



# CENTER FOR MAUNAKEA STEWARDSHIP

2024 Highlights

Resource Management Team

Justin Yeh

Taylor Warner

Anuheia Robins

Leiana Kekoa-Lum

Carmen Liberatore

12/12/2024

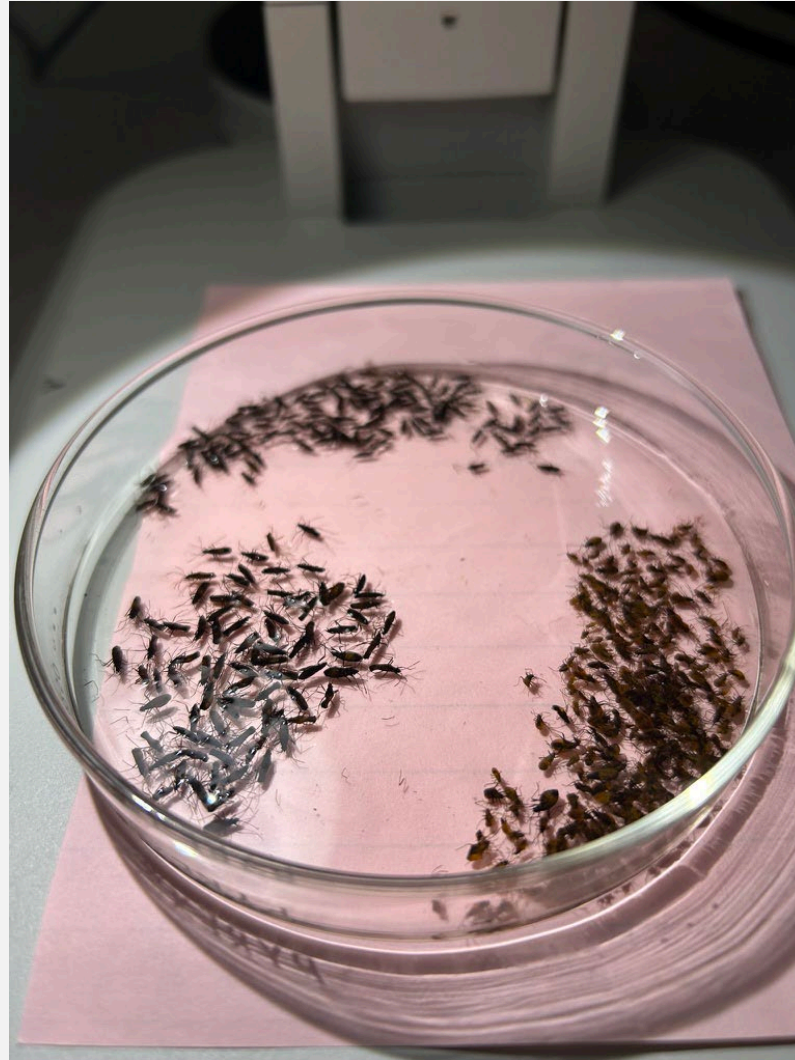
# STAFFING

- Resource Management Associates
  - Taylor Warner
  - Anuheia Robins
- Hired on Native Plant Restoration Assistant/ Guide Leiana Kekoa-Lum
- Summer PIPES Intern
  - Taylor Jenkins from UH Hilo
- Kupu Intern Carmen Liberatore
- Selfless Volunteers



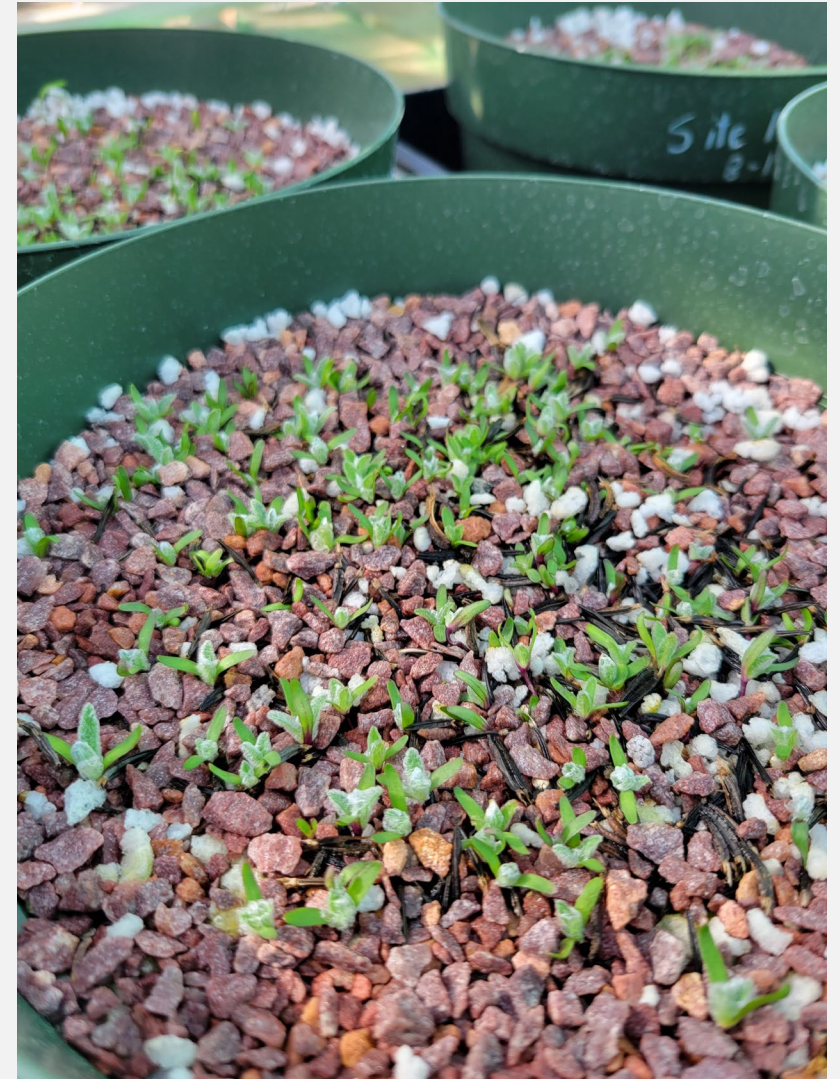
# STANDARD OPERATING PROCEDURES (SOP'S)

- SOP 01 Cleaning of Vehicles and Personal Belongings
- SOP 02 Inspection of Vehicles and Construction Materials
- SOP 10 Invasive Invertebrate Early Detection Surveys of Facilities
- SOP 11 Annual Alien Invertebrate Early Detection and Wekiu Bug Monitoring
- SOP 12 Early Detection Arthropod and Vegetation Surveys



# RESTORATION ACTIVITIES

- Volunteer weed pulls.
- Native plant propagation and out planting.
- Partnership with DLNR and Ahinahina propagation.
- Predator Control with MKFRP



# CULTURAL LANDSCAPE

- 263 historical sites within the UH managed lands
- There are an additional 109 sites within the MKIANAR



# RESEARCH PERMITS

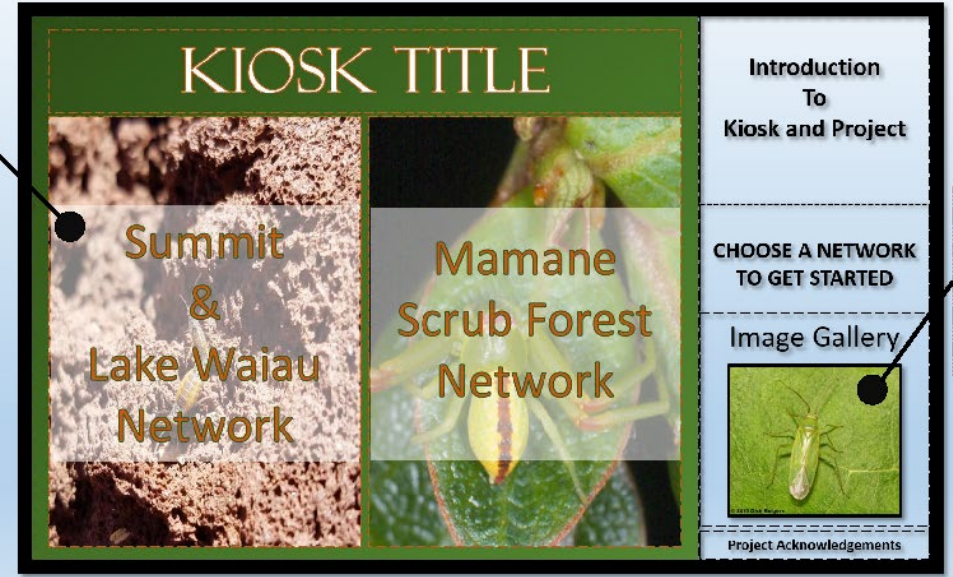
- Walter Hailes- High elevation effects
- Ryan Perroy- Erosion (continued after hurricane Hone)
- Dan Rubino and Brad Reil- Arthropod food web
  - Arthropod Interactive Food Network Display
- Norbert Schorghofer- Permafrost
- UH-Hilo- Hawaii Arthropod Genetics sequencing project

Resting Display/Intro Screen

Title Screen with Network Options

Images and Info

Select a Network to Begin using Touch Display



Auto-Scroll Photo-gallery With Specimen Or Other Photos

### IMPACT OF NOCTURNAL OXYGEN ENRICHMENT ON HIGH ELEVATION ACCLIMITIZATION

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<sup>1</sup>Montana Center for Work Physiology and Exercise Metabolism, The University of Montana  
<sup>2</sup>University of Nebraska at Omaha, School of Health and Kinesiology

**ABSTRACT**  
 To offset sleep disturbances at high altitude during acclimatization, those operating at high elevations occasionally use nocturnal oxygen enrichment. However, substantially dampening the hypoxic stimulus for acclimatization may limit adaptation. **PURPOSE:** Determine the impact of nocturnal oxygen enrichment on altitude acclimatization. **METHODS:** 22 males were assigned to sleep with (O<sub>2</sub> = 21.5±2.5% O<sub>2</sub>) or without (O<sub>2</sub> = 20.6±0.1% O<sub>2</sub>) nocturnal oxygen enrichment. An 8-day acclimatization protocol occurred at a field-based research site with access to sea level (SL), sleeping elevations (SE), and a hikeable route to 4200m. Participants were housed at 2800 m and completed 2 daily hikes of 10.4±1.2 km with 1371.5±145.1 m of gain. To assess acclimatization, testing occurred on Day 0 (at SL) and Days 1, 4, and 7 at 2800m to evaluate various markers: nocturnal oxygen consumption (overnight hemoglobin, O<sub>2</sub>HR), overnight hemoglobin (Hb), arterial oxygen saturation (SpO<sub>2</sub>), heart rate (HR), and respiratory gas at rest and during a 5-min cycling bout (1.75 W kg<sup>-1</sup>). **RESULTS:** Total sleep was longer in the O<sub>2</sub> (4.2 ± 0.3 h) than the O<sub>2</sub>- group (4.27 ± 0.3, p = 0.028). Accordingly, the O<sub>2</sub>- group had a higher overnight SpO<sub>2</sub> (96 ± 1; 91 ± 2%, p < 0.001) and lower overnight heart rate (43 ± 5; 57 ± 10 beat min<sup>-1</sup>; p < 0.003) than the O<sub>2</sub>- group. However, no other group differences were noted at rest, while cycling, or on any acclimatization day. ΔO<sub>2</sub>Hb did not differ between the O<sub>2</sub>- (2.2 ± 2.4 A.U.) and O<sub>2</sub>- groups (-1.6 ± 2.6 A.U.; p = 0.626). ΔHb did not differ between the O<sub>2</sub>- (4.2 ± 4.8 A.U.) and O<sub>2</sub>- groups (3.4 ± 3.8 A.U.; p = 0.643). SpO<sub>2</sub> did not differ between the O<sub>2</sub>- (91 ± 2%) and O<sub>2</sub>- groups (91 ± 2%; p = 0.416). HR did not differ between the O<sub>2</sub>- (86 ± 20 beat min<sup>-1</sup>) and O<sub>2</sub>- groups (91 ± 33 beat min<sup>-1</sup>; p = 0.741). Respiratory exchange ratio did not differ between the O<sub>2</sub>- (0.74 ± 0.27) and O<sub>2</sub>- groups (0.84 ± 0.08, p = 0.360). **CONCLUSION:** Nocturnal oxygen enrichment during terrestrial altitude acclimatization promoted longer total sleep but did not hinder short-term acclimatization when performing daily prolonged exercise at high elevation.

**BACKGROUND**  
 To offset sleep disturbances, those working and recreating at high elevations have taken to using nocturnal oxygen enrichment to increase the fraction of inspired oxygen and stabilize lower elevations. Historical anecdotes of sleeping with supplemental oxygen and feeling "refreshed" date as far back as 1953 on Mount Everest. In the short term, this practice is useful in improving comfort and sleep quality, but the long-term implications on high-altitude acclimatization are unclear.

**PURPOSE**  
 It is important to contextualize the consequences of nocturnal oxygen enrichment with other acclimatization interventions. Therefore, the purpose of this work was to evaluate low acclimatization in unpaired with (O<sub>2</sub>) and without (O<sub>2</sub>-) nocturnal oxygen enrichment.

**RESULTS**  
 Figure 1: Experimental overview: High altitude acclimatization occurred over a 7-day period spent between 2800m (9100 ft) and 4200m (13770 ft) of elevation. Participants slept in tents with (O<sub>2</sub>- dotted line) and without (O<sub>2</sub>-) nocturnal oxygen enrichment.

**CONCLUSIONS**  
 Nocturnal oxygen enrichment during terrestrial altitude acclimatization promoted longer total sleep but did not hinder short-term acclimatization when performing daily prolonged exercise at high elevation.

**ACKNOWLEDGMENTS**  
 Research supported by a Donald Sorenson Fund for Research Laboratory grant (FA8650-04-1-0001) and a National Science Foundation grant (IBN-0313303).

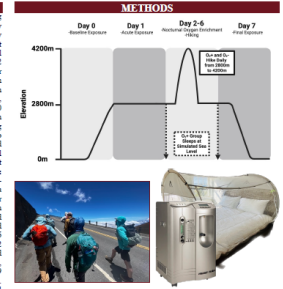


Figure 1: Experimental overview: High altitude acclimatization occurred over a 7-day period spent between 2800m (9100 ft) and 4200m (13770 ft) of elevation. Participants slept in tents with (O<sub>2</sub>- dotted line) and without (O<sub>2</sub>-) nocturnal oxygen enrichment.

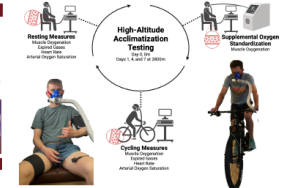


Figure 2: High-altitude acclimatization testing schematic conducted on Day 0, 0m and on Days 1, 4, and 7 at 2800m.

**Table 1: Test prior and post and week-end sleep data during altitude acclimatization with (O<sub>2</sub>-) and without (O<sub>2</sub>-) overnight oxygen enrichment.**

Measure	O <sub>2</sub> -	O <sub>2</sub>
Oxygen (%)	21.3 ± 1.5*	20.8 ± 0.1
Carbon dioxide (ppm)	1776 ± 171	2028 ± 217
Total sleep (minutes)	451 ± 61*	471 ± 63
SpO <sub>2</sub> (%)	96 ± 1*	91 ± 2
Heart rate (beats min <sup>-1</sup> )	48 ± 2*	57 ± 10

\* p < 0.05; O<sub>2</sub>- vs O<sub>2</sub>. Data presented as mean ± SD.

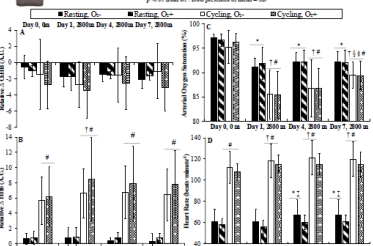


Figure 3: Overnight hemoglobin (O<sub>2</sub>Hb), A), arterial oxygen saturation (SpO<sub>2</sub>), and heart rate (HR) at rest and 5 minutes of cycling at 1.75 W kg<sup>-1</sup> during altitude acclimatization with (O<sub>2</sub>-) and without (O<sub>2</sub>-) overnight oxygen enrichment. \* p < 0.05; O<sub>2</sub>- vs O<sub>2</sub>. Data presented as mean ± SD. Error bars represent standard error of the mean. # p < 0.05; O<sub>2</sub>- vs O<sub>2</sub> on corresponding Day. Data presented as mean ± SD.

**Table 2: Respiratory gas at rest and 5 minutes of cycling (1.75 W kg<sup>-1</sup>) during altitude acclimatization with (O<sub>2</sub>-) and without (O<sub>2</sub>-) overnight oxygen enrichment.**

Measure	O <sub>2</sub> -				O <sub>2</sub>				
	Day 0	Day 1, 2800m	Day 4, 2800m	Day 7, 2800m	Day 0	Day 1, 2800m	Day 4, 2800m	Day 7, 2800m	
V̇O <sub>2</sub> (L min <sup>-1</sup> )	Rest	0.27 ± 0.04	0.27 ± 0.03	0.28 ± 0.01*	0.3 ± 0.04*	0.28 ± 0.06	0.28 ± 0.04	0.28 ± 0.01*	0.28 ± 0.04*
	Cycling	1.97 ± 0.31	1.94 ± 0.31	1.91 ± 0.33*	1.98 ± 0.33*	2.06 ± 0.28	2.02 ± 0.24	2.07 ± 0.27*	2.04 ± 0.30*
V̇O <sub>2</sub> (L kg <sup>-1</sup> min <sup>-1</sup> )	Rest	0.22 ± 0.02	0.22 ± 0.02	0.24 ± 0.01*	0.24 ± 0.02*	0.23 ± 0.05	0.23 ± 0.03	0.23 ± 0.02*	0.23 ± 0.02*
	Cycling	1.7 ± 0.17	1.78 ± 0.17	1.75 ± 0.17	1.78 ± 0.17	1.75 ± 0.18	1.8 ± 0.17	1.8 ± 0.17	1.8 ± 0.17
RER	Rest	0.8 ± 0.04	0.82 ± 0.07	0.82 ± 0.07	0.8 ± 0.08	0.8 ± 0.07	0.8 ± 0.04	0.78 ± 0.06	0.78 ± 0.05
	Cycling	1.8 ± 0.17	1.87 ± 0.17	1.8 ± 0.17	1.81 ± 0.17	1.81 ± 0.18	1.8 ± 0.17	1.8 ± 0.17	1.8 ± 0.17

\* p < 0.05; O<sub>2</sub>- vs O<sub>2</sub>. Data presented as mean ± SD.

Nocturnal oxygen enrichment during terrestrial altitude acclimatization promoted longer total sleep but did not hinder short-term acclimatization when performing daily prolonged exercise at high elevation.



# FUTURE GOALS

- Restoration plan for Halepohaku
  - Seed Scatter Trials
  - Seed Bank
- Reassessing our monitoring plans for both arthropod and cultural sites
- Co-management with MKSOA