricity cables (Gill et al. 2009)

- West Scotland, 2007, 125 kV AC cable buried 0.5-1m
- Mesocosms with energized and control cables (3 trials)
- Rays and Catsharks (Dogfish) responded to EMFs from cable
- No evidence of positive or negative effect on elasmobranchs


COWRIE

March 2009

COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2

EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry

Contract No.: COWRIE-EMF-1-06
Ref: EP-2054-ABG

COWRIE 2.0 EMF Final Report

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COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2 was a collaborative project between Cranfield University, Centre for Fisheries, Environment and Aquaculture Science (CEFAS), CMS Centre for Intelligent Monitoring Systems, University of Liverpool & Centre for Marine and Coastal Studies Ltd

Sub-sea power cables and the migration behaviour of the European eel (Westerberg and Lagenfelt 2008)

- East Sweden, 2006, unburied 130 kV AC cable
- Used acoustic tags to track movements of 60 eels
- Eels swam more slowly over energized cable
- Effect was small, no evidence of barrier effect


Fisheries Management and Ecology

Sub-sea power cables and the migration behaviour of the European eel

H. WESTERBERG & I. LAGENFELT

EMF Evidence Base

EMF impacts on elasmobranch and American lobster movement and migration from direct current cables [(Hutchison et al. 2018)]

- NE U.S., 2016, 10m deep, buried 300 kV DC cable
- Enclosures with animals using acoustic telemetry tags
- Lobster – statistically significant, but subtle change in behavior
- Skate – strong behavioral response, results suggested an increase in exploratory activity and/or area restricted foraging behavior with EMF
- EMF from cable didn’t act as a barrier to movement for either species

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EMF Feedback

Consensus

- Participants agreed that the risk could be retired for single devices or small arrays
- Level of power carried in MRE cables is very small compared to offshore wind farms

Knowledge Gaps

- Field measurements of EMFs needed to improve and validate models
- Increased understanding of how EMF emissions vary with cable configuration and power variability
- Risks associated with offshore substations and vertical and draped cables

Recommendations

- Work with MRE industry to help regulators understand that risk will be minimal
- Larger deployments may still require measurements to be taken

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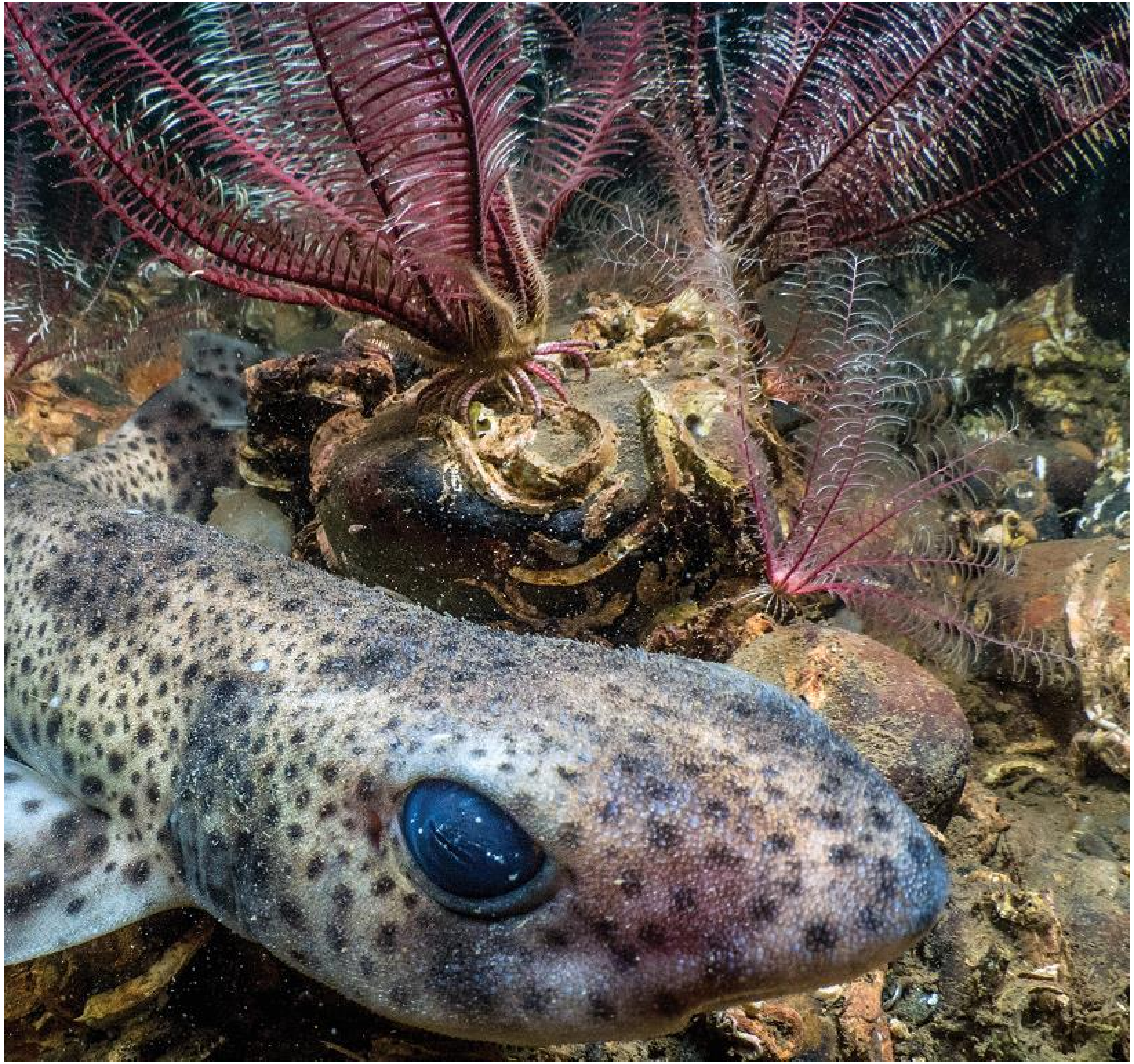
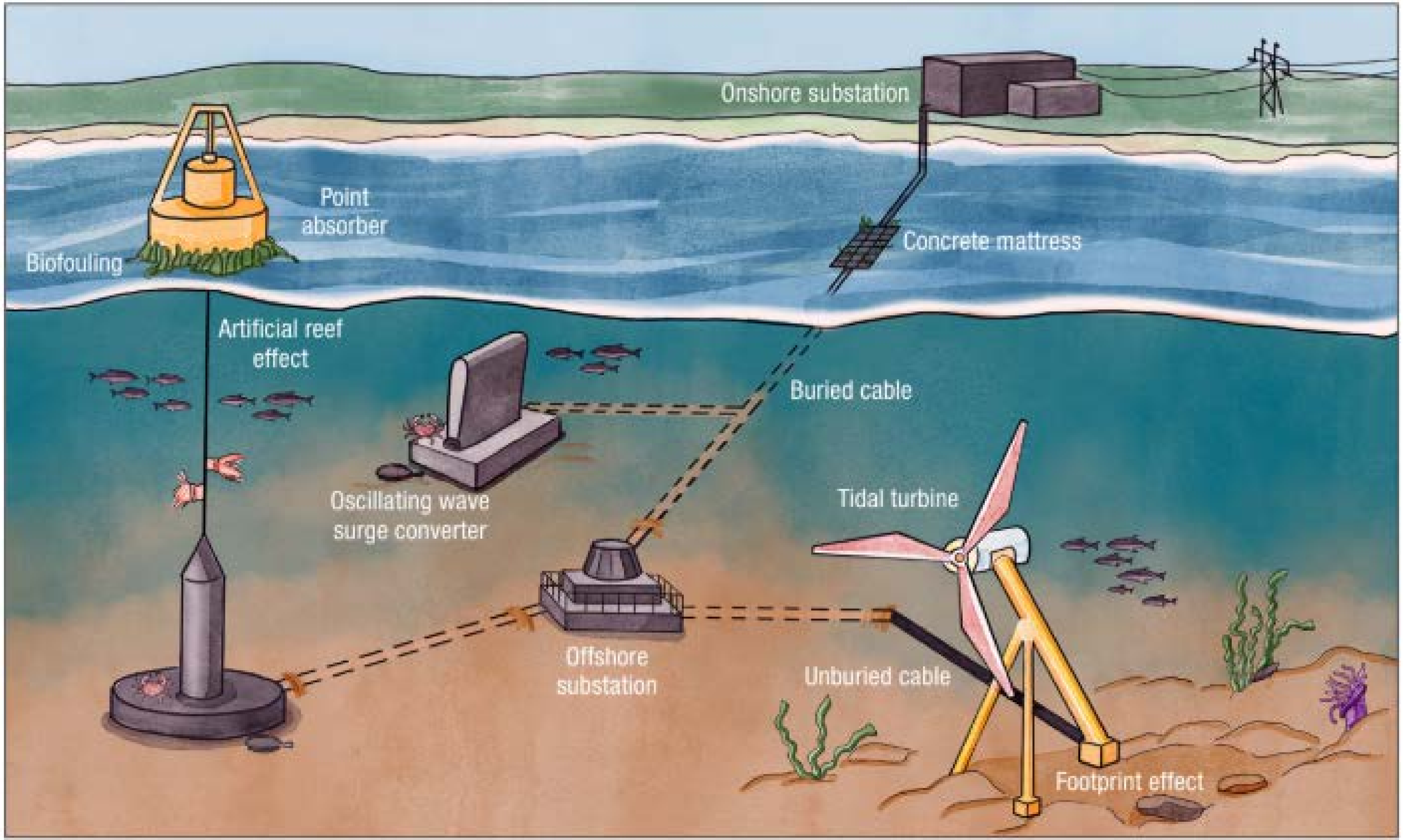
Risk Retirement:
Habitat Changes

https://tethys.pnnl.gov/habitat-change-evidence-base



Habitat Changes



Habitat Change Evidence Base

Effects of Device Installation / Removal on Benthos

SeaGen Tidal Turbine (Keenan et al. 2011)

- 50% of the visible surface area of the device had been colonized after 2 years (37.6m^2)
- This surpasses the area that was removed from the footprint due to installation (36.3m^2)

Habitat Change Evidence Base

Changes in Community Composition On and Near Device

Orkney Fouling Communities (Want et al. 2017)

- MRE devices were not colonized by invasive species (though they do experience biofouling)
- Harbors / marinas and MRE test sites have different biofouling compositions

Habitat Change Evidence Base

Artificial Reef Effect

Review of surrogates for MRE, U.S. West Coast and Hawai’i (Kramer et al. 2015)

- MRE devices are expected to function as small-scale reefs, with variation based on geographic location
- Negative effects on special status fish species due to increased predation are not likely

Habitat Changes Feedback

Consensus

- Most participants agreed that risks associated with installation/removal and changes in community composition could be retired for single devices or small arrays
- Concerns about effects should not prevent installation or further study

Knowledge Gaps

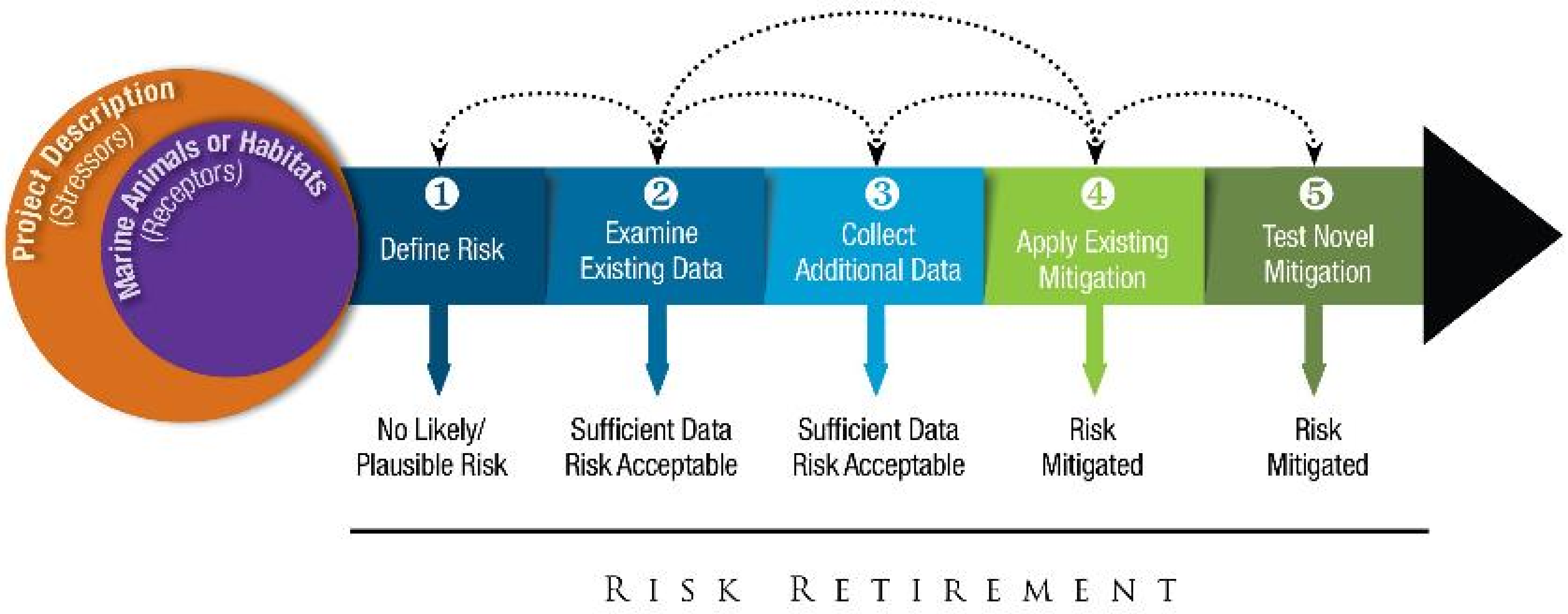
- Decommissioning and removal of devices
- Biofouling and non-native species
- Colonization patterns in high-energy tidal environments

Recommendations

- Continue monitoring programs to improve understanding
- Collect quality, long-term data to prepare for scaling up to arrays
- Establish guidelines, standard mitigation, and frameworks for monitoring
- Require identification of baseline conditions and species present

Summary

- Risk retirement, and data transferability, aim to assist regulators in decision-making, distinguishing between perceived and actual risk, and accessing available data
- Based on feedback:
  - Risk from underwater noise and EMF can be retired for single devices or small arrays
  - Some aspects of habitat change can be retired for single devices or small arrays
  - Additional discussions may be needed to consider all risks from habitat change retired
- More data and information needed to consider risk retirement for other stressors, especially collision risk



Next Steps

- Developing risk retirement guidance documents
  - Used to support consenting of small MRE projects
  - Guide application of data transferability in consenting processes
  - Create country specific documents for OES-Environmental
- Risk retirement for changes in oceanographic systems
  - Developing a white paper – evidence base and potential for risk retirement
  - Work with experts to understand on risk retirement

OES-Environmental

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OES-Environmental Nations

- Australia
- Canada
- China
- Denmark
- France
- India
- Italy
- Japan
- Sweden
- Portugal
- South Africa
- Spain
- Sweden
- United Kingdom
- United States

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Thank You!

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Feedback Survey:

https://www.surveymonkey.com/r/risk-retirement

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