

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Synthesis of Climate Change Sensitivity and Information Gaps in Priority Management Areas of the Outer Continental Shelf (OCS)
Administered by	Office of Environmental Programs
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Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	May 10, 2023
Problem	Climate change is altering abiotic conditions throughout the OCS including for sensitive habitats and species of special interest to all BOEM programs and regions. It is challenging for environmental assessments to thoroughly evaluate potential climate change impacts in the deeper waters of the OCS where less information is readily available.
Intervention	This study will compile, synthesize, and evaluate existing information on climate change-related changes and impacts in OCS environments within the BOEM management context, particularly impacts associated with sensitive species and habitats.
Comparison	Without this study, BOEM’s subject matter experts (SMEs) will not have access to the proposed “one-stop,” easily accessible, synthesized and relevant information resources designed to support BOEM assessment and management needs related to climate change-related effects and impacts in OCS environments.
Outcome	This study will expand knowledge and fill in information and data gaps related to climate change in OCS environments. Information will be synthesized to create several specific resource deliverables SMEs can use for management decision making and planning of future research.
Context	The scope and results of this study span all BOEM regions and programs with results useful for all BOEM-managed activities. The focus will be on OCS environments where these activities occur, with particular emphasis on deeper waters that are relatively understudied by climate change scientific research.

BOEM Information Need(s): Climate change has far-reaching impacts that can have a variety of consequences for marine environments. Information on climate change is needed to inform BOEM’s assessments and evaluations of impacts in areas of BOEM-managed activities and for sensitive species and habitats of interest. The study will focus on the OCS and directly address areas and resources of concern for BOEM. This study’s deliverables will contribute to more effective assessments and

consultations, also helping to address current information gaps and inform best management practices (BMPs) and future research needs. As climate change effects are expected to magnify over time, the information will be of particular importance for accurately and more precisely estimating the cumulative effects of BOEM-managed activities on the OCS. Species-, population-, and habitat-level impacts of climate changes need to be better understood for BOEM analyses, including to better assess proposed actions, evaluate appropriate alternatives and mitigation measures, accurately assign impact levels, and inform future operational management decisions.

The information collected and synthesized will allow for more informed resource-management decisions for BOEM-regulated offshore wind, oil and gas, marine minerals, and carbon sequestration activities throughout the OCS. It will inform numerous national and/or programmatic efforts, a variety of National Environmental Policy Act sections, Tribal consultations, and Coastal Zone Management Act consistency determinations. The study will also contribute to BOEM's ability to meet its responsibilities under the Federal Ocean Acidification Research and Monitoring Act (FOARAM 2009) and Executive Order 14008.

Background: Climate change and its effects are a growing concern for marine environments, and such effects are increasingly being observed in deeper ocean waters (Sweetman et al. 2017) such as those deeper than the photic zone. Despite this, until recent years there has been relatively limited research into characterizing climate change-related effects such as ocean acidification, deoxygenation, temperature changes, ocean circulation changes, and other parameters in deeper waters and associated habitats. Key climate change documents such as the IPCC Sixth Assessment Report (IPCC 2021) and UN World Ocean Assessment II (United Nations 2021) do not focus on or adequately address climate change in deeper waters (Levin 2021). Information that does exist is located across disparate sources and often not specifically focused on BOEM's areas of activities or resources of interest, with much of the current knowledge specific to relatively shallow marine habitats such as tropical coral reefs.

Climate change can have both indirect and direct impacts on fauna and sensitive habitats, with effects on individual species populations and wider ecosystem integrity and connectivity. Climate change can disproportionately affect certain sensitive marine species, prey, and habitats. Ecologically important biogenic habitats such as those formed by cold-water corals (actively protected by BOEM) are at risk because climate change affects their environmental conditions. Cold-water coral habitats are being increasingly exposed to acidified conditions, with live corals showing reduced calcification and coral skeletons becoming eroded (Maier et al. 2008, Lunden et al. 2014, Hennige et al. 2020). Deeper marine areas serve as global carbon reservoirs, accumulating carbon from ocean uptake of anthropogenic carbon dioxide (CO₂) at the surface and subsequent circulation to deep water. This is leading to shifts of the aragonite saturation horizon, which is the depth at which corals may be vulnerable to dissolution (Zheng and Cao 2014, Perez et al. 2018). Within the century, most current cold-water coral habitats could be beneath the aragonite saturation horizon (Guinotte et al. 2008). Regional- or global-scale climate change impacts on foundational, habitat-forming species can potentially have even further reaching effects on the other benthic and pelagic species that are dependent on them.

Objectives: The objectives of this study are to:

- Identify habitats and/or species of concern in areas of the OCS where BOEM-managed activities occur that may potentially be affected by climate change. Identify types and extent of climate change potential impacts on those habitats or species and associated prey based on the current state of knowledge.

- Compile and synthesize information on climate change effects in areas of BOEM-managed activities and for sensitive habitats/species to create resources for BOEM SMEs.
- Determine BOEM management-focused data and information gaps related to climate change that need addressing, also aiming towards building future interagency and non-federal partnerships to collectively coordinate and conduct field-based focused data collection studies.
- Provide recommendations on how climate change information can be incorporated into BOEM environmental analyses and assessments. Provide recommendations for future study needs and BMPs related to climate change, within the specific context of BOEM-managed areas.

Methods: This study will enable a better understanding of the data and information that are available related to climate change effects in the OCS, as well as potential impacts to ecosystems. Emphasis will be placed on waters deeper than the photic zone and/or depths of ≥ 200 m, with exceptions made, where applicable, to accommodate region-specific sensitive habitat variations. Such exceptions will be made in consultation with BOEM SMEs based on agency needs. This study will include multiple parts:

- Part 1: Compile a scientific literature review and written synthesis report about climate change in relation to key resources in OCS environments where BOEM-managed activities occur. The study will focus on compiling existing information and data. Examples of information include types of potential climate change effects and related geochemical or biological parameters; impacts of climate change on OCS habitats; approaches for measuring parameters and effects; best practices; and more. The scope will be guided by BOEM and other federal SMEs.
- Part 2: Identify information and data gaps related to climate change in OCS environments that warrant further investigation by BOEM and its partners.
- Part 3: Develop recommendations for future research that is needed for BOEM to better understand climate change in OCS environments in the BOEM management context, including what should be researched and approaches that should be used. This may include recommendations for topics and geographies for future field-based studies to conduct that would include new sampling and analysis needed to address identified data gaps.
- Part 4: Develop a set of BMPs for BOEM's assessment and operational considerations related to climate change with the goal of integrating information into existing BOEM SME resources.

Specific Research Question(s):

1. What information and data are currently available about climate change effects in areas of the OCS where BOEM-managed activities occur?
2. What are the potentially affected habitats, organisms, and associated resources of concern and potential short- and long-term effects on them?
3. Are specific species/habitats likely to be disproportionately affected by specific climate change-driven factors (e.g., change in aragonite levels) and how?
4. How can BOEM and others address identified information/data gaps regarding climate change in deeper waters of the OCS (e.g., specific recommended future field work and BMPs)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

- Guinotte JM, Orr JC, Cairns S, Freiwald A, Morgan L, George RY. 2006. Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals? *Front. Ecol. Environ.* 4:141–146. doi: 10.1890/1540-9295(2006)004[0141:whcisc]2.0.co;2
- Hennige SJ, Wolfram U, Wickes L, Murray F, Roberts JM, Kamenos NA, Schofield S, Groetsch A, Spiesz EM, Aubin-Tam M-E, et al. 2020. Crumbling reefs and cold-water coral habitat loss in a future ocean: evidence of “coralporosis” as an indicator of habitat integrity. *Front. Mar. Sci.* 7. <https://doi.org/10.3389/fmars.2020.00668>
- IPCC. 2021. *Climate Change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte V, Zhai P, Pirani A, Connors SL, Péan C, Berger S, Caud N, Chen Y, Goldfarb L, Gomis MI, et al. editors]. Cambridge University Press. In Press.
- Lawman AE, Dee SG, DeLong KL, Correa AMS. 2022. Rates of future climate change in the Gulf of Mexico and the Caribbean Sea: implications for coral reef ecosystems. *JGR Biogeosciences.* 127(9). <https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2022JG006999>
- Levin L. 2021. IPCC and the deep sea: a case for deeper knowledge. *Front. Clim.* 27. <https://doi.org/10.3389/fclim.2021.720755>
- Lunden JJ, McNicholl CG, Sears CR, Morrison CL, Cordes EE. 2014. Acute survivorship of the deep-sea coral *Lophelia pertusa* from the Gulf of Mexico under acidification, warming, and deoxygenation. *Front. Mar. Sci.* 19(1). <https://doi.org/10.3389/fmars.2014.00078>
- Maier C, Hegeman J, Weinbauer MG, Gattuso JP. 2009. Calcification of the cold-water coral *Lophelia pertusa*, under ambient and reduced pH. *Biogeosciences.* 6:1671–1680. <https://doi.org/10.5194/bg-6-1671-2009>
- Perez F, Fontela M, García-Ibáñez M, Mercier H, Velo A, Lherminier P, Zunino P, de la Paz M, Alonso-Pérez F, Guallart EF, et al. 2018. Meridional overturning circulation conveys fast acidification to the deep Atlantic Ocean. *Nature.* 554:515–518. <https://doi.org/10.1038/nature25493>
- Sweetman AK, Thurber AR, Smith CR, Levin LA, Mora C, Wei C-L, Gooday AJ, Jones DOB, Rex M, Yasuhara M, et al. 2017. Major impacts of climate change on deep-sea benthic ecosystems. *Elementa: Science of the Anthropocene* 5(4). doi: <https://doi.org/10.1525/elementa.203>
- United Nations (2021). *The Second World Ocean Assessment*, United Nations. <https://doi.org/10.18356/9789216040062>
- Zheng M-D, Cao L. 2014. Simulation of global ocean acidification and chemical habitats of shallow- and cold-water coral reefs. *Adv. Climate Change Res.* <https://doi.org/10.1016/j.accre.2015.05.002>