Patrick M. Kiel

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EDUCATION

Ph.D. Marine Biology and Ecology, January 2022 - Present (anticipated December 2026)

Rosenstiel School of Marine, Atmospheric, and Earth Science, Miami, FL

- Advisors: Drs. Vivek Prakash (chair), Ian Enochs, Prannoy Suraneni
- Topics: coral reefs, ocean acidification, alkalinity enhancement

Bachelor of Science in Marine and Atmospheric Science, May 2020

University of Miami, Coral Gables, FL

- Majors: Marine Science and Biology
- Thesis: "Examining structural and mechanical properties of the threatened coral *Acropora cervicornis*: Effects of nursery grow-out platforms on mechanical strength"
- Study Abroad: UGalapagos - International Outreach Initiative, Galapagos Islands, Spring 2019

RESEARCH INTERESTS

- Coral reef ecology
- Ocean acidification and alkalinity enhancement
- Global change biology

PROFESSIONAL EXPERIENCE

Graduate Research Assistant January 2022 - Present

University of Miami's Rosenstiel School of Marine, Atmospheric, and Earth Science

Committee: Drs. Vivek Prakash (chair), Ian Enochs, Chris Langdon, Diego Lirman, Prannoy Suraneni

- Led three research projects on coral response to climate change and alkalinity enhancement, resulting in two first-authored publications and several international conference presentations
- Mentored seven students in their independent research projects, providing technical and professional guidance that yielded six senior theses and three placements into postgraduate research programs
- Balanced research collaboration across three academic and government laboratories, producing four peer-reviewed publications, two decision-support management tools, and 97 scientific dives

Research Assistant I October 2020 - December 2021

NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) Coral Program

Supervisors: Dr. Ian Enochs, Nathan Formel

- Developed and published the *Acropora cervicornis* Data Coordination Hub, an open-access database and management tool to align datasets, evaluate genet performance, and scale restoration potential
- Conducted carbonate budget surveys and deployed in situ instrumentation via scientific diving in support of the National Coral Reef Monitoring Program
- Supported diverse projects within the AOML Coral Program and Experimental Reef Laboratory investigating ocean acidification, bioerosion, coral disease, heterotrophy, and thermal tolerance

Undergraduate Research Assistant September 2018 - May 2020

Lirman Benthic Ecology and Coral Restoration Lab, University of Miami

Supervisors: Drs. Diego Lirman, Jane V. Carrick

- Led independent research project investigating mechanical strength of coral skeletons and the capacity of coral restoration to increase the wave attenuation of degraded reefs
- Conducted field surveys to monitor seagrass and mangrove communities in support of the Integrated Biscayne Bay Ecological Assessment and Monitoring program

- Supported team of researchers and graduate students conducting research projects to assess new coral restoration methods and increase the efficiency and scale of restoration efforts

Undergraduate Research Assistant February 2017 - May 2019
South Florida Corals and Climate Change Laboratory, University of Miami
Supervisor: Dr. Chris Langdon

- Analyzed *Acropora cervicornis* and *Orbicella faveolata* under ocean acidification conditions to determine effects on growth rates and physiology
- Maintained coral mesocosms in forecasted high CO_2 reef conditions
- Collected and analyzed seawater samples for total alkalinity and spectrophotometric pH

AWARDS & RECOGNITIONS

- NOAA Oceanic and Atmospheric Research 2023 Team Member of the Year for Outreach and Education
- National Science Foundation, Graduate Research Fellowship, $147,000
- Dr. Linda Farmer Undergraduate Research Award, $2,500
- University of Miami Eco Agency Programming Grant for Coral Restoration, $1,500
- University of Miami Graduate Student Travel Awards, $2,400

Total Funding Received: $153,400

Publications

Peer-reviewed Manuscripts (7)

1. Gill TJ, Jankulak M, Osborne J, **Kiel PM**, Palacio-Castro AM, Enochs IC (2026) Real-time acidification monitoring through Sofar buoy and SAMI-pH integration. *HardwareX (26).* doi:10.1016/j.ohx.2026.e00772
2. Cooke KM, Palacio-Castro AM, Boyd A, Soderbeg N, **Kiel PM**, Stevens A, Langdon C, Enochs IC (2026) Alkalinity enrichment stimulates calcification and linear extension in Acropora cervicornis. *Scientific Reports*. doi:10.1038/s41598-026-44817-6
3. **Kiel PM**, McConnell M*, Boyd A, Soderberg N, Suraneni P, Prakash VN, Enochs IC (2026) Electrochemically induced alkalinity enhancement increases coral growth rates in the local microenvironment. *Coral Reefs (45):737-752*. doi:0.1007/s00338-025-02791-x
4. Ruszczyk M, **Kiel PM**, Chandragiri S, Guigand CM, Xia J, Brown O, Haus BK, Baker AC., Miller MW, Suraneni P, Langdon C, Prakash VN (2025) Flumex: A modular flume design for laboratory-based marine fluid-substrate studies. *HardwareX (24)*. doi:10.1016/j.ohx.2025.e00697
5. DeMerlis A, Studivan M, Wong K, Soderberg N, Ehrens D, Isma L, Cocson K, Rosing K, Thomas R, D'Alessandro M, Dvorkin D, Unsworth J, **Kiel PM**, Palacio-Castro A, Lirman D, Baker AC, Muller E, Traylor-Knowles N, Enochs IC (2025) Species-level differences in molecular responses to a thermally variable stress-hardening treatment for Caribbean corals. *Ecology & Evolution (15)*. doi:10.1002/ece3.72108
6. Webb AE, Palacio-Castro AM, Cooke K, Eaton KR, Chomitz B, Soderberg N, Chakraborty M, Zagon Z, Boyd A, **Kiel PM**, DeMerlis A, Perry CT, Enochs IC (2024) Rubble persistence under ocean acidification threatened by accelerated bioerosion and lower-density coral skeletons. *Global Change Biology* (30). doi:10.1111/gcb.17371
7. **Kiel PM**, Formel N, Jankulak M, Baker AC, Cunning R, Gilliam DS, Kenkel CD, Langdon C, Lirman D, Lustic C, Maxwell K, Moulding AL, Moura A, Muller EM, Schopmeyer S, Winters RS, Enochs IC (2023) *Acropora cervicornis* Data Coordination Hub, an open access database for evaluating genet performance. *Bulletin of Marine Science 99 (2): 119-136*. doi:10.5343/bms.2022.0064

Editorials and Commentaries (1)

1. **Kiel PM**, Prakash VN (2022) Coral physiology: Going with the ciliary flow. *Current Biology* (32):998–1022. doi:10.1016/j.cub.2022.08.049

Manuscripts in Review (2)

1. Studivan MS, Soderberg N, Boyd A, Chomitz B, Rubin E, **Kiel PM**, Kolodziej G, Jankulak M, Enochs IC. Corals from extreme urbanized environments are resilient to climate stress. [Preprint], 1 April 2026.

2. Morris JT, Hirsh HK, Gill T, Webb A, Takeshita Y, Palacio-Castro AM, Barkley H, Warren JK, Werb B, Monismith SG, **Kiel PM**, Besemer N, Enochs IC. Dissolution and heterotrophy prevail at a Florida coral reef one year after sublethal bleaching. [Preprint], 18 March 2026.

*undergraduate student mentee

PRESENTATIONS

1. **Kiel PM,** Karp R, Jankulak M, Enochs IC (2025, June 4-6) Expanding the *Acropora cervicornis* Data Coordination Hub, an open access tool for evaluating coral genotype performance. 3rd United Nations One Ocean Science Congress, Nice, France. **Poster Presentation**
2. **Kiel PM**, McConnell M, Boyd A, Soderberg N, Suraneni P, Unsworth J, Lirman D, Prakash V, Enochs IC (2024, December 9-13) Increasing massive coral growth rates with electrochemically induced alkalinity enhancement. Reef Futures Conference, Riviera Maya, Mexico. **Oral Presentation**
3. **Kiel PM,** Karp R, Enochs IC (2024, December 9) The *Acropora cervicornis* Data Coordination Hub, an open access tool for evaluating coral genotype performance. Reef Futures Conference, Riviera Maya, Mexico. **Hosted Workshop**
4. **Kiel PM,** Enochs IC, Lirman D, Prakash VN, Suraneni P, Boyd A, Chomitz B, Oehlert A, Pollier C, Pourmand A, Sharifi A, Soderberg N (2024, May 26-31) Surface roughness induces intraspecific ocean acidification resistance. 7th Microscale Ocean Biophysics Meeting, Heron Island, Australia. **Poster Presentation**
5. **Kiel PM,** Eaton K, Enochs IC (2023, November 8) The *Acropora cervicornis* Data Coordination Hub, an open access tool for evaluating coral genotype performance. ReeFL Conference, Miami, Florida. **Hosted Workshop**
6. **Kiel PM,** Enochs IC, Lirman D, Prakash VN, Suraneni P, Boyd A, Chomitz B, Oehlert A, Pollier C, Pourmand A, Sharifi A, Soderberg N (2023, April 26-29) Can genet-specific morphology ameliorate the effects of ocean acidification? 51st Benthic Ecology Meeting, Miami, FL. **Oral Presentation**
7. **Kiel PM,** Enochs IC, Lirman D, Prakash VN, Suraneni P (2023, March 21) Engineering corals for climate change resilience. University of Miami Graduate & Postdoctoral Research Symposium, Miami, FL. **Poster Presentation**
8. **Kiel PM,** et al. (2022, September 26-30) *Acropora cervicornis* Data Coordination Hub: An open-access tool for coordinating datasets and evaluating genet-specific performance of *Acropora cervicornis*. Reef Futures Conference, Key Largo, FL. **Oral Presentation**
9. **Kiel PM,** et al. (2022, July 3-8) *Acropora cervicornis* Data Coordination Hub, an open-access tool for aligning datasets and evaluating genotype-specific performance. 15th International Coral Reef Symposium, Bremen, Germany **Oral Presentation**
10. **Kiel PM**, Carrick JV, Ramanathan S, Suraneni P, Rhode-Barbarigos L, Lirman D (2020, April 28) Examining structural and mechanical properties of the threatened coral *Acropora cervicornis*: Effects of nursery grow-out platforms on mechanical strength. Rosenstiel Undergraduate Research Symposium, Miami, FL. **Poster Presentation**

Management Tools & Data Portals

1. Gill T, Jankulak M, **Kiel PM**, Enochs IC. Mission Iconic Reefs Environmental Monitoring Portal. https://coral.aoml.noaa.gov/mir/
2. Webb AE, **Kiel PM**, Jankulak M, Enochs IC. Reef Persistence Evaluation Tool. https://coral.aoml.noaa.gov/RPTool_simulation/
3. **Kiel PM**, Karp R, Formel N, Jankulak M, Enochs IC. The *Acropora cervicornis* Data Coordination Hub. https://www.coral.noaa.gov/AcDC/

TEACHING & MENTORSHIP

Teaching

- Teaching Assistant, "MBE 408, Climate Change: Limits of Marine Invertebrate Adaptability". Guided 11 students through a research-focused course investigating chronic hypoxia stress on coral health. Student learning outcomes included proficiency in analytical water chemistry, measuring metabolic enzyme activity, respirometry, experimental design, and data analysis.
- Teaching Assistant, "MSC 112, Introduction to Marine Science Laboratory" - 2 sections. Taught 24 students in a laboratory and field-based course. Student learning outcomes included understanding the scientific method, scientific writing, and data analysis.

Mentorship

- Ambar Condori-Boughton, April 2025 - present
- Merritt Sherrer, September 2023 - May 2025
- Inge Brijker, May 2023 - December 2024
- Matthew McConnell, January 2024 - May 2024
- Samantha Levine, January 2022 - August 2023
- Carolyn Delli-Santi, May 2022 - August 2023
- Alexandra Redford, January 2022 - May 2022

FIELD EXPERIENCE

- Dry Tortugas (2021), Florida (2018-2026), Flower Garden Banks (2025), Galapagos (2019)

SKILLS & Certifications

Research Skills

- Analytical water chemistry: spectrometric pH, dissolved inorganic carbon, total alkalinity, dissolved oxygen, nutrients (ammonia, nitrate, nitrite, orthophosphate, silica)
- Calibration, implementation, and analysis of coral reef monitoring instruments: tilt current meters, Nortek acoustic doppler current profilers, SeaBird EcoPAR and SeaFET sensors, Sunburst SAMI-pH, Sub-surface Automated Samplers, HOBO pendant loggers
- Maintenance of microcosms and mesocosms for long-term experimental coral observations and rapid metabolic assessment
- Marine invertebrate incubations to investigate respirometry and calcification
- Development of in-house custom built experimental equipment: CAD, 3D printing, laser cutting, CNC, electronics
- Microscopy/Digital Imaging: scanning electron microscope, μCT-scanning, 3D-scanning, reef-scale photogrammetry
- Marine carbonate geochemistry ($\delta^{11}B$, ICP-QQQ)
- Particle Image Velocimetry (PIV) experimental design and data analysis

Software

- Data analysis (R, Python), Database management (MySQL), Adobe Creative Suite, Web Design (HTML, CSS, JavaScript), 3D Analysis (Amira-Avizo, MeshLab, FlexScan, Agisoft Metashape), ArcGIS

Diving and Marine Operations

- Scientific Diver, University of Miami (AAUS: 150 ft, rebreather, mixed-gas, decompression authorized)
- Small Boat Operations, US Department of Interior Motorboat Operator Certification
- Closed-circuit rebreather (Optima, Inspiration, XCCR, FXCCR), Technical Diving International
- DPV/Trimix open circuit cave diver, Global Underwater Explorers & Technical Diving International
- Divemaster and Rescue Diver, Professional Association of Diving Instructors
- Scuba equipment maintenance and gas blending, Technical Diving International
- Professional First Aid/CPR/AED, Divers Alert Network/Red Cross
- Emergency Oxygen Provider, Divers Alert Network/Professional Association of Diving Instructors

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Professional Service

Scientific Journal Reviews (10)

- Current Biology, Ecological Engineering, Frontiers in Marine Science, Scientific Reports, Global Change Biology

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COMMUNITY OUTREACH

Coral Restoration Educator May 2019 - present

Rescue a Reef, Miami, FL

- Communicated economic and social value of coral reefs to the public in outreach events and lab tours
- Taught citizen scientists coral restoration principles and techniques during field excursions

Science Communicator May 2021 - present

Multiple initiatives including*, Skype a Scientist, 4-H, MacArthur Beach State Park's Marine Biology Camp, Miami-Dade County Girl Scouts, Miami Waterkeeper, Miami Children's Trust STEM Summer Program*

- Lectured on coral reef science and conducted interactive presentations to 22 school and summer camp groups aged 6-16 throughout the United States and Canada
- Demonstrated how technology can help scale coral reef science and restoration to local political leaders and general public audiences

President May 2019 - April 2020

University of Miami Scuba Club, Coral Gables, FL

- Organized twice-weekly dive trips, training courses, and managed gear procurement and maintenance for membership of 400+ students, faculty, and alumni.
- Worked closely with University officials to obtain $60,000 in annual funding and ensured proper risk management and dive safety policies.
- Previous roles: Dive Safety Officer (2016-2017), Treasurer (2017-2018), Vice President (2018-2019)

Divemaster and Science Educator May 2017 - August 2018

Florida National High Adventure Sea Base, Boy Scouts of America, Islamorada, FL

- Guided divers between the ages of 14-18 around local reefs and instilled safe diving practices
- Revised seminar curriculum and taught local ecology, fish and coral identification to a public audience
- Additional responsibilities included dive equipment maintenance, boat handling, boat maintenance

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REFERENCES

1. **Dr. Vivek N. Prakash**
   Assistant Professor
   Department of Physics, University of Miami
   1320 Capo Sano Ave, Coral Gables, FL 33146
   E-mail: vprakash@miami.edu
2. **Dr. Ian C. Enochs**
   Research Ecologist
   Atlantic Oceanographic and Meteorological Laboratory, NOAA
   4301 Rickenbacker Cswy, Miami, FL 33149
   E-mail: ian.enochs@noaa.gov
3. **Dr. Prannoy Suraneni**
   Associate Professor
   College of Engineering, University of Miami
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