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Pacific Islands Water Science Center

The Hawai‘i Volcanic Aquifer Study

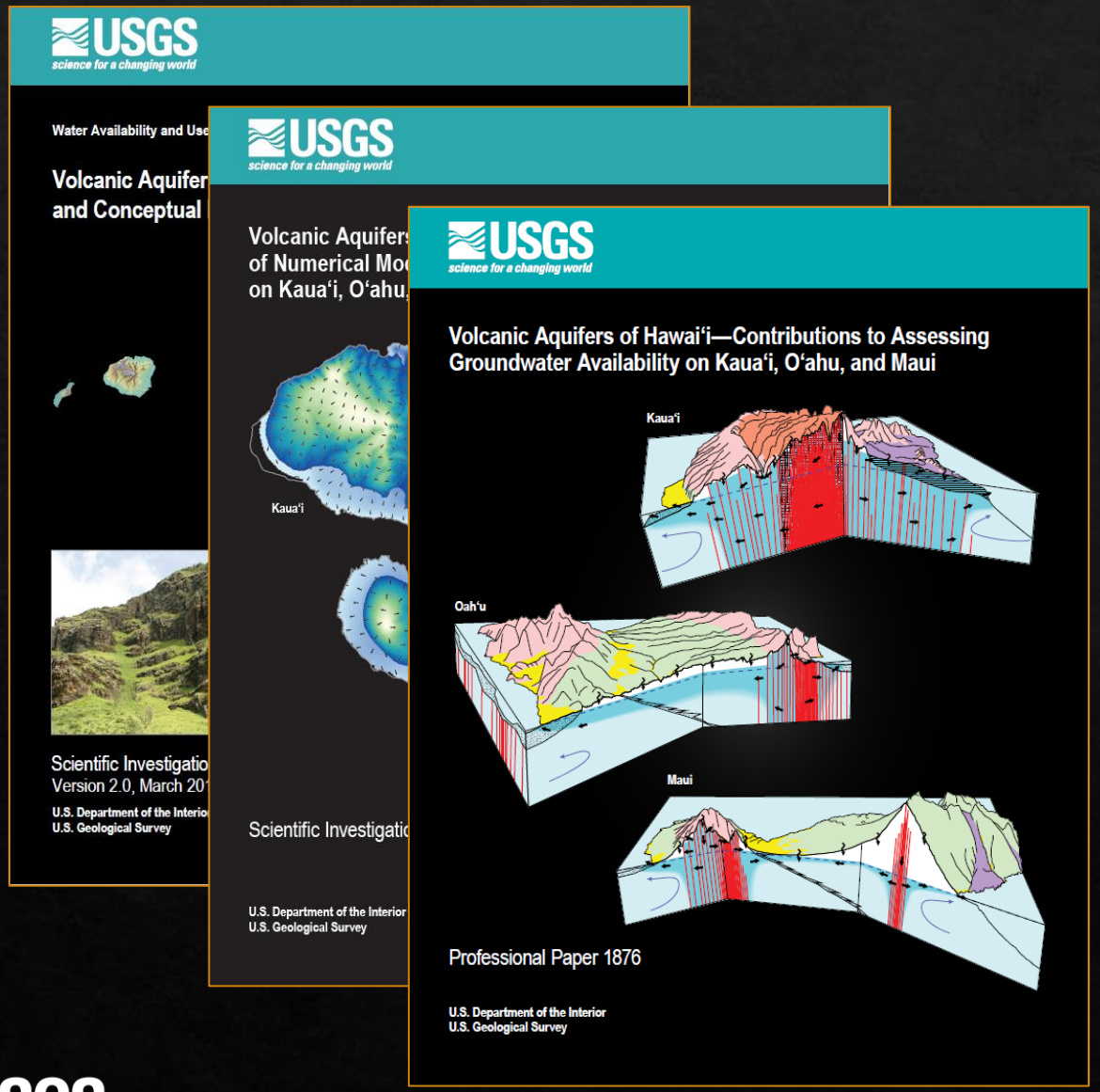
Assessing Groundwater Availability in Hawai‘i

Scot Izuka, U.S. Geological Survey

Presented to the State of Hawai‘i Commission on Water Resource Management, Honolulu, Hawai‘i, July 26, 2023

U.S. Department of the Interior
U.S. Geological Survey

Hawai‘i Volcanic Aquifer Study



Izuka, S.K., Engott, J.A., Rotzoll, K., Bassiouni, M., Johnson, A.G., Miller, L.D., and Mair, A., 2018, Volcanic aquifers of Hawai‘i—Hydrogeology, water budgets, and conceptual models (v. 2.0): USGS Scientific Investigations Report 2015–5164, https://doi.org/10.3133/sir20155164

Izuka, S.K., Rotzoll, K., and Nishikawa, T., 2021, Volcanic aquifers of Hawai‘i—Construction and calibration of numerical models for assessing groundwater availability on Kaua‘i, O‘ahu, and Maui: USGS Scientific Investigations Report 2020–5126, https://doi.org/10.3133/sir20205126

Izuka, S.K., and Rotzoll, K., in press, Volcanic aquifers of Hawai‘i—Contributions to assessing groundwater availability on Kaua‘i, O‘ahu, and Maui: USGS Professional Paper 1876. https://doi.org/10.3133/pp1876 (**NEW**)

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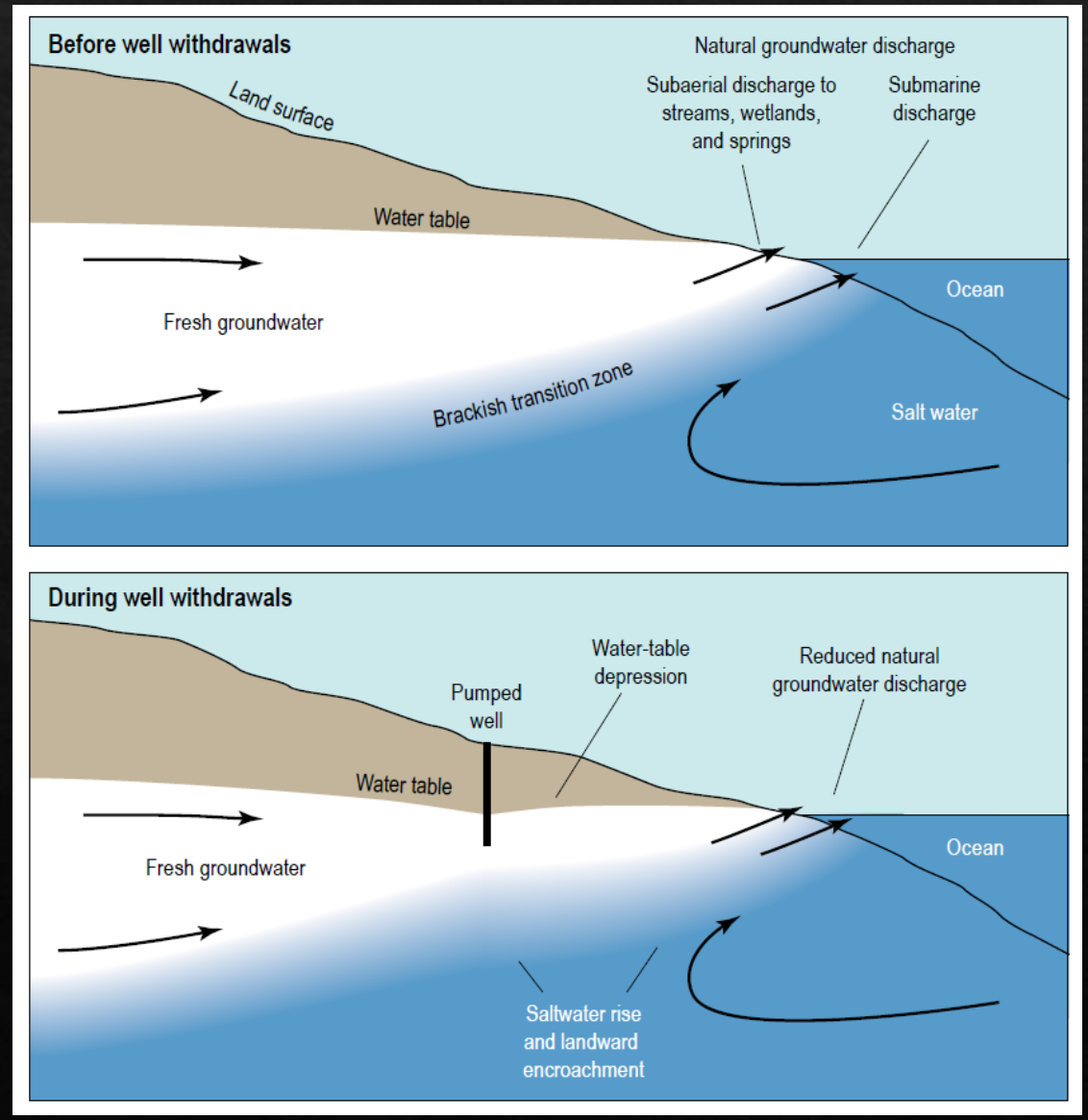
How Much Groundwater is Available?

All groundwater withdrawals have consequences

- **Water-table decline**
- **Saltwater rise, encroachment**
- **Reduction of groundwater discharge to springs, streams, wetlands, and ocean**

Groundwater availability depends on the severity of consequences a community is willing to accept



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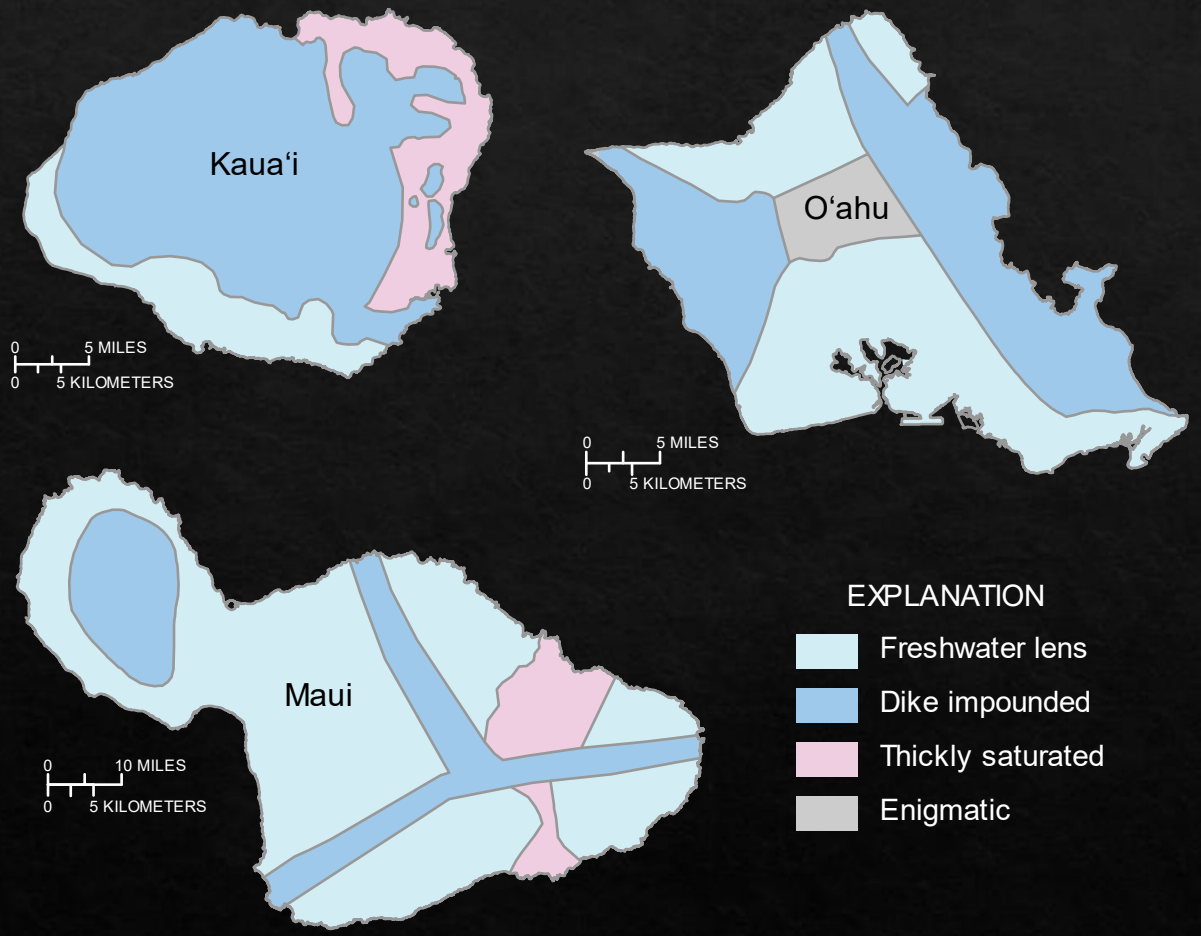
Consequences Differ by Hydrogeologic Setting



Principal hydrologic settings in Hawai‘i

- **Freshwater (“basal”) lens**
- **Dike-impounded groundwater**
- **Thickly saturated aquifers**
- **Perched groundwater**
- **Enigmatic**

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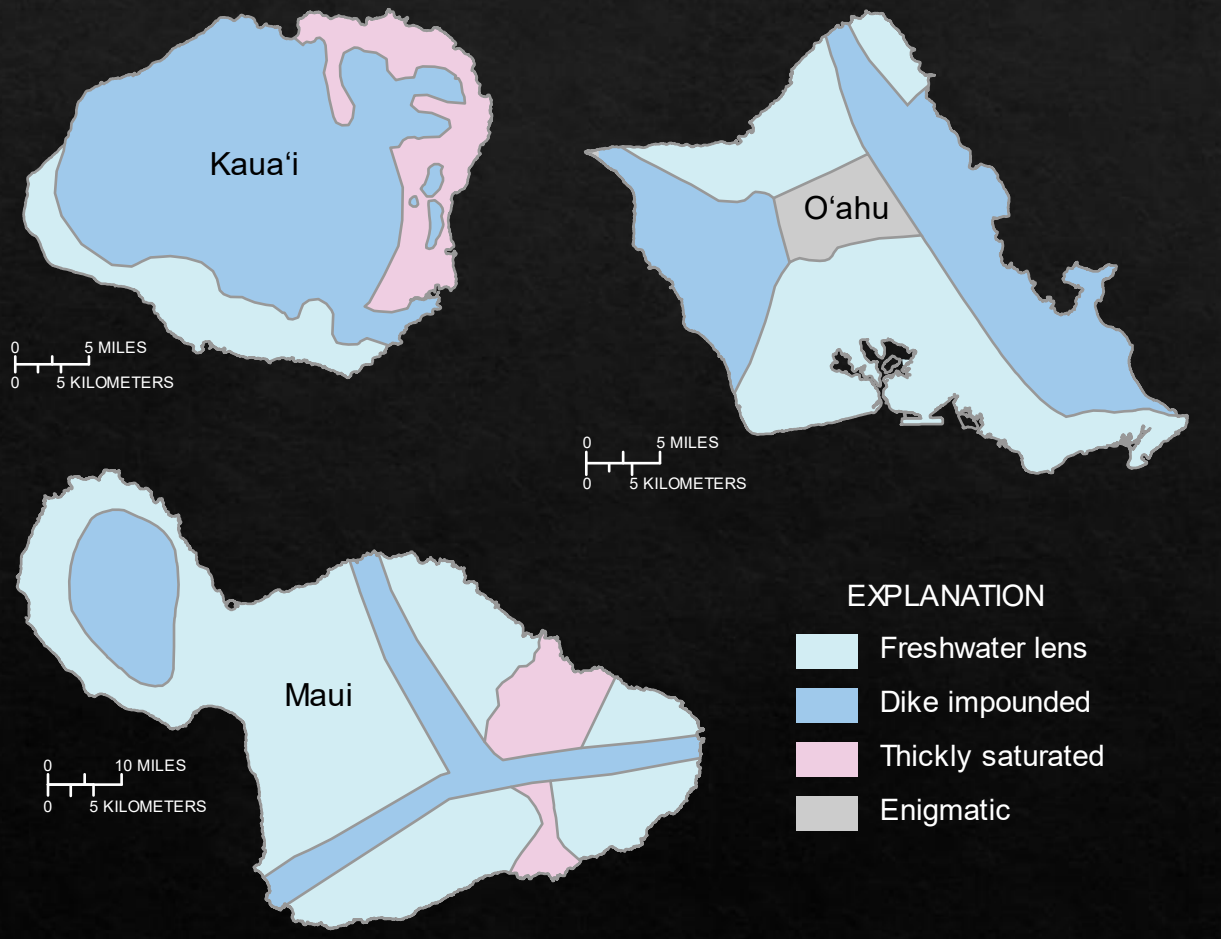
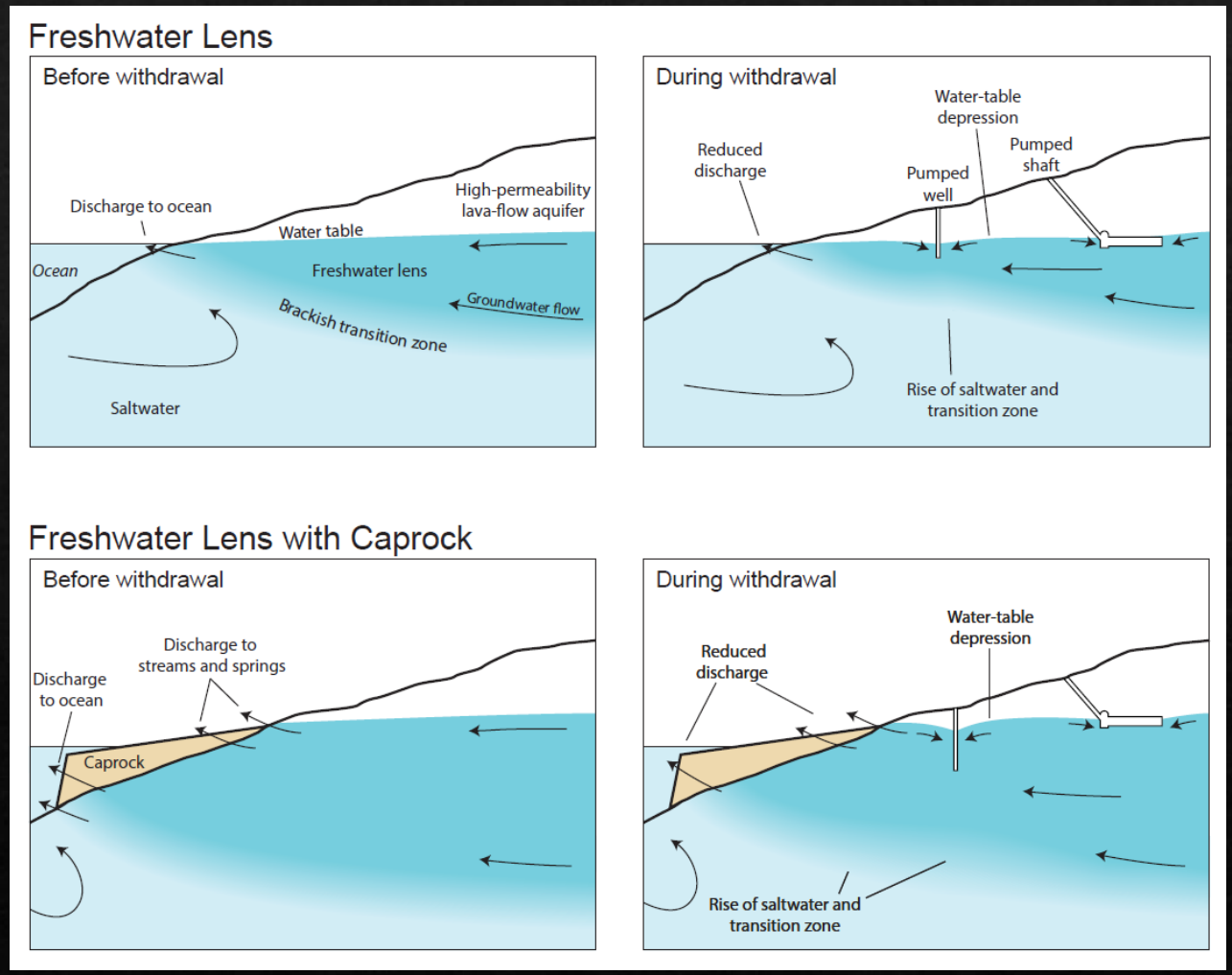
Freshwater (Basal) Lens





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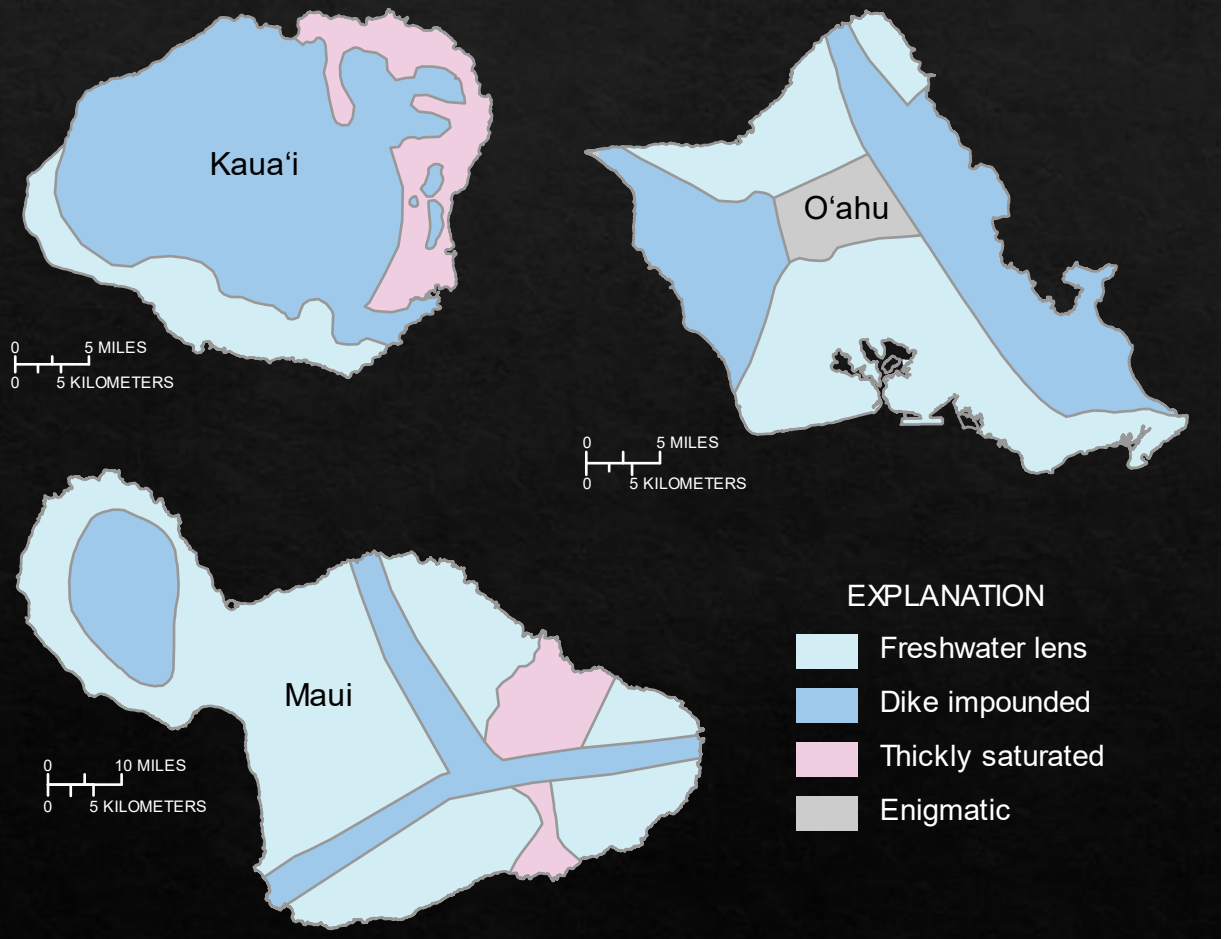
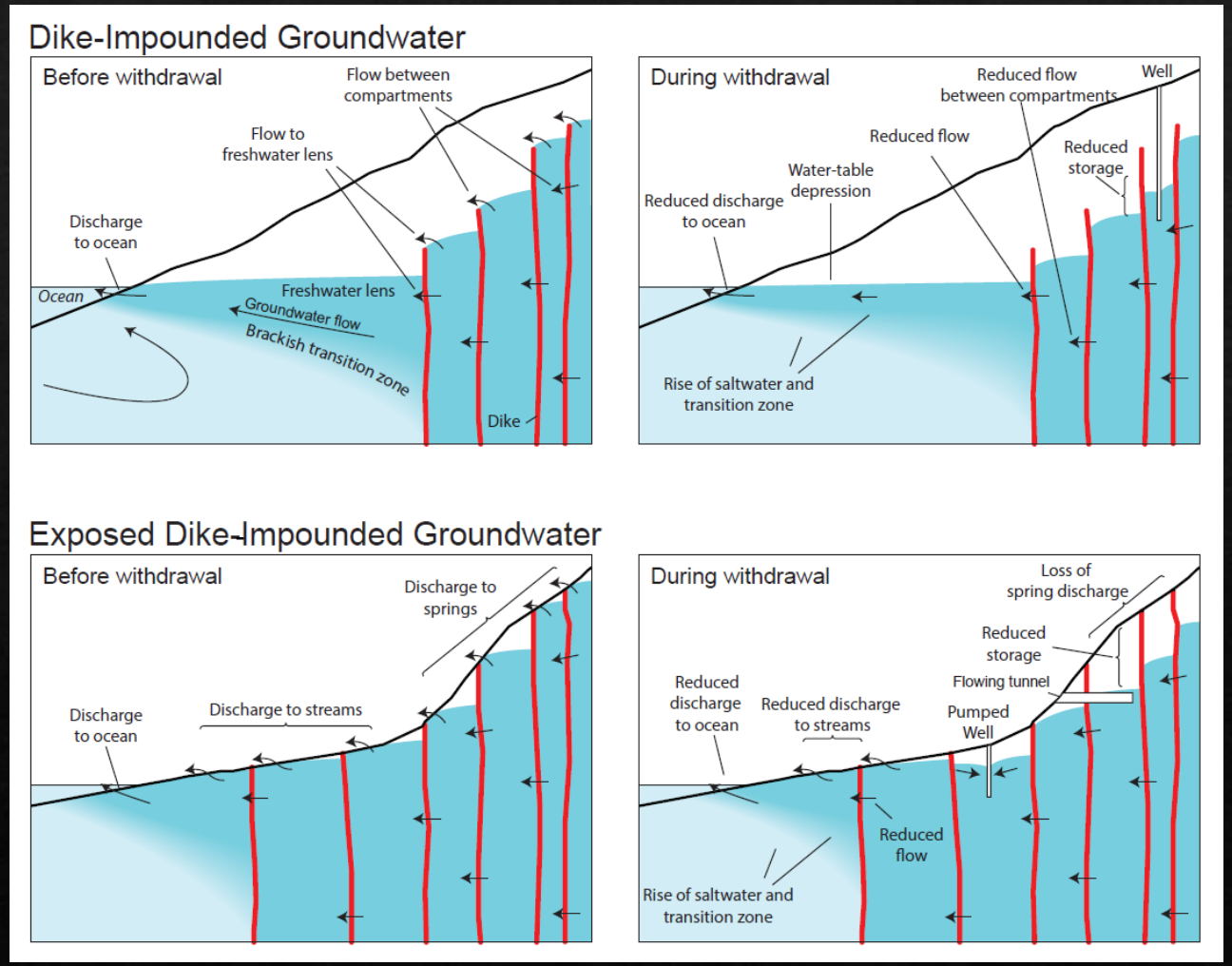
Preliminary Information-Subject to Revision. Not for Citation or Distribution.

Dike-Impounded Groundwater





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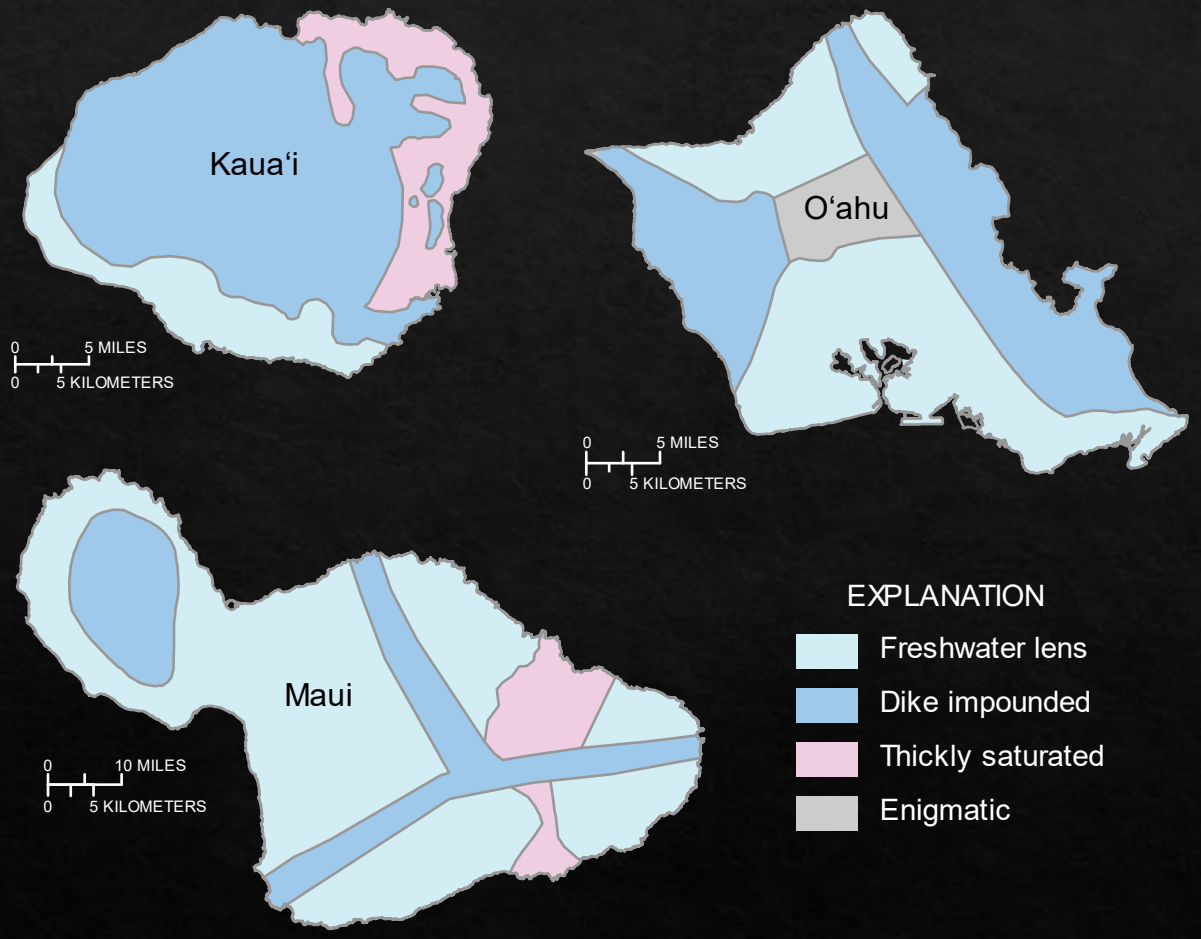
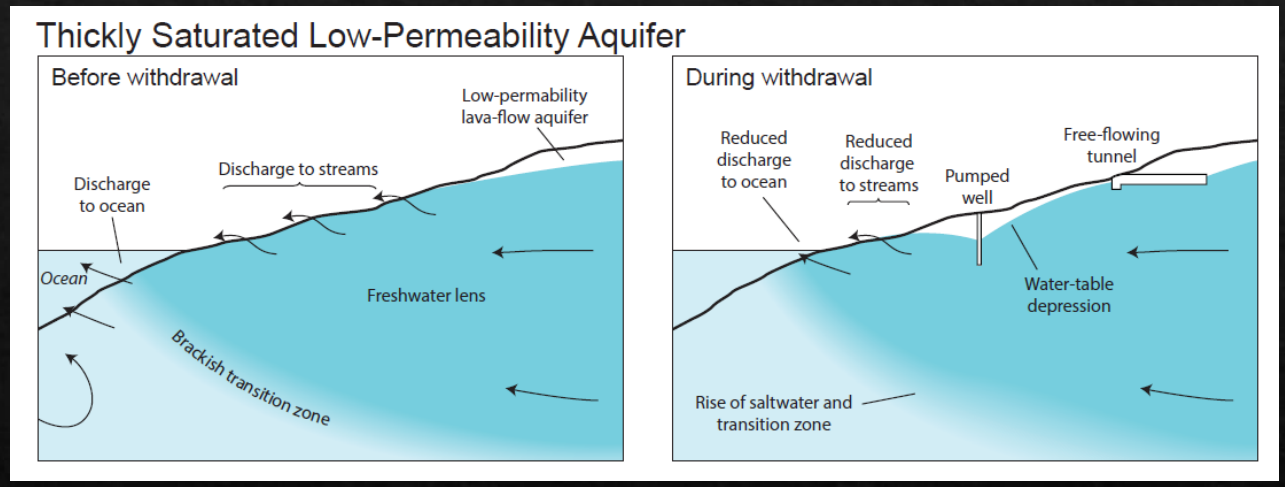
Thickly Saturated Aquifers





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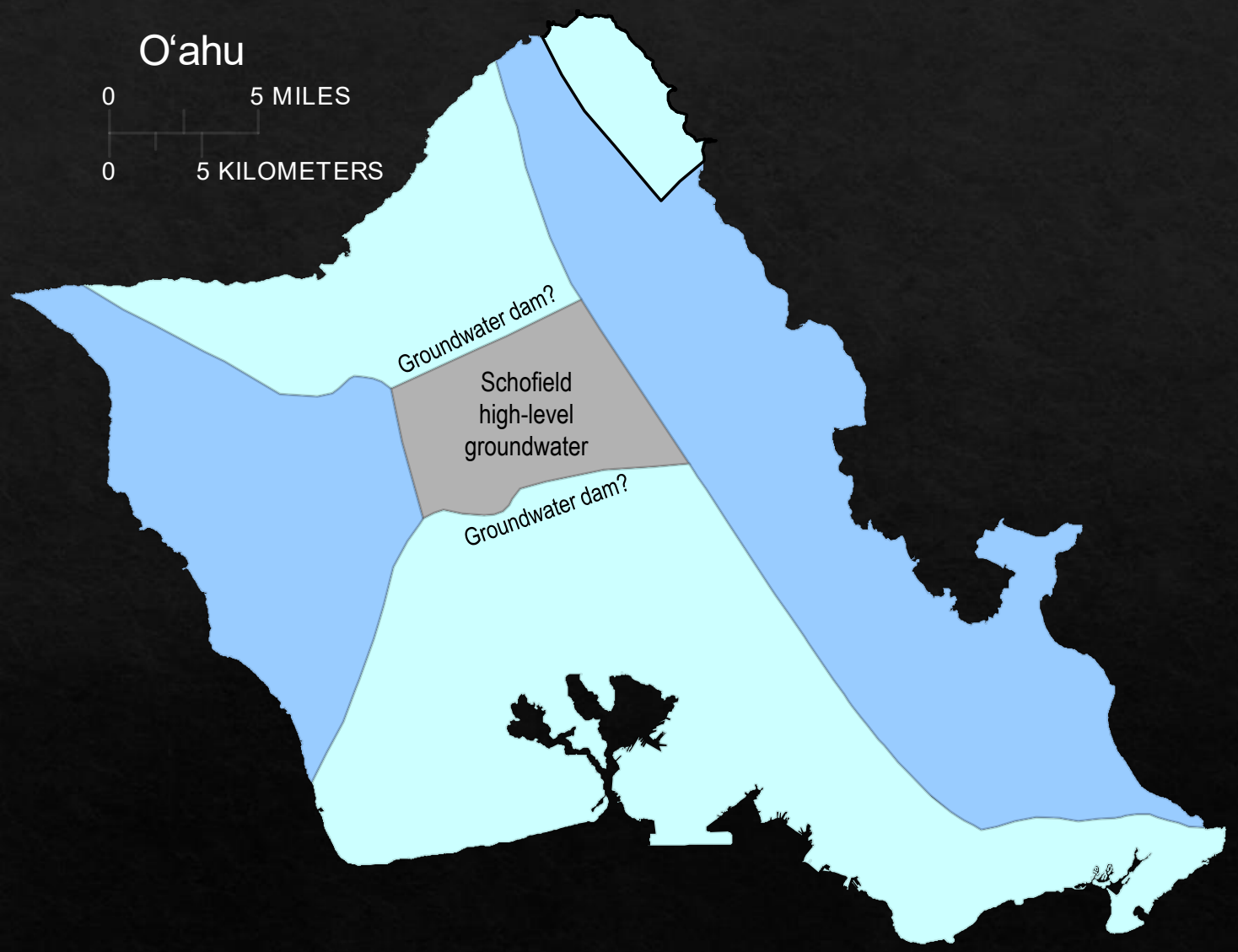
Schofield High-Level Groundwater



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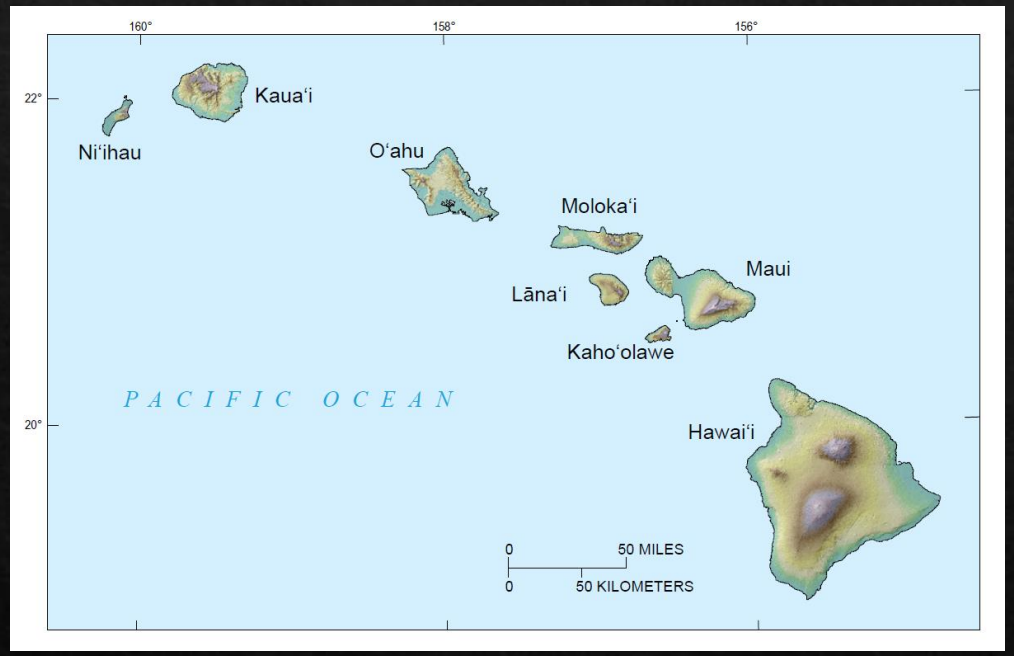
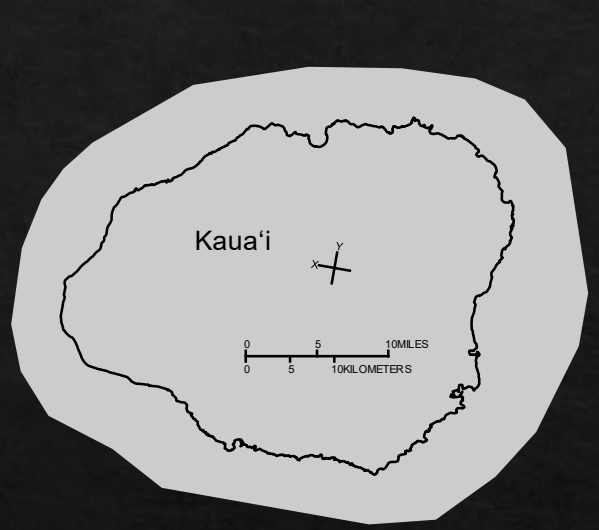
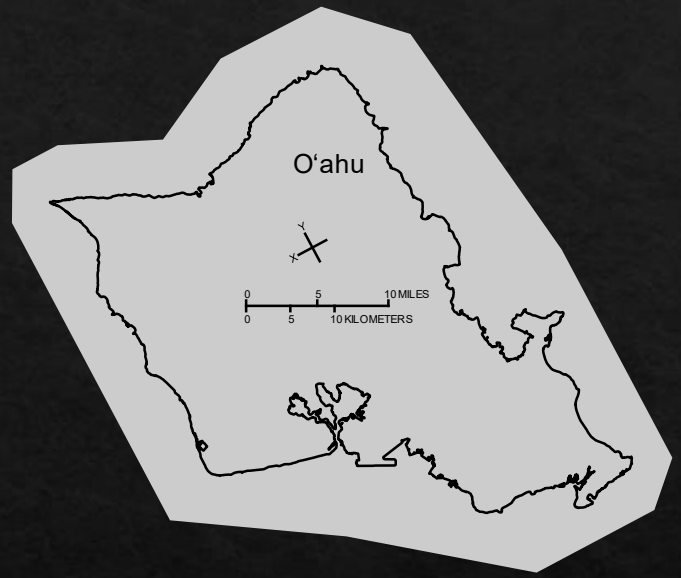
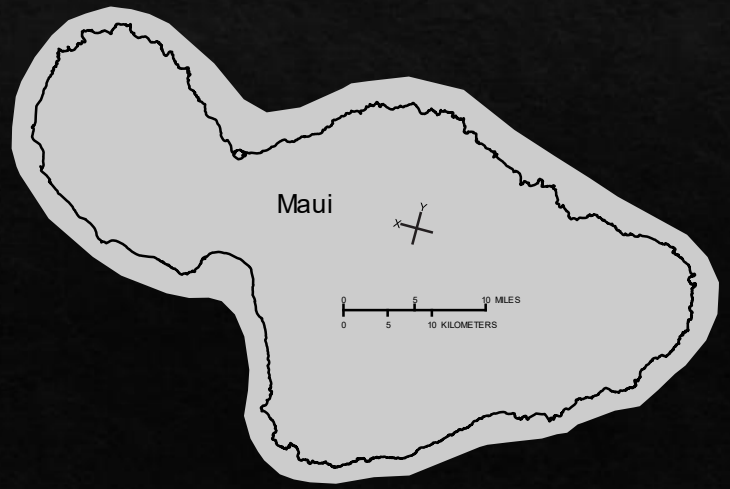
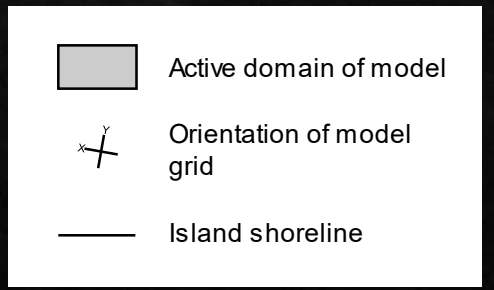
MODFLOW-SWI Models of Kaua‘i, O‘ahu, and Maui











From Izuka et al., 2021

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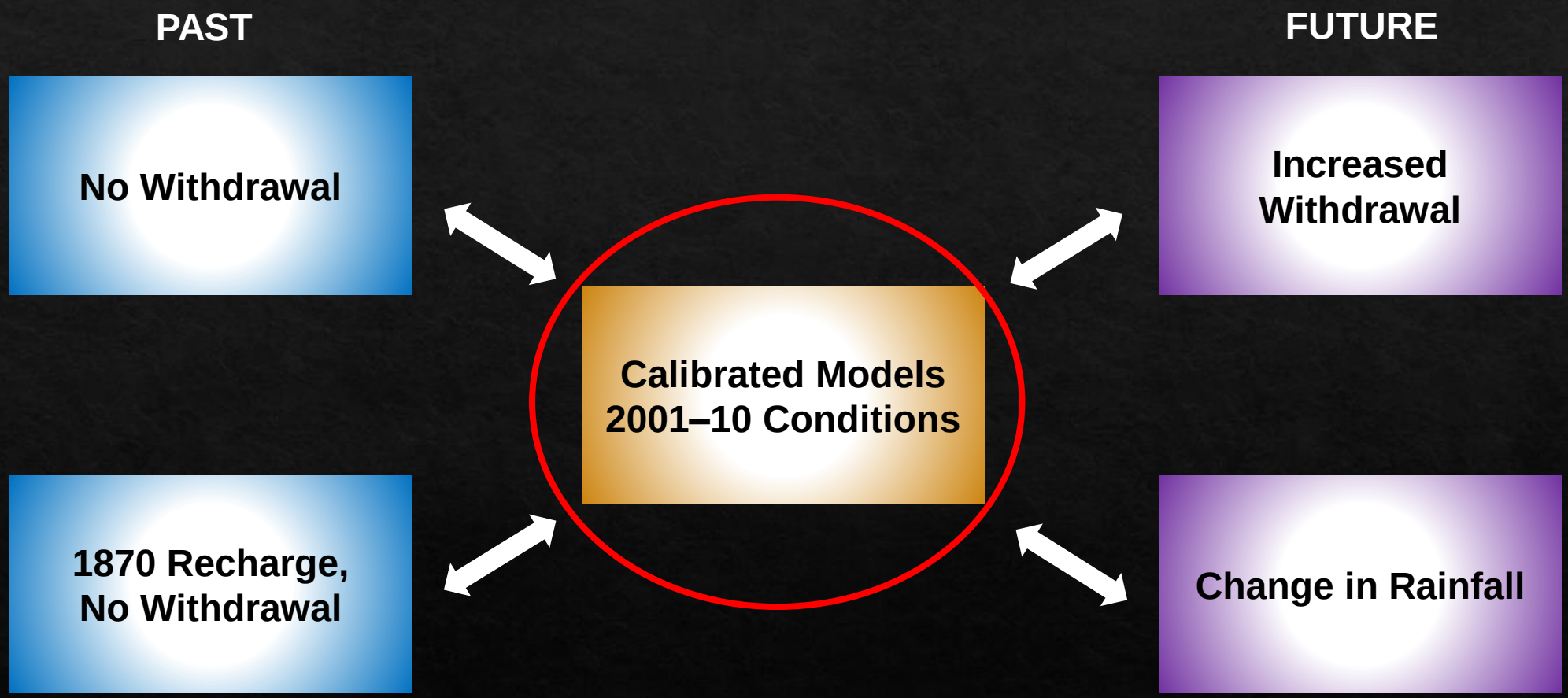
Calibrated Model and Multiple Scenarios



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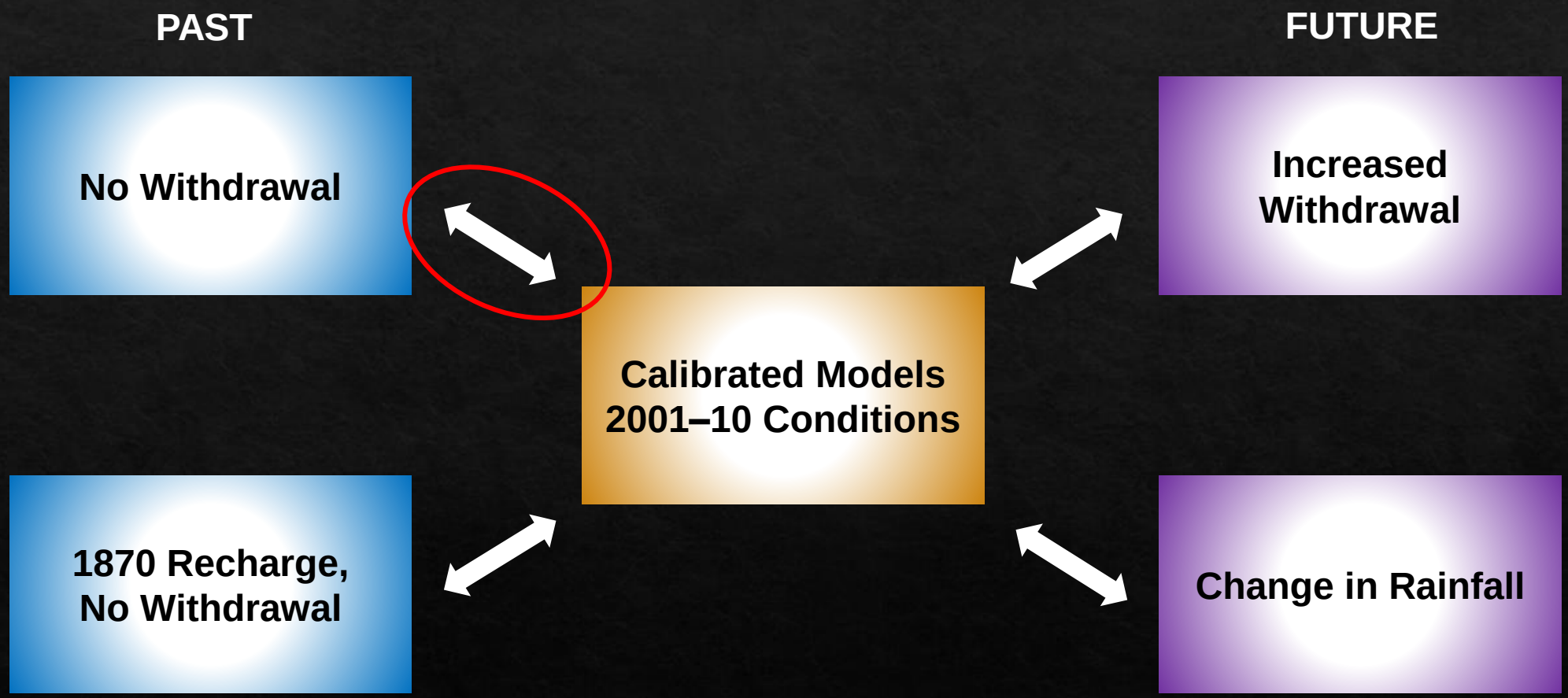
Effect of 2001–10 Groundwater Withdrawal Rate



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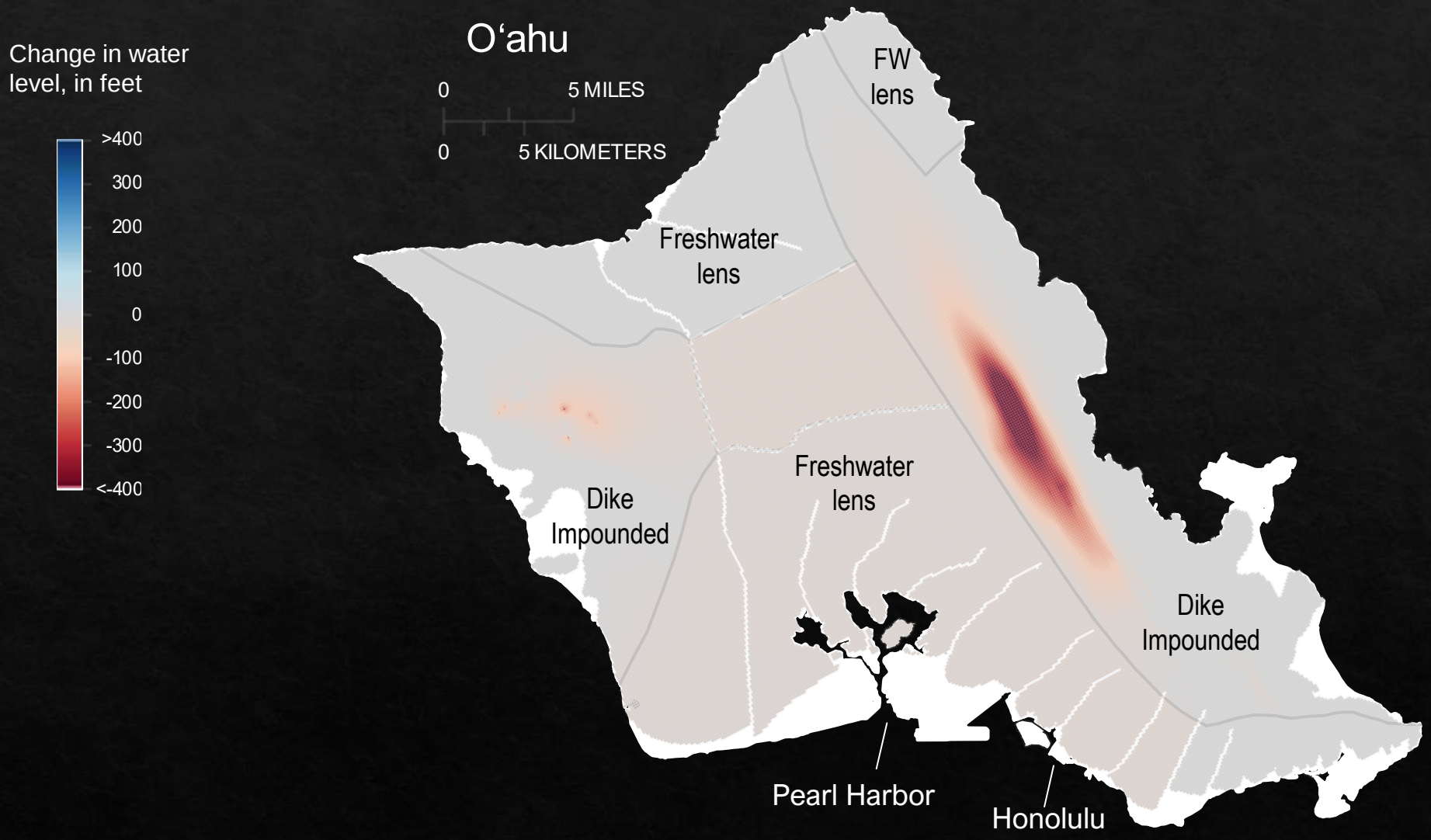
Effect of 2001–10 Withdrawal on Water Levels



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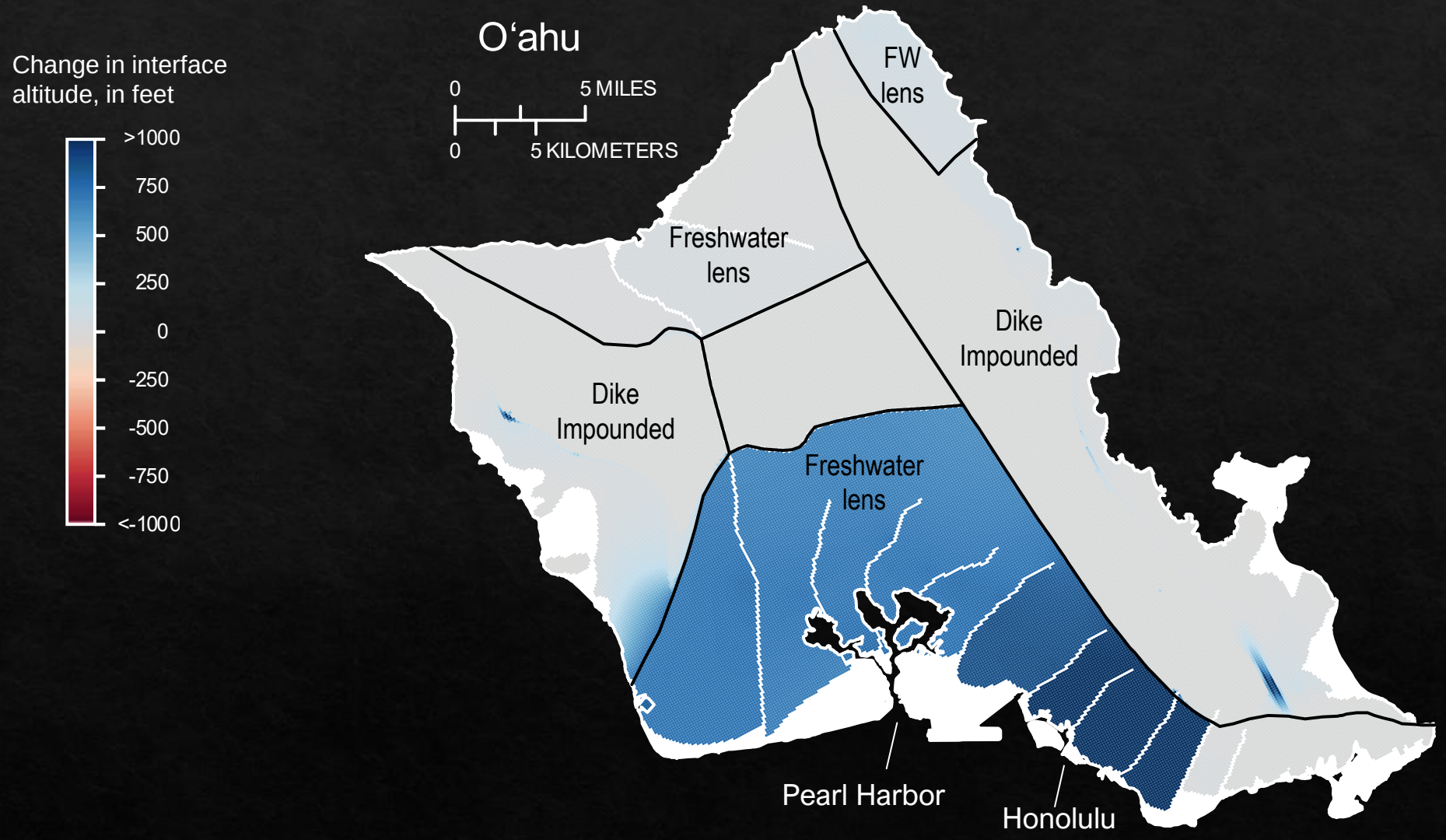
Effect of 2001–10 Withdrawal on Saltwater/Freshwater Boundary



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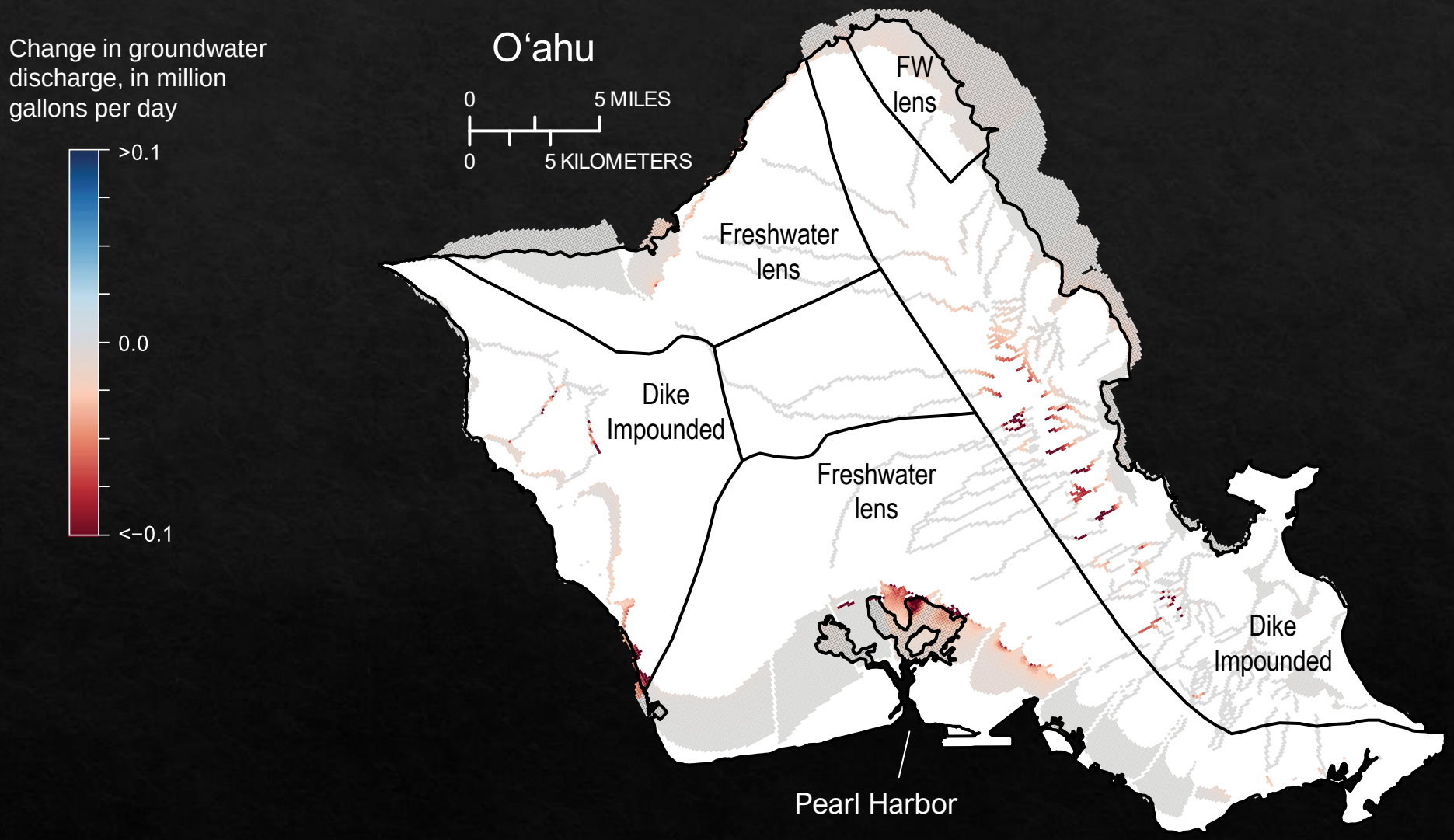
Effect of 2001–10 Withdrawal on Streams and Ocean



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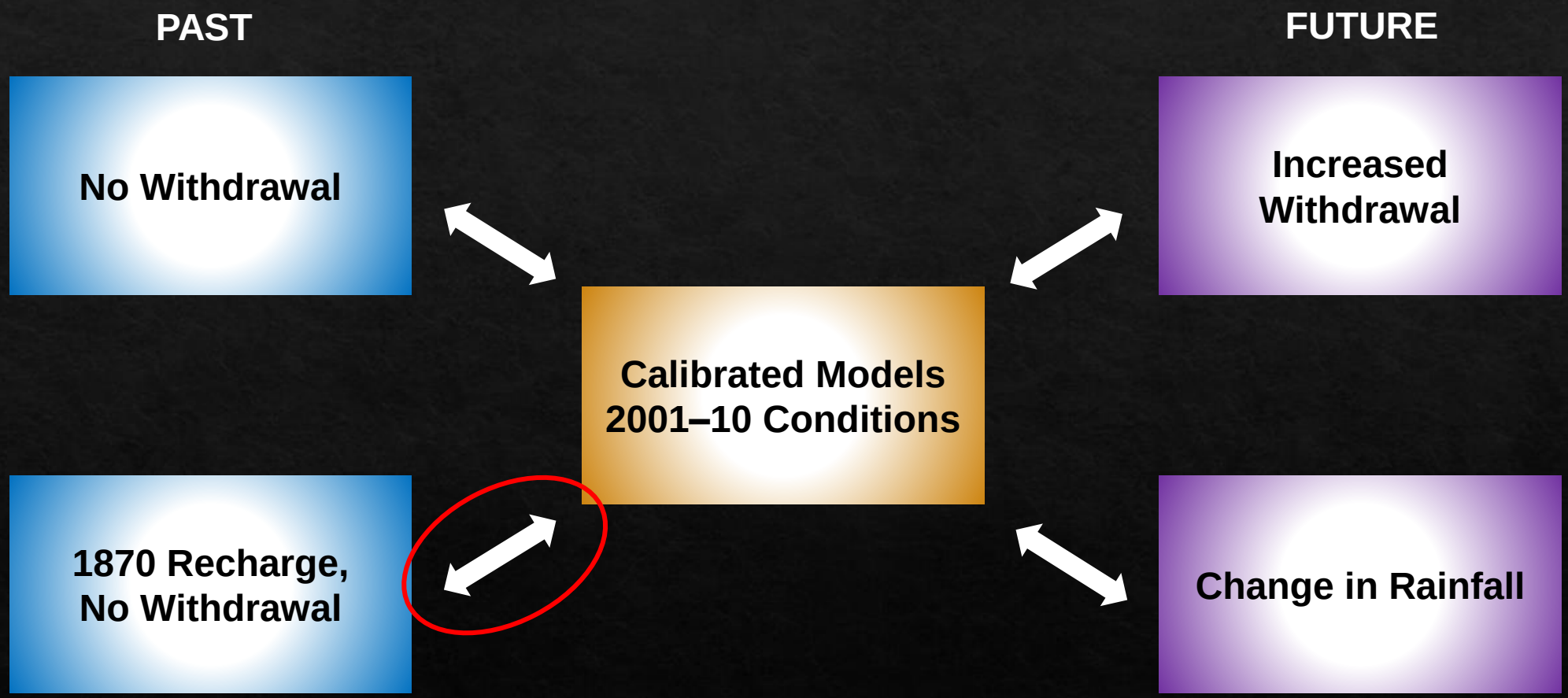
Combined Effect of Withdrawal and Recharge Changes



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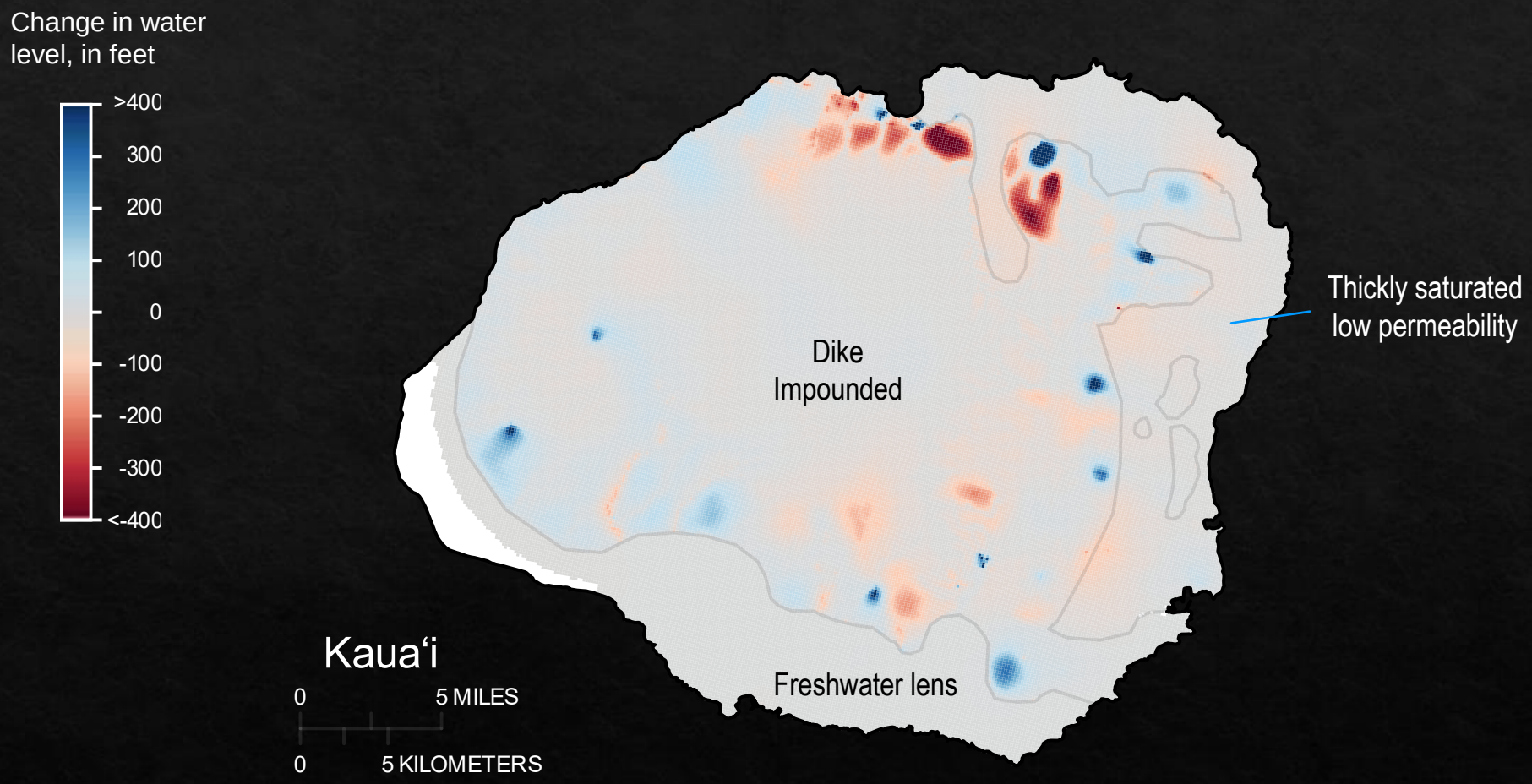
Effect of Withdrawal and Recharge Changes on Water Levels



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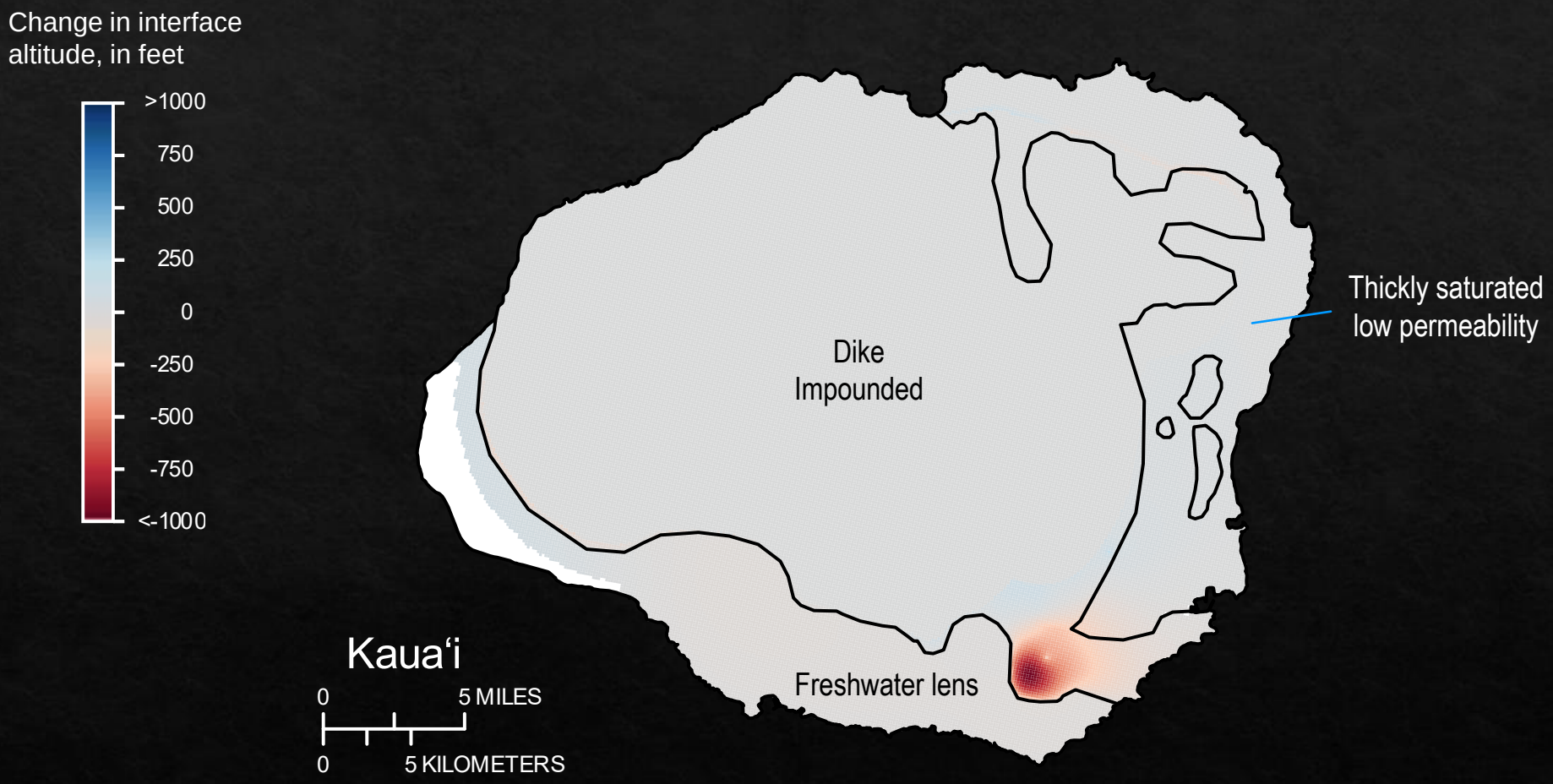
Effect of Withdrawal and Recharge Changes on Interface



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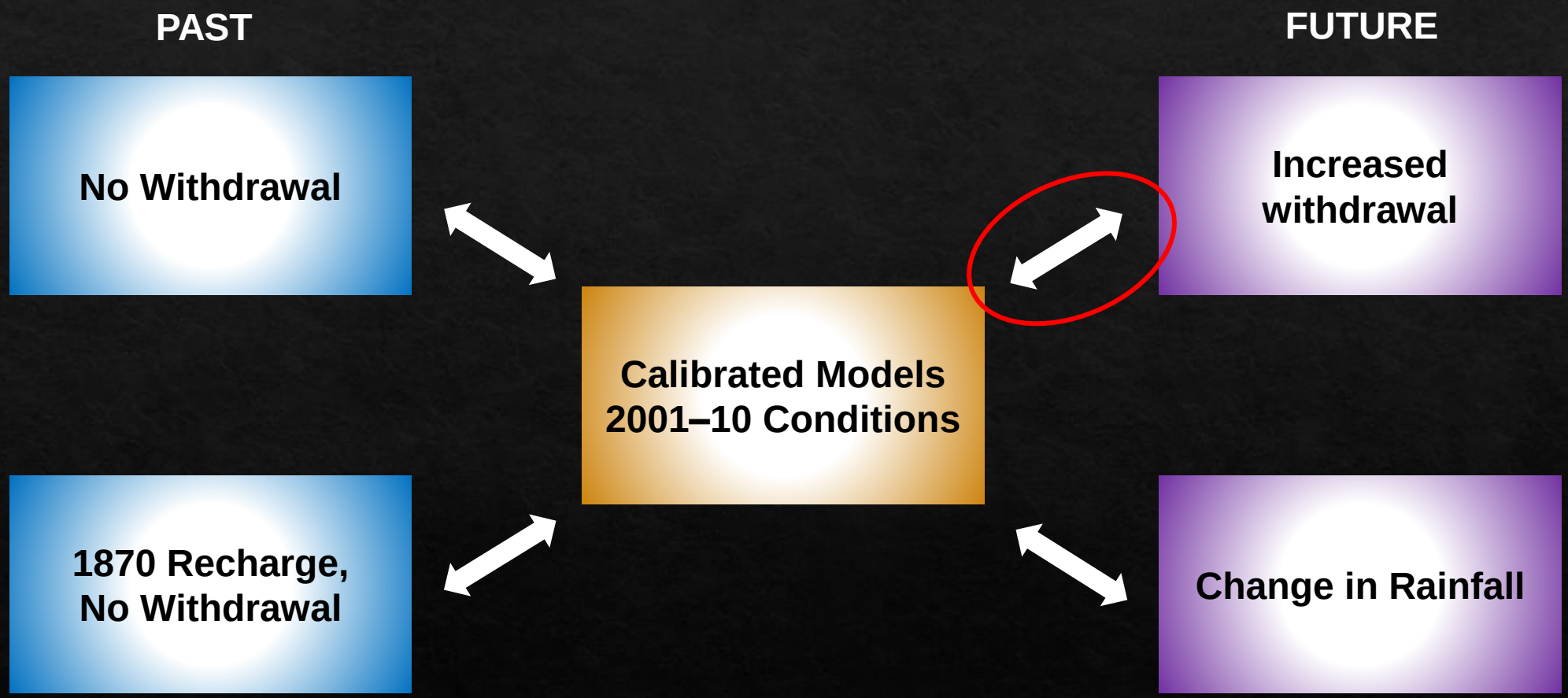
Effect of Future Changes in Withdrawal



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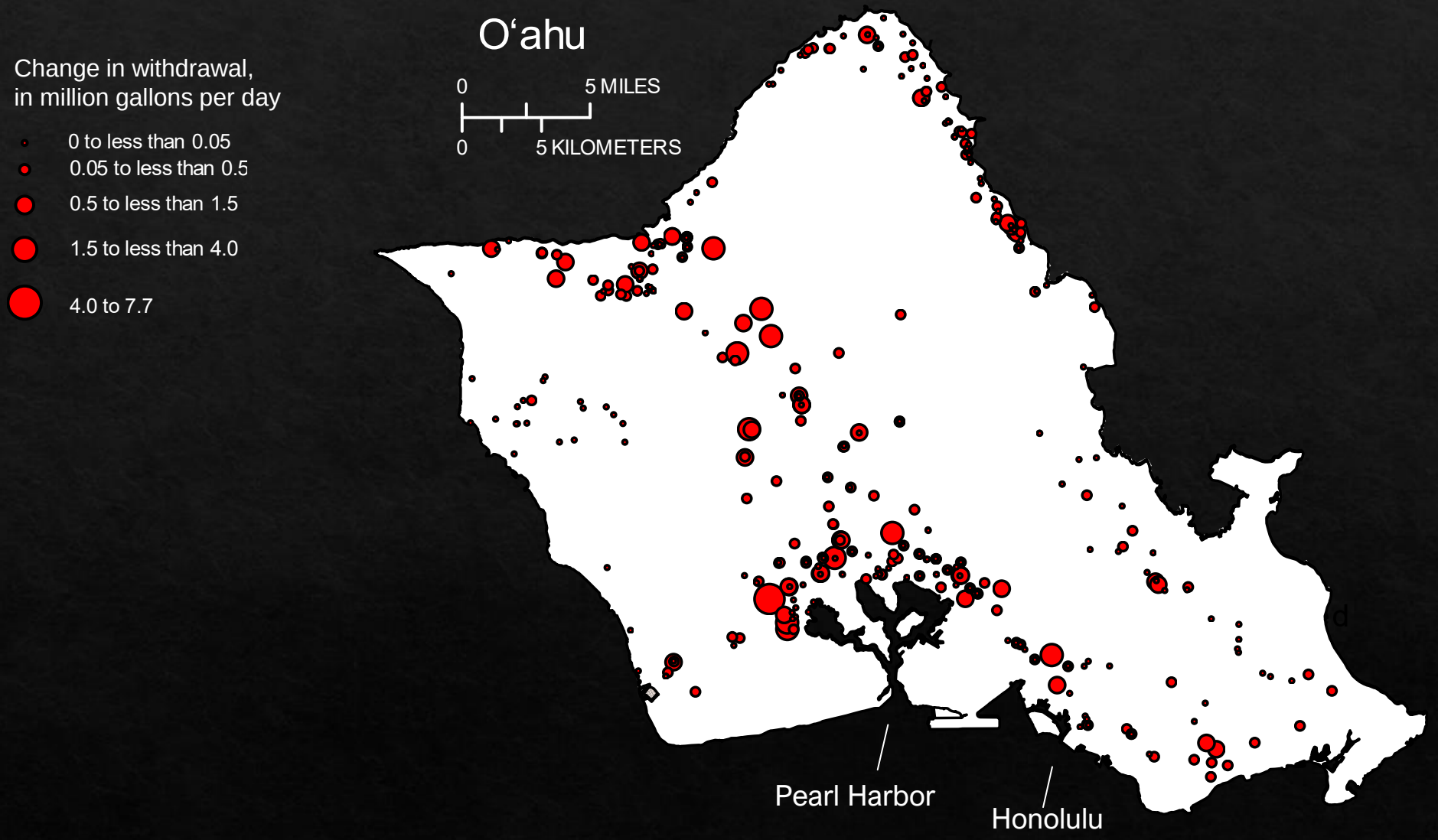
Simulated Future Withdrawal Change



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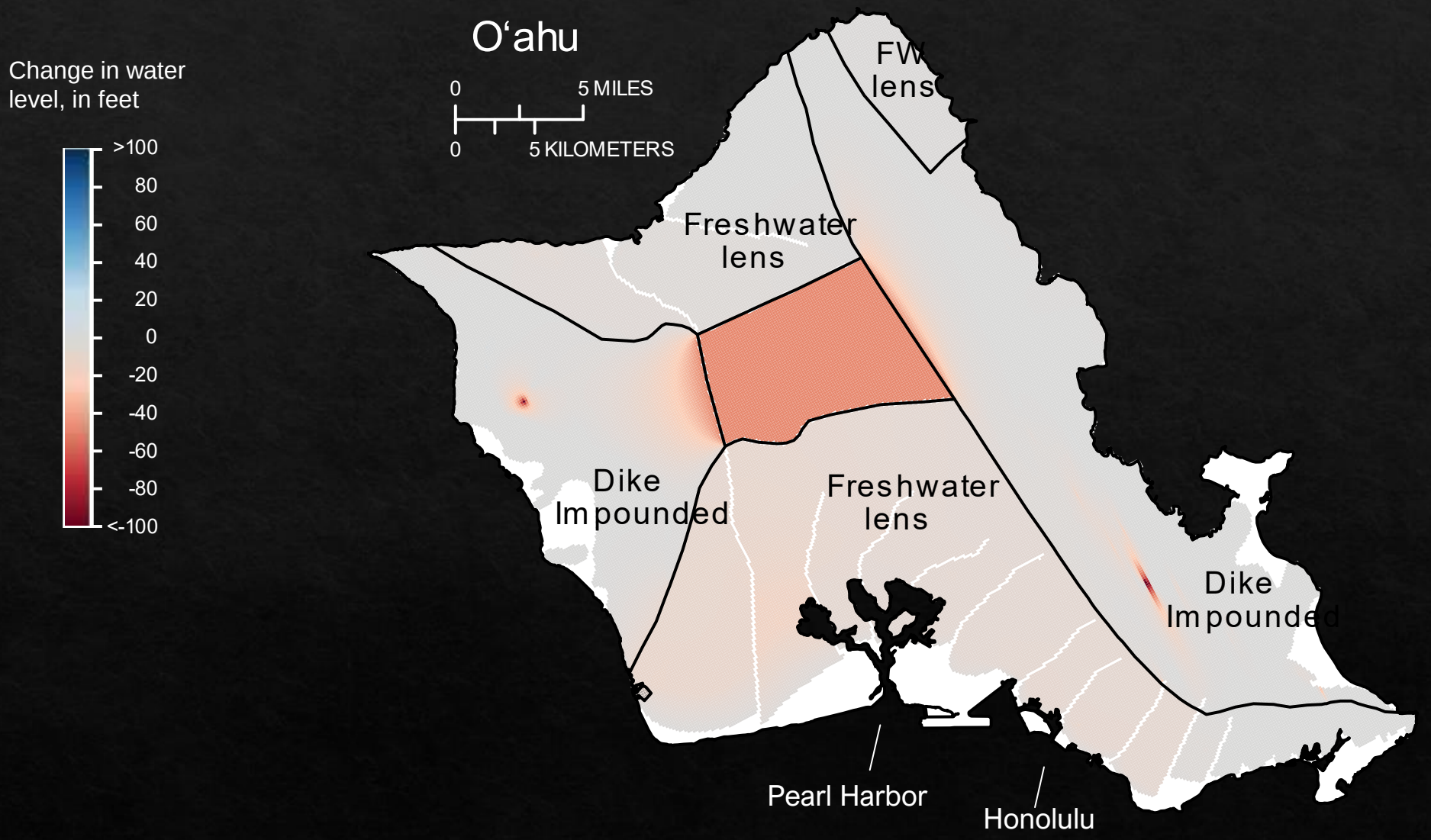
Effect of Future Withdrawal Change on Water Levels



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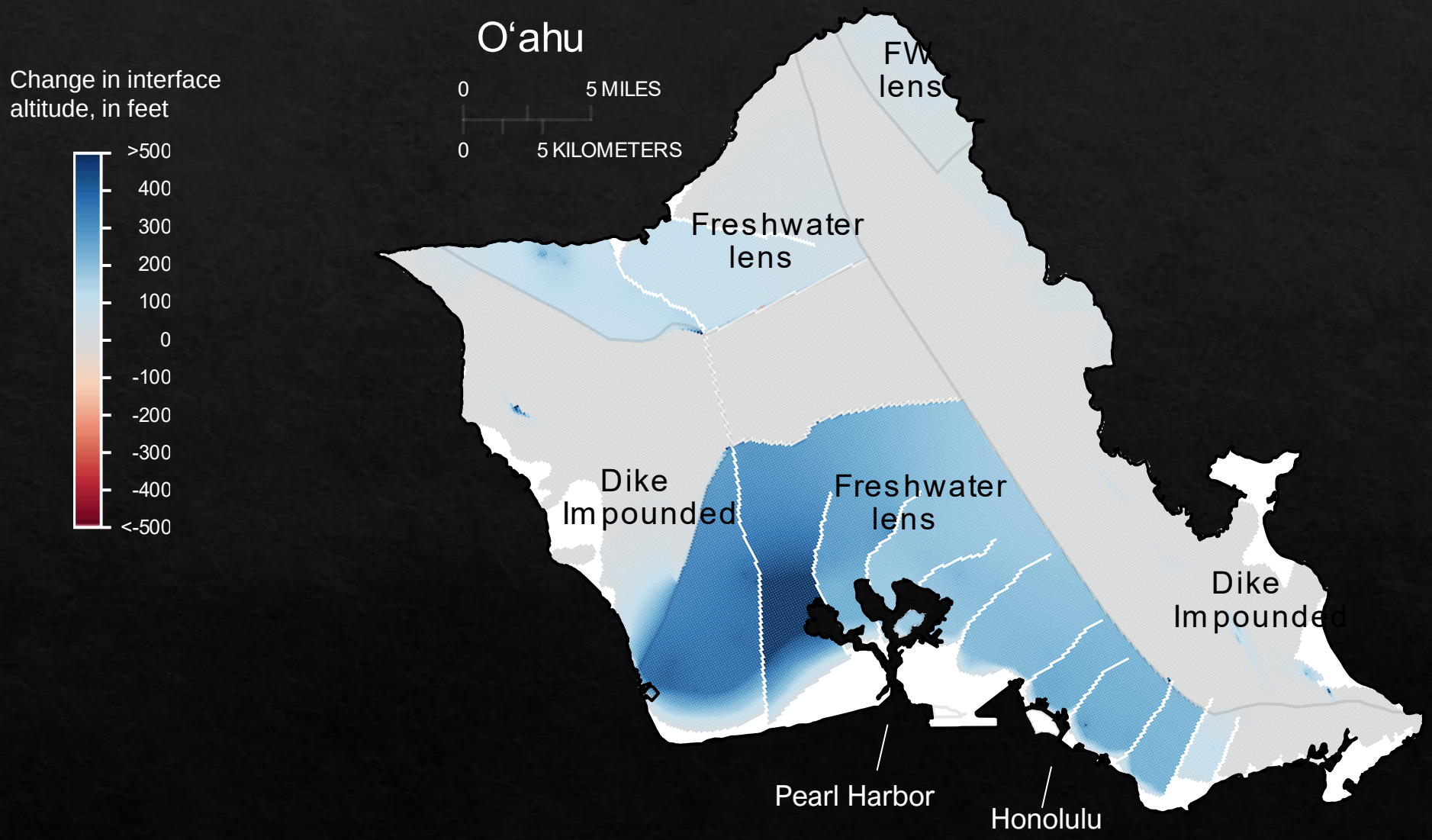
Effect of Future Withdrawal on Saltwater/Freshwater Boundary



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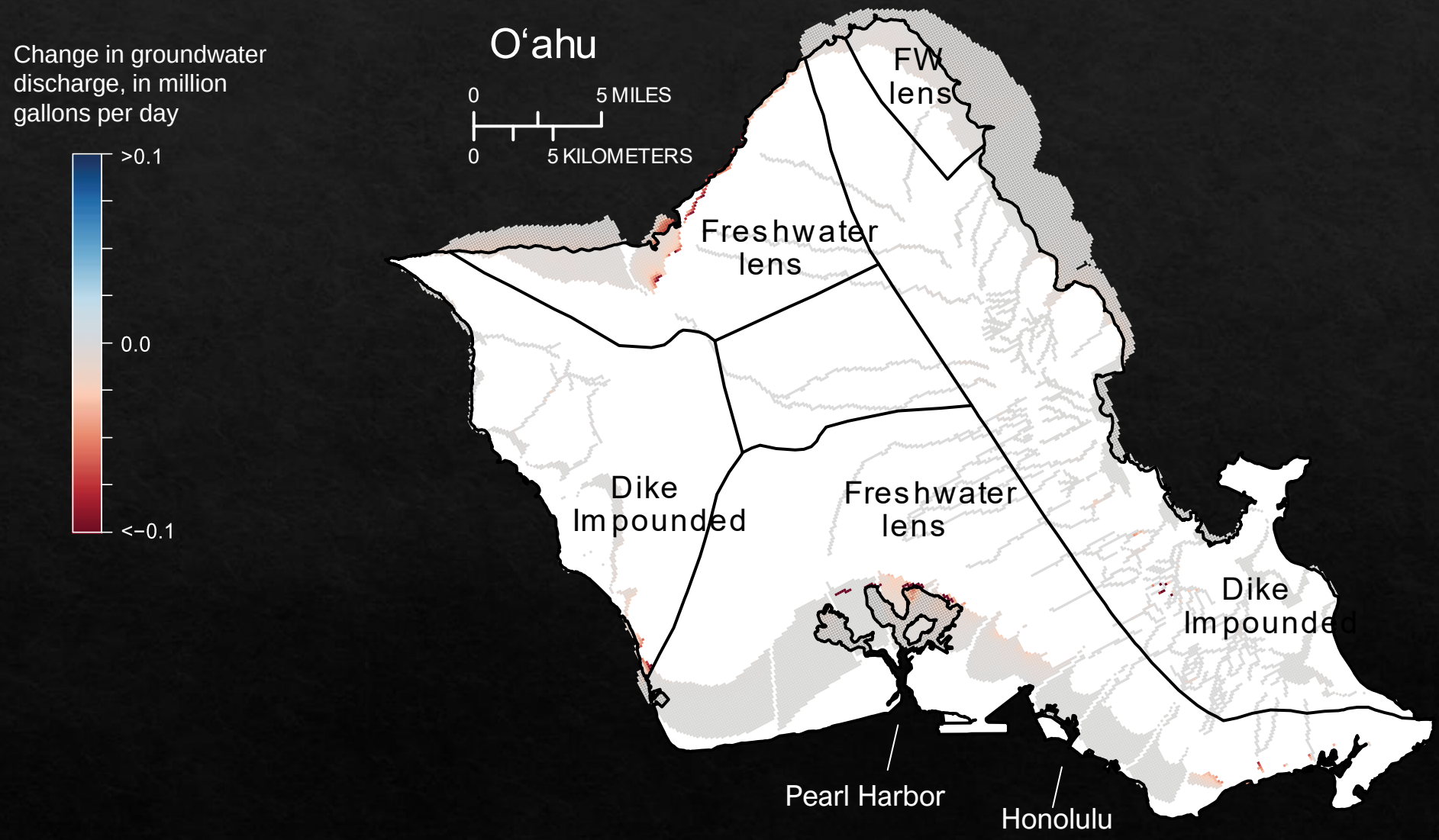
Effect of Future Withdrawal Change on Streams and Ocean



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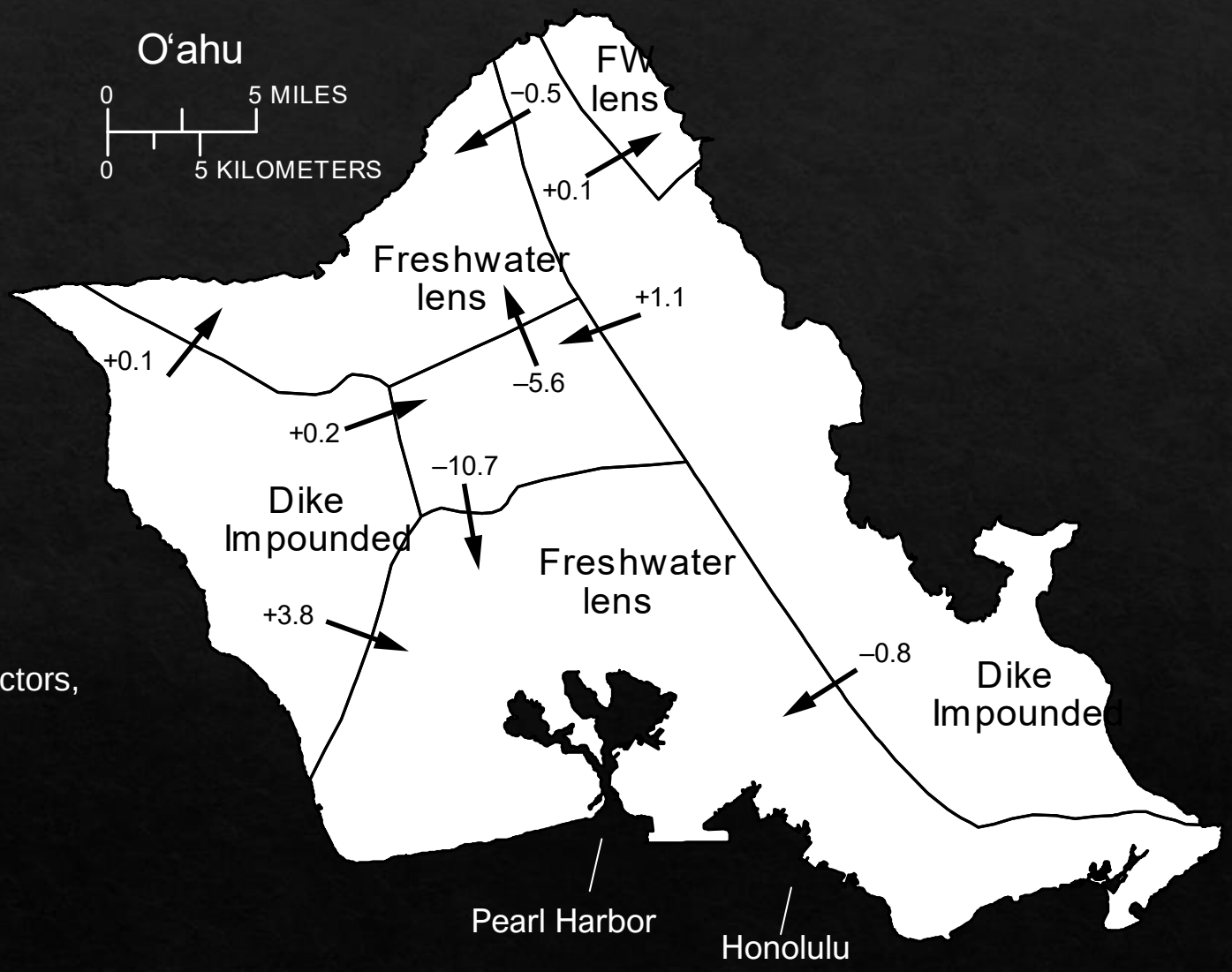
Effect of Future Withdrawal Change on Subsurface Flow



Arrows indicate change in subsurface flow between sectors, in million gallons per day

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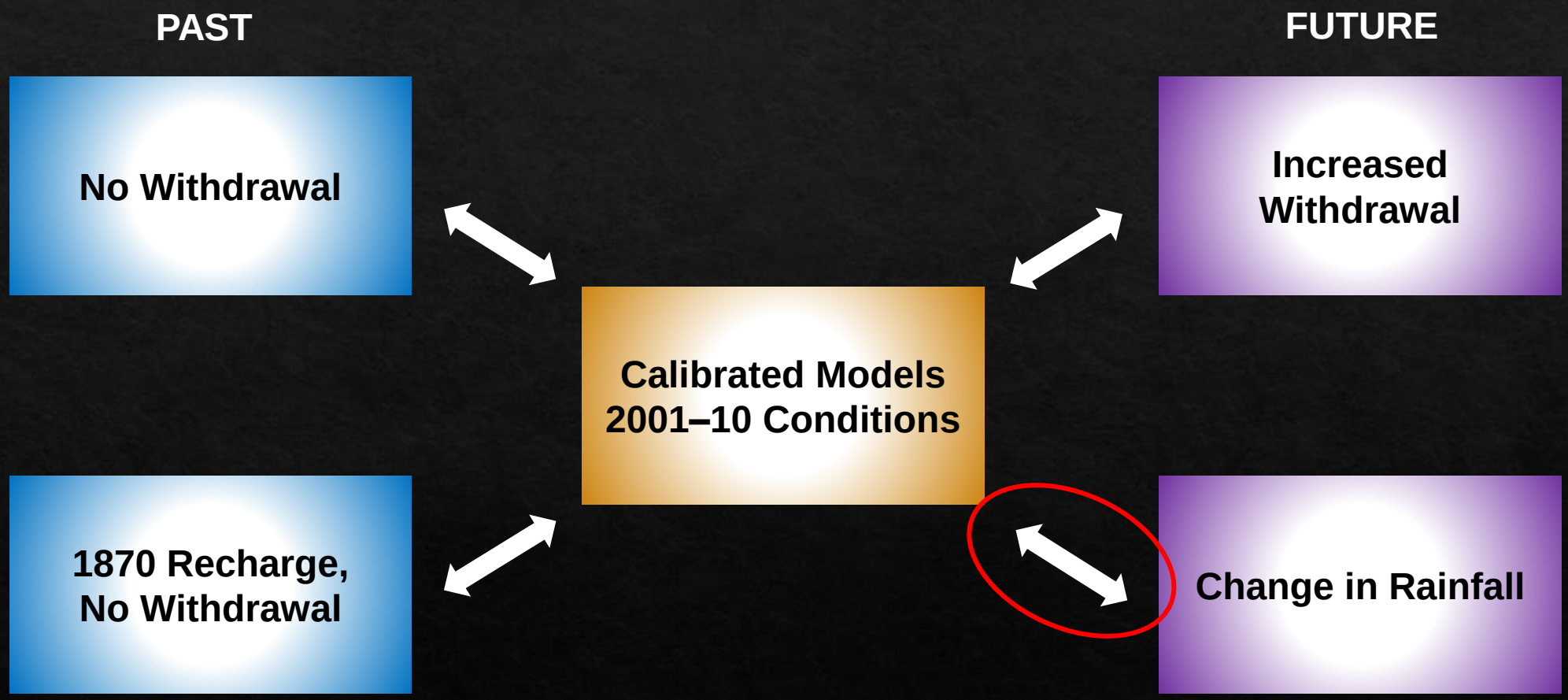
Effect of Future Changes in Rainfall



(Statistical downscaling of RCP 8.5, mid century [Elison Timm et al., 2015])

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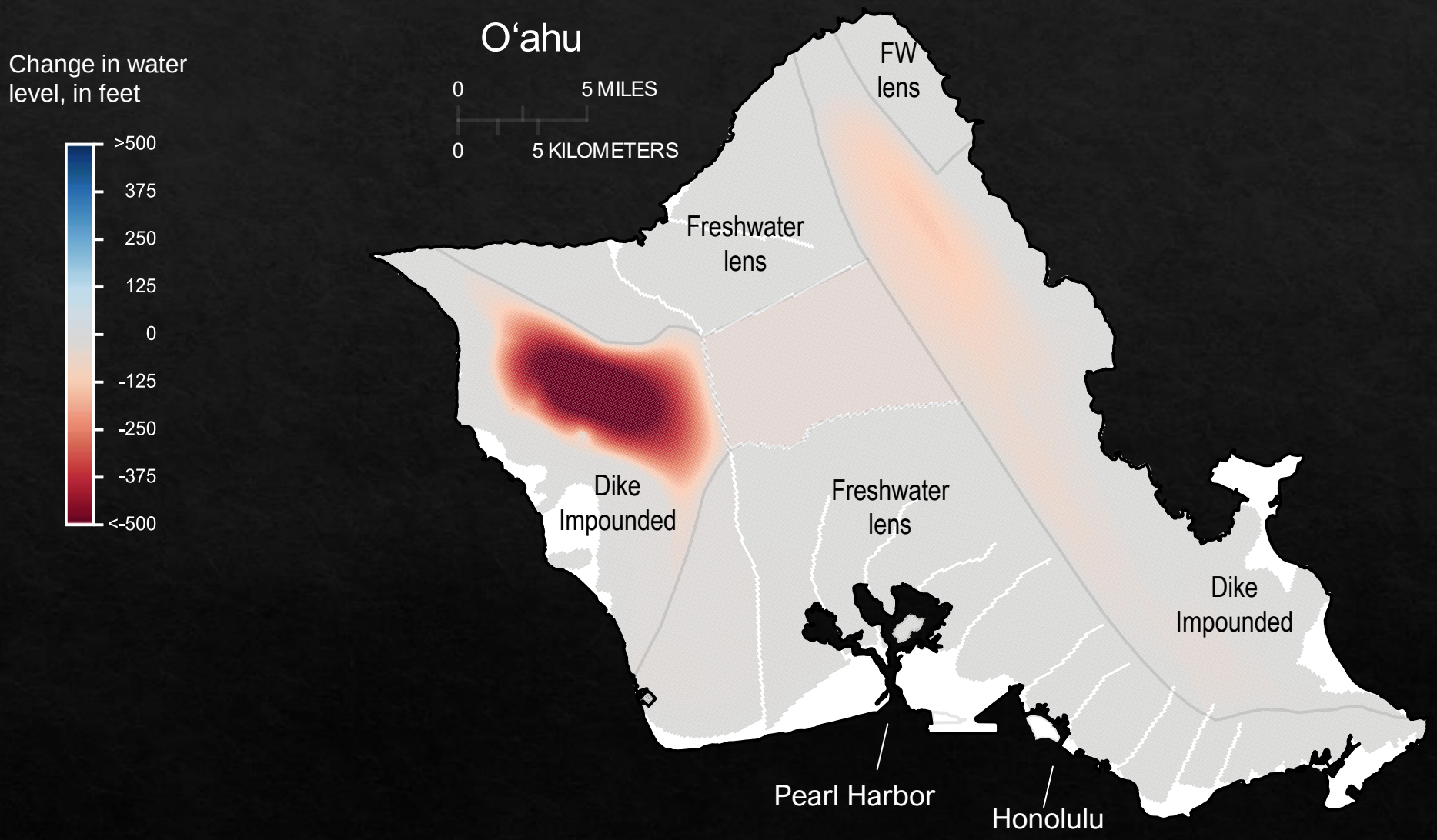
Effect of Future Rainfall Change on Water Levels



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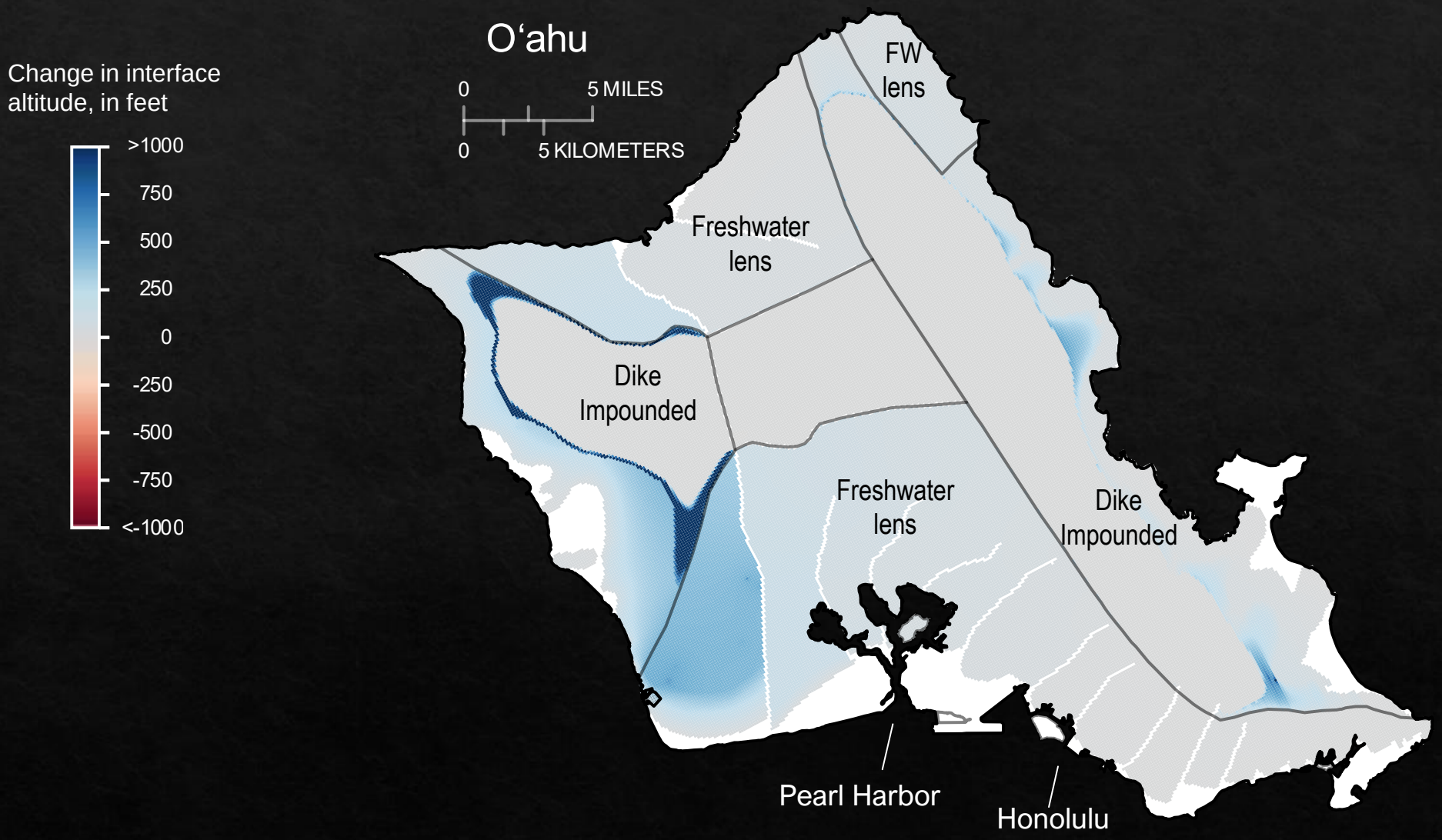
Effect of Future Rainfall Change on Saltwater/Freshwater Boundary



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Summary

Primary consequences limiting availability differ among hydrogeologic settings

- Freshwater lens—Saltwater rise and encroachment, reduction of groundwater discharge to the ocean (also to springs where there is caprock)
- Dike-impounded, thickly saturated aquifers—Water-level decline, reduction of discharge to streams and springs
- Upgradient aquifers—Reduced flow to adjacent aquifers

Consequences depend on magnitude of withdrawals and can change with changes in recharge

Collaboration between management and science can work toward a balance between groundwater withdrawal and the need to limit the consequences

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Acknowledgments and Contact Information

Funding source

USGS Water Availability and Use Science Program

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