



WEARABLE DATA UTILITY AND PERCEIVED VALUE: LESSONS LEARNED FROM MONITORING SLEEP ON NINE WARSHIPS DURING NAVY DEPLOYMENTS

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NON-DISCLOSURE

Rachel R. Markwald, no conflicts to report.

Peter G. Roma, no conflicts to report.

J. Eduardo Uriarte, no conflicts to report.

Emily M. Moslener, no conflicts to report.

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SHIPBOARD FATIGUE CONTRIBUTES TO MISHAPS



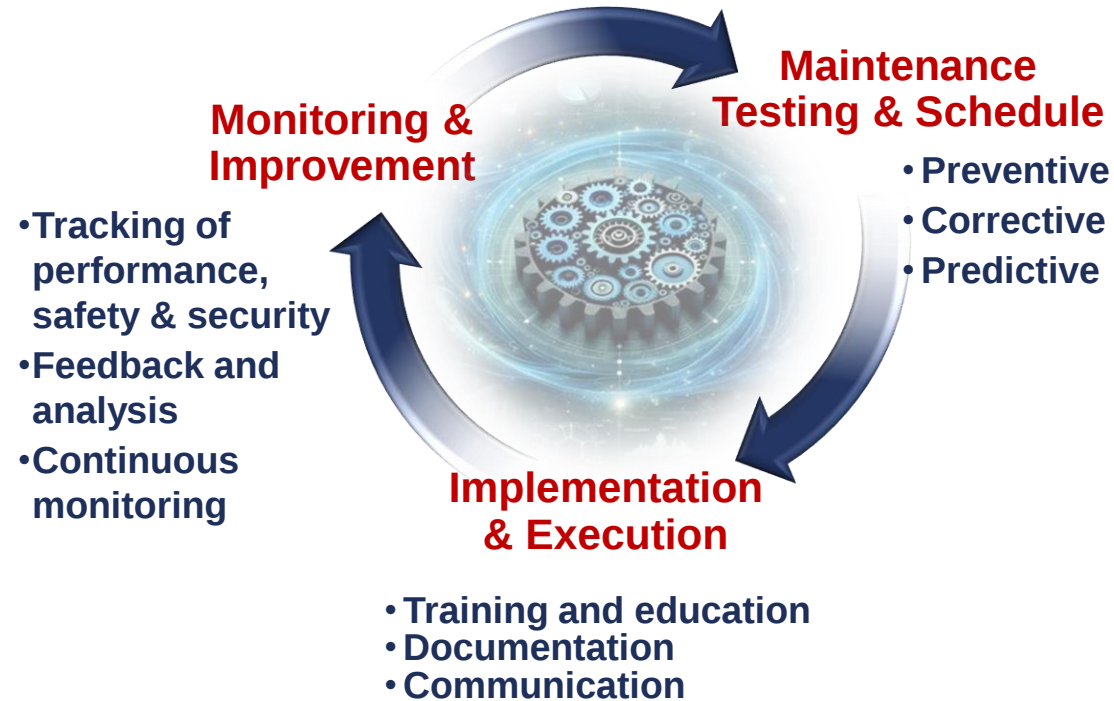
U.S. Navy photos by Chief Petty Officer Joshua Karsten/Released

USS Fitzgerald and USS John S. McCain collisions

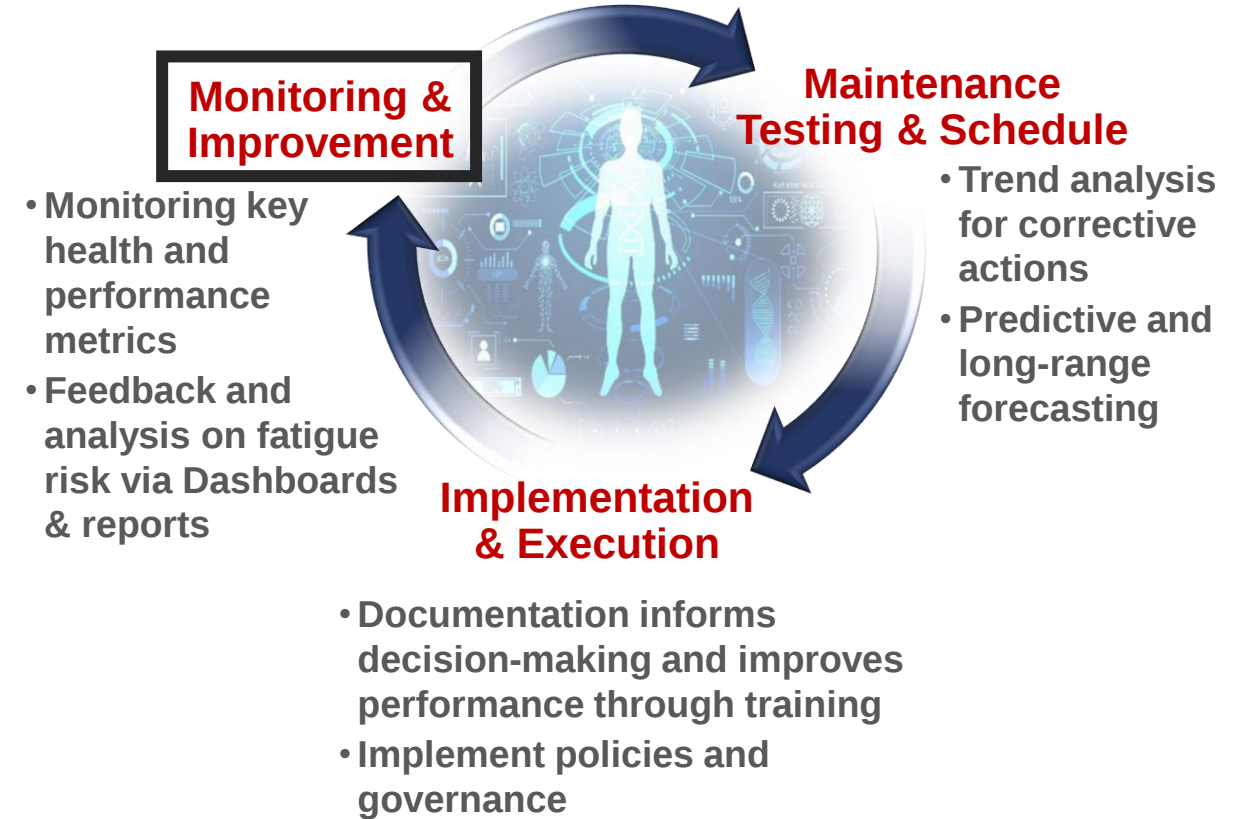


TIME TO MONITOR THE HUMAN SYSTEM?

Equipment System Maintenance Life Cycle



Human System Maintenance Life Cycle





WEARABLES USE ON DEPLOYMENT

Purpose

To explore the operational **feasibility** of sustained wearable device and app use throughout deployment

To explore the **individual value** of wearable data for Sailors

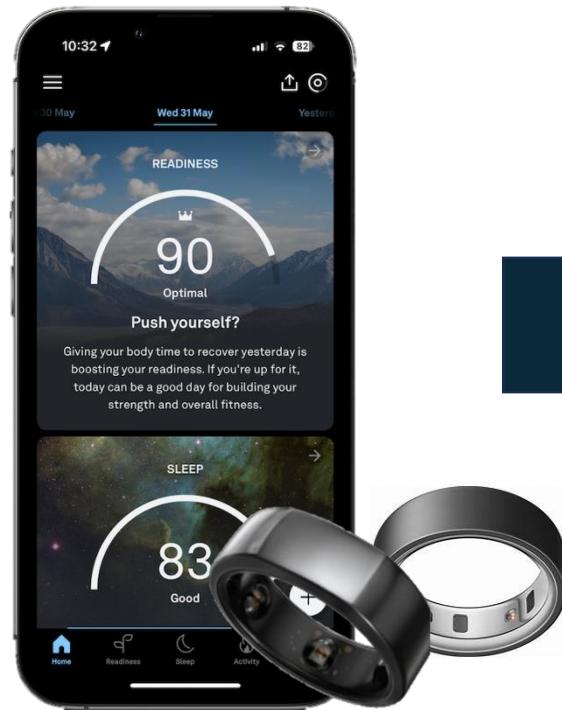
To explore the value of data for command leadership in supporting **operational fatigue risk management**



U.S. Navy photo by Mass Communication Specialist 2nd Class Christian Senyk/Released



WEARABLES USE ON DEPLOYMENT



Photos courtesy of Oura



U.S. Navy photo by Mass Communication Specialist 2nd Class Christian Senyk/Released



PROJECT PROCEDURES

1,362 Sailors attached to 9 Arleigh-Burke Guided Missile Destroyers deployed across 2024-2025 in 2 Carrier Strike Groups (CSGs)



Photos courtesy of DVIDS

Enrollment

Pre-Deployment Survey

**Oura Ring Setup on
Personal Phone**

Deployment

**Continuously Wear
Oura Ring**

**Upload Oura Ring Data to
Cloud Database**

**Mid- and End-of-
Deployment Surveys**



PROJECT PROCEDURES: WEARABLE DEVICE

Sailors were instructed to wear, charge, and sync Oura ring with application daily.

Sailors had access to the Oura Health app on their personal phone.

For research team to obtain data, Sailors had to open the app while connected to Starlink.



Photos courtesy of Oura



PROJECT PROCEDURES: LEADERSHIP REPORTS

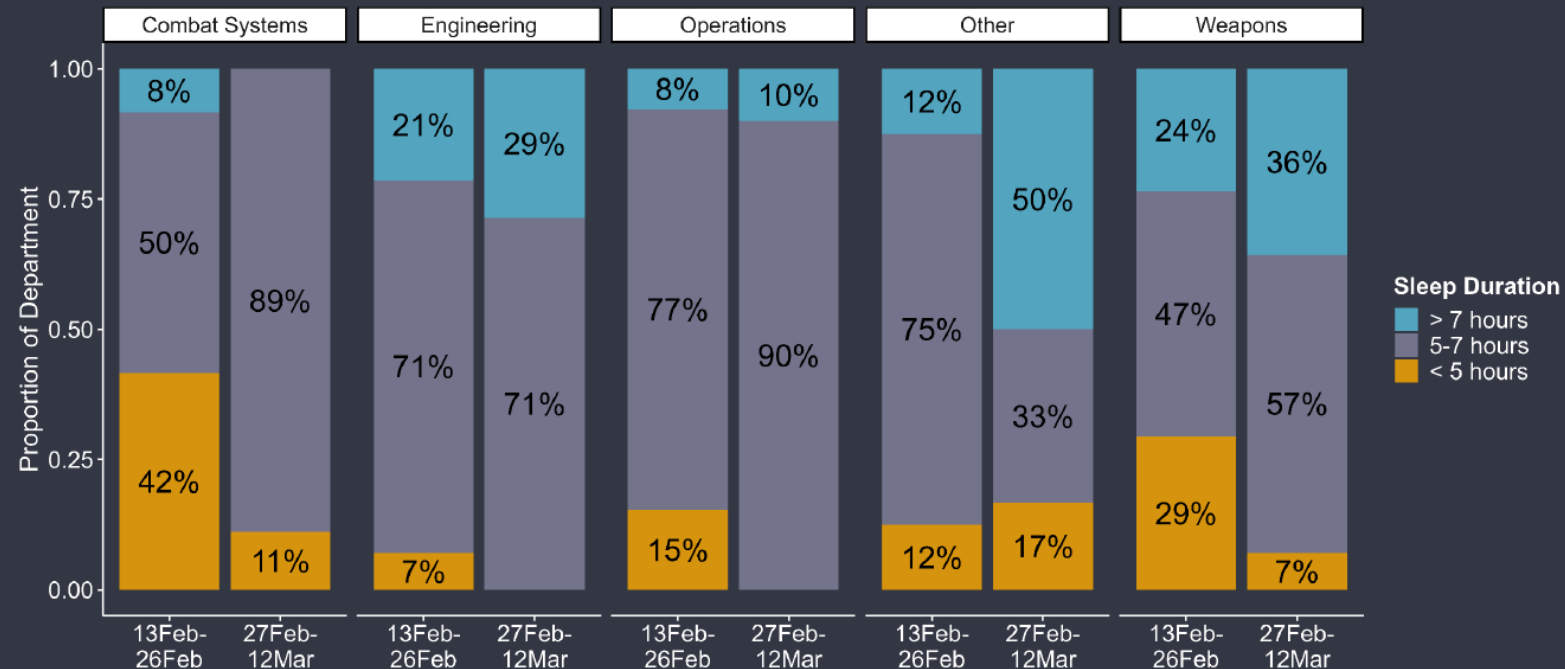
Example Sleep Readiness Summary Report (provided every 2 weeks)

Changes in Sleep by Department

13Feb-26Feb vs. 27Feb-12Mar

All departments but Combat Systems had an increase in crew obtaining the recommended 7hr of sleep per day.

All departments except Other had a decrease in crew obtaining <5hr of sleep.

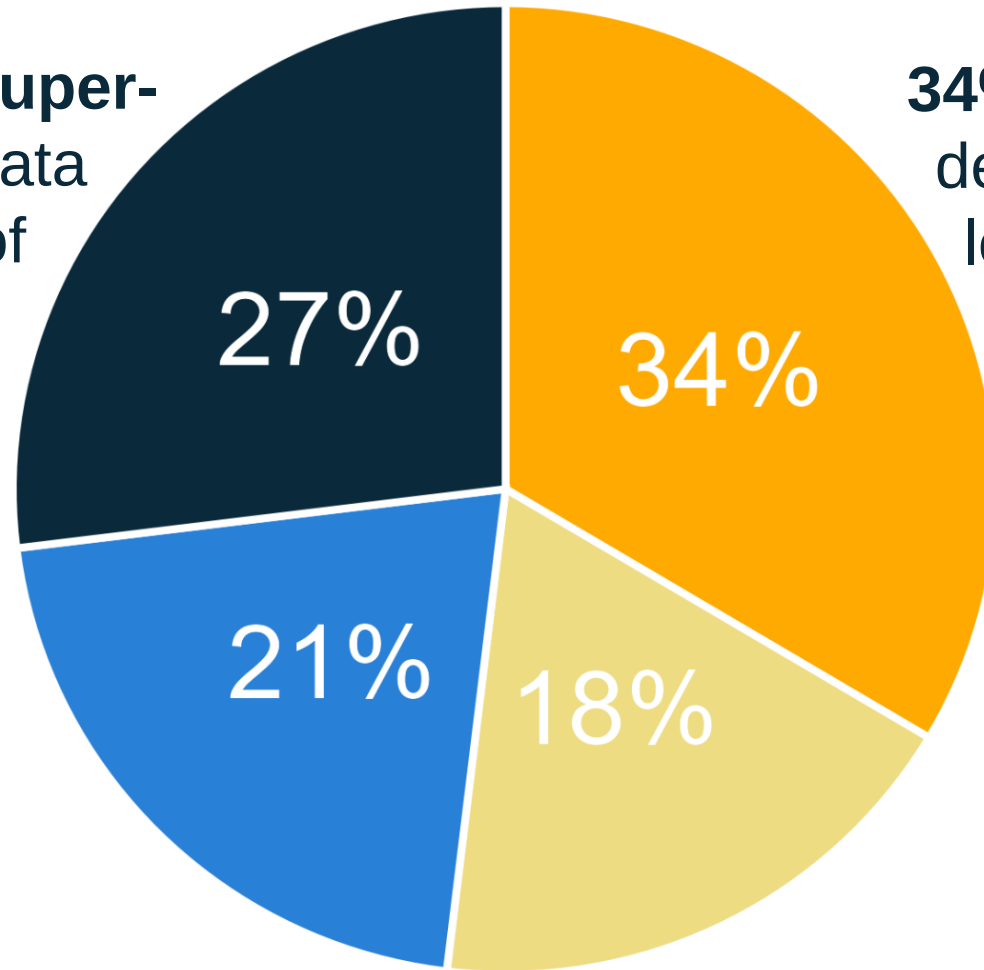




DEVICE USE DURING 5-11 MONTHS ON DEPLOYMENT

27% of Sailors were **super-users** who provided data from more than 75% of available nights.

34% of Sailors did not wear the device enough to contribute at least 25% of available nights.

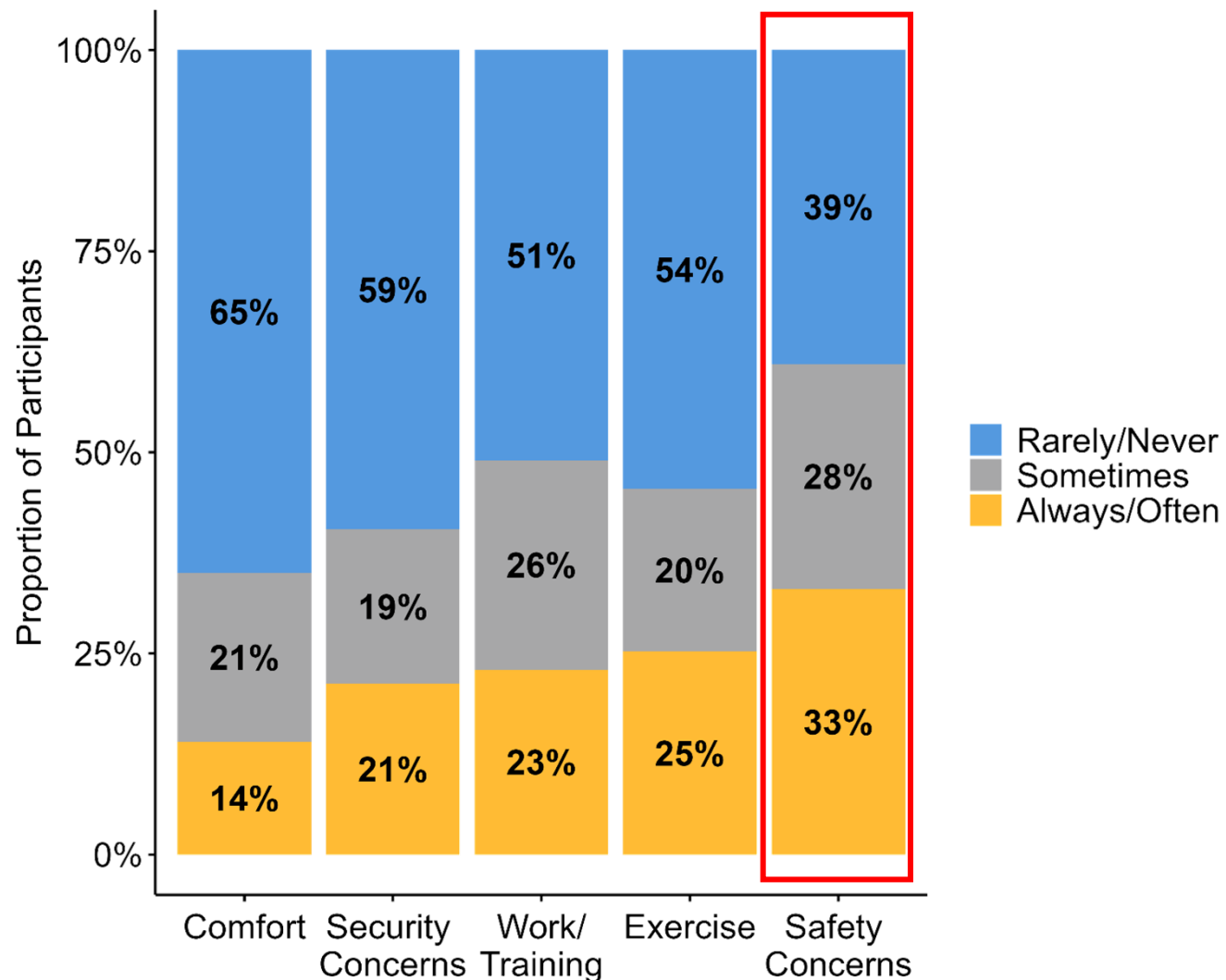


Nights of Data from Each Participant

- > 75%
- 50-75%
- 25-50%
- 0-25%



BARRIERS TO DEVICE USE DURING DEPLOYMENT



The most frequently reported barrier to Oura device use was **safety concerns**.

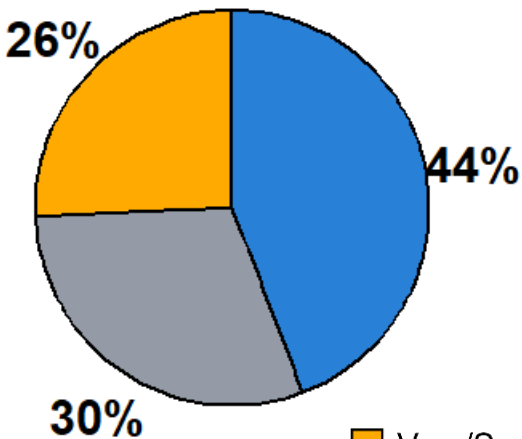
Device use was also limited by device-specific factors, including the need to sync and battery life.



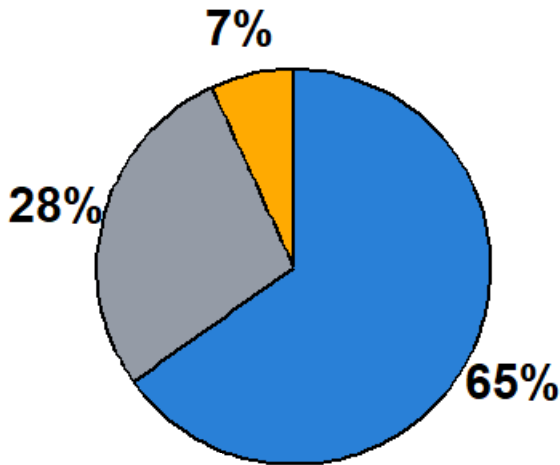
SAILOR WILLINGNESS TO USE WEARABLES FOR OPERATIONAL FATIGUE MONITORING

Sailors were asked to what extent they would be willing to use a wearable to support underway ORM when leadership had access to different data:

Individual-Level Data



Group-Level Data

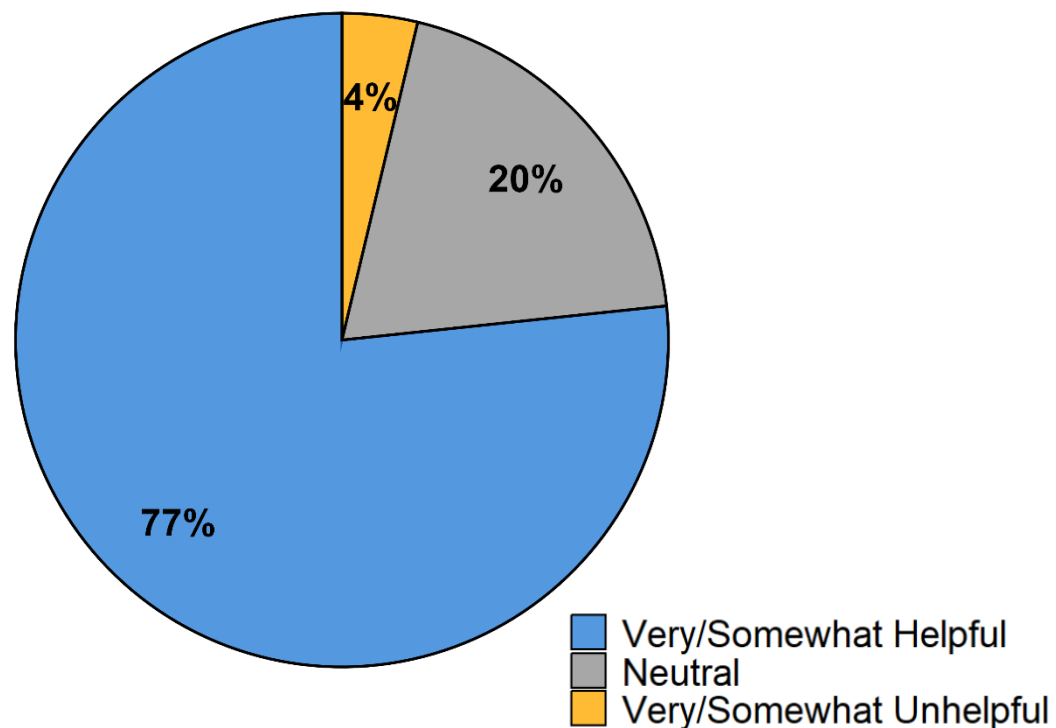


- Very/Somewhat Unwilling
- Neutral/Unsure
- Very/Somewhat Willing

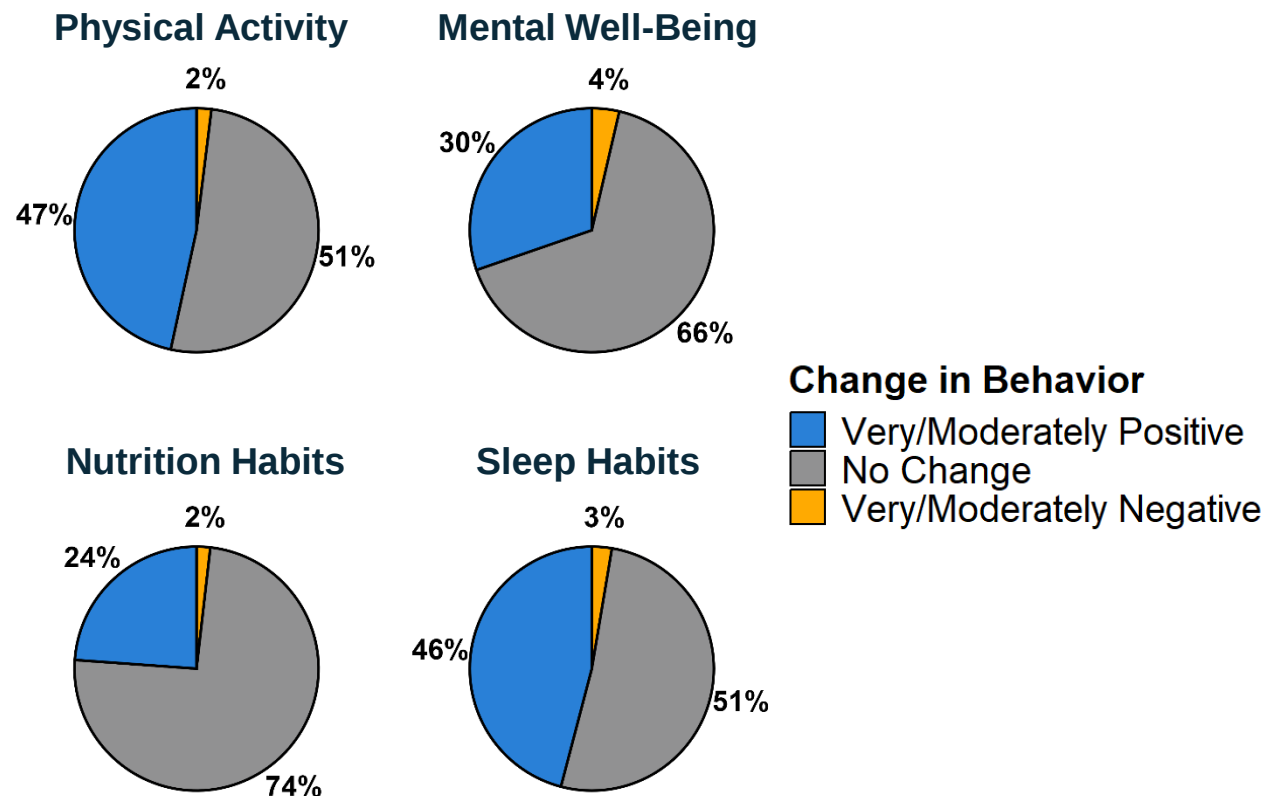


UTILITY OF DATA FOR INDIVIDUAL SAILORS

Perceived Helpfulness of App Data & Summary Information



Self-Reported Health-Related Changes Due to Device Feedback



Operational constraints limit the ability to make health-related changes, yet many Sailors still reported that they experienced some positive changes.



INTRODUCING SLEEP READINESS DATA TO DEPLOYMENT OPERATIONS

Workflows and Processes for Command-Level Data

- Leadership published the command-level data for all Sailors to access.
- Reports were brought up at quarters ~2x per week for opportunities to provide education and support.
- Department heads regularly reviewed data to provide insight on how they can better manage fatigue at departmental level.



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Lessons Learned

- More spare devices are needed onboard. Gen 4 Oura had increased battery failures and physical failures. Sailors needed replacements and tech support.
- Periods of lack of connectivity meant that some reports did not have data for that period, reducing data usefulness.
- Many Sailors were provided devices weeks before deployment and either lost or forgot devices before departing.



UTILITY OF DATA FOR LEADERSHIP

Commanding Officers were asked several questions about their perceptions and use of the sleep data/visualizations provided in biweekly reports.

How to Better Operationalize Wearables Data

- More data – Include sleep timing data as well as activities, heart rate, stress, etc.
- Real time – COs noted if data were real time, they could adjust ship schedules for the following day to offset shortened sleep periods, and/or adjust divisional workloads.
- Specificity – COs indicated a desire to be able to check in on a Sailor.



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How Sleep Data Were Used During the Deployment

- Confirmed/validated intuitions about which departments were struggling
- Adjusted Wi-Fi availability in berthing and implemented quiet hours
- Adjusted long-range schedules (e.g., FQs, drills, meetings)
- Verified watchbill schedule changes did affect/improve sleep over time
- Implemented additional rest periods



NEXT STEPS FOR HUMAN SYSTEM MONITORING

Address Compliance

Introduce different device form factors (e.g., wrist or arm worn) to address safety concerns and comfort

Make it optional to download an app on a personal device

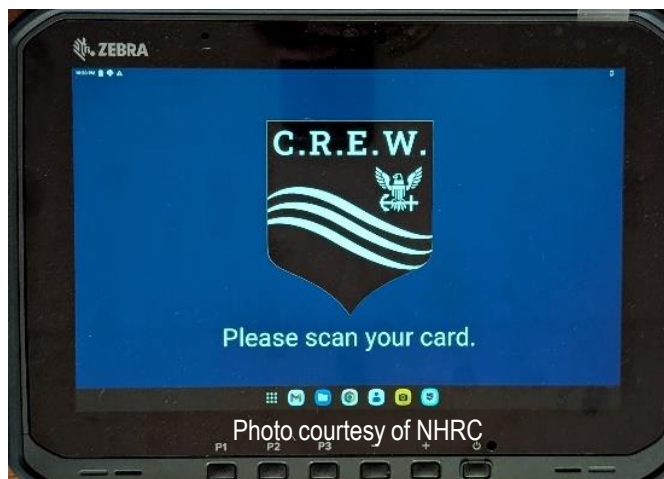
Automate data transfer so Sailors do not have to sync with a device every day

Provide data transparency and assurances against data used punitively

Implement CREW System

- Secure, shipboard system
- Uses hubs to automatically collect sleep readiness data
- Provides on-demand data to support underway decision-making in near real-time
- Provides a choice in form factor

Developed by MIT – Lincoln Laboratory



Further Examination

Confirm CREW system will improve compliance and data availability over multiple months of use

Assess value of real-time data to operational decision-making

Link wearable outcome data with operational data for a ROI determination



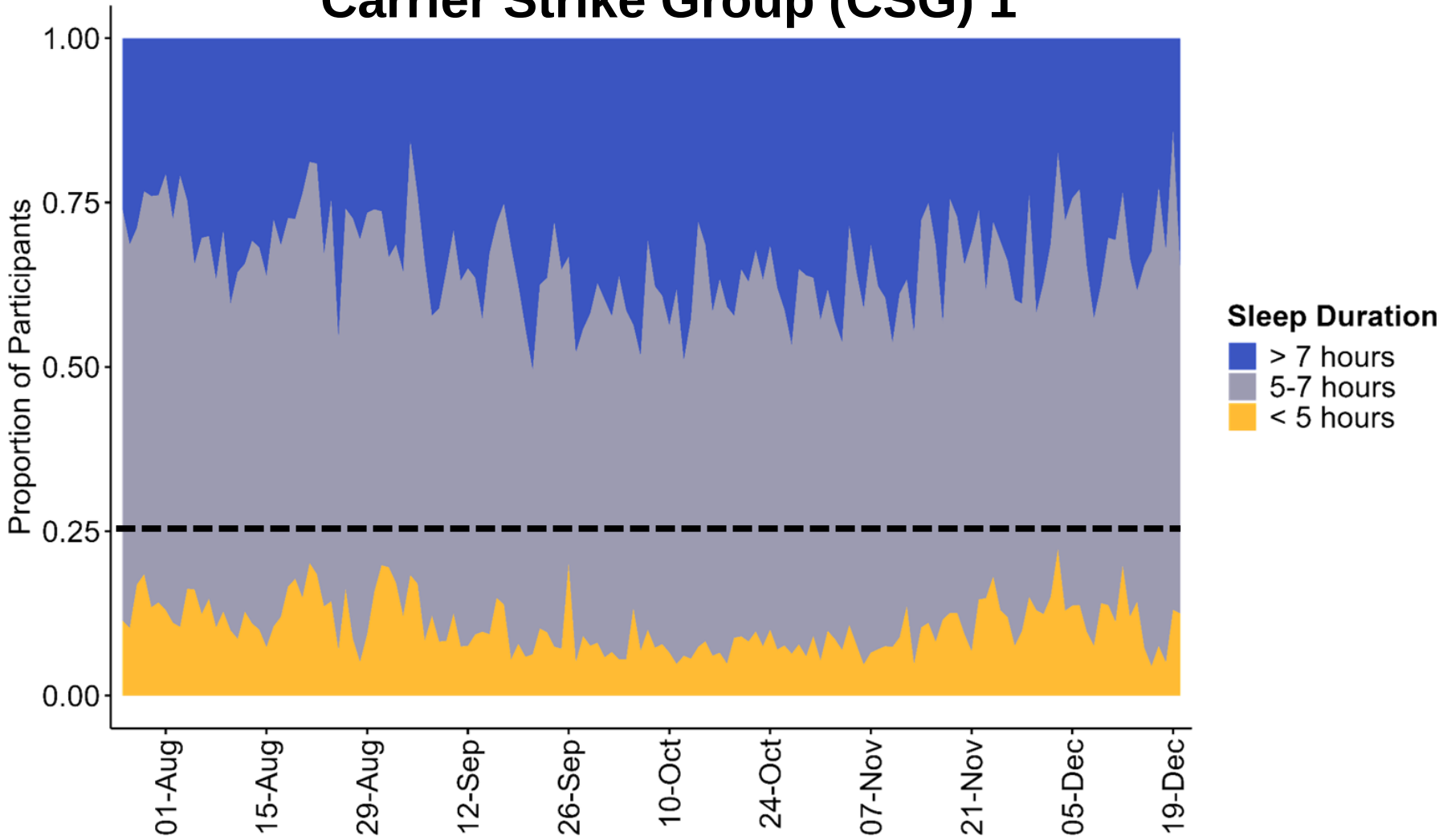
BACKUP SLIDES



SLEEP DURATION OVER DEPLOYMENT LENGTH

Carrier Strike Group (CSG) 1

**CSG 1:
5-month
deployment**

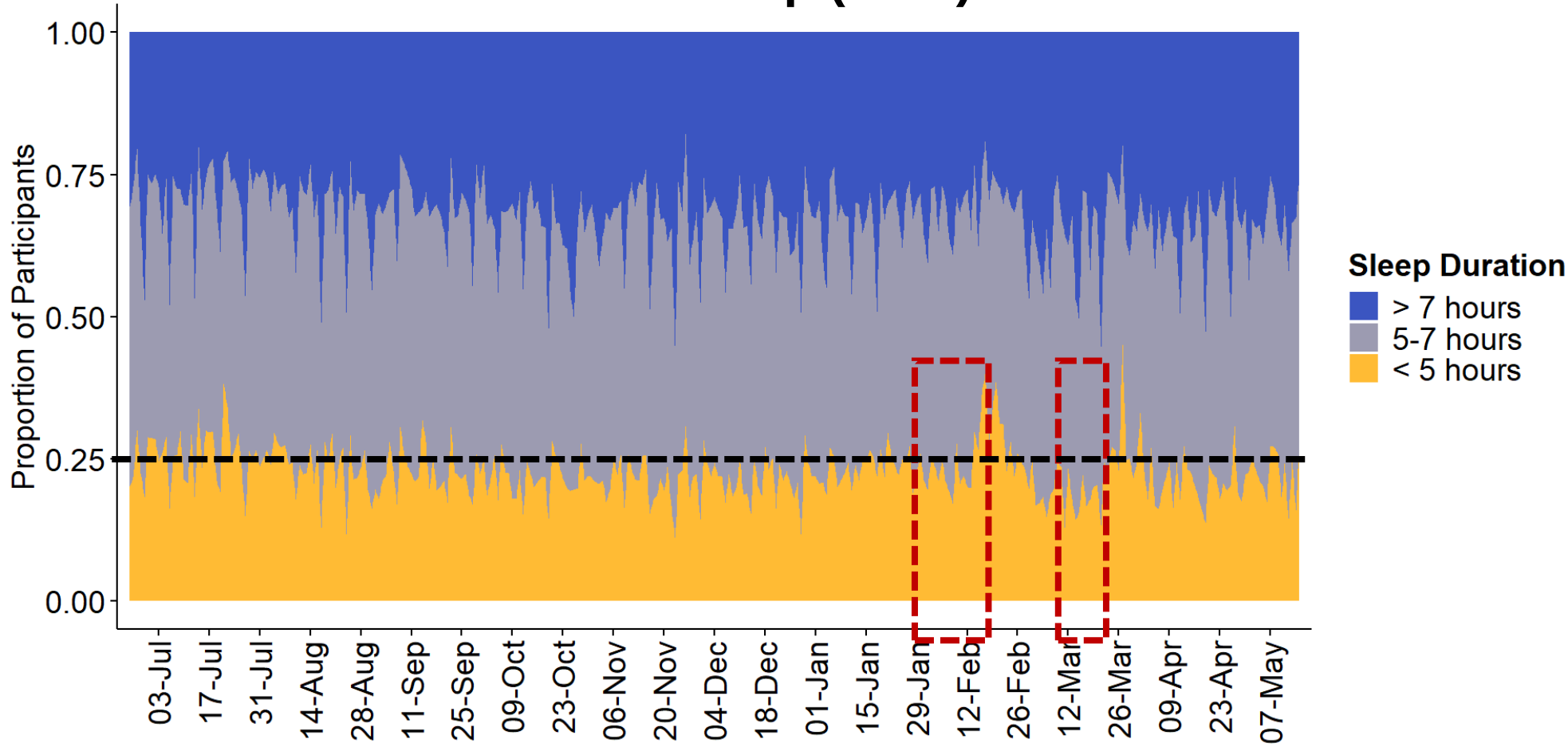




SLEEP DURATION OVER DEPLOYMENT LENGTH

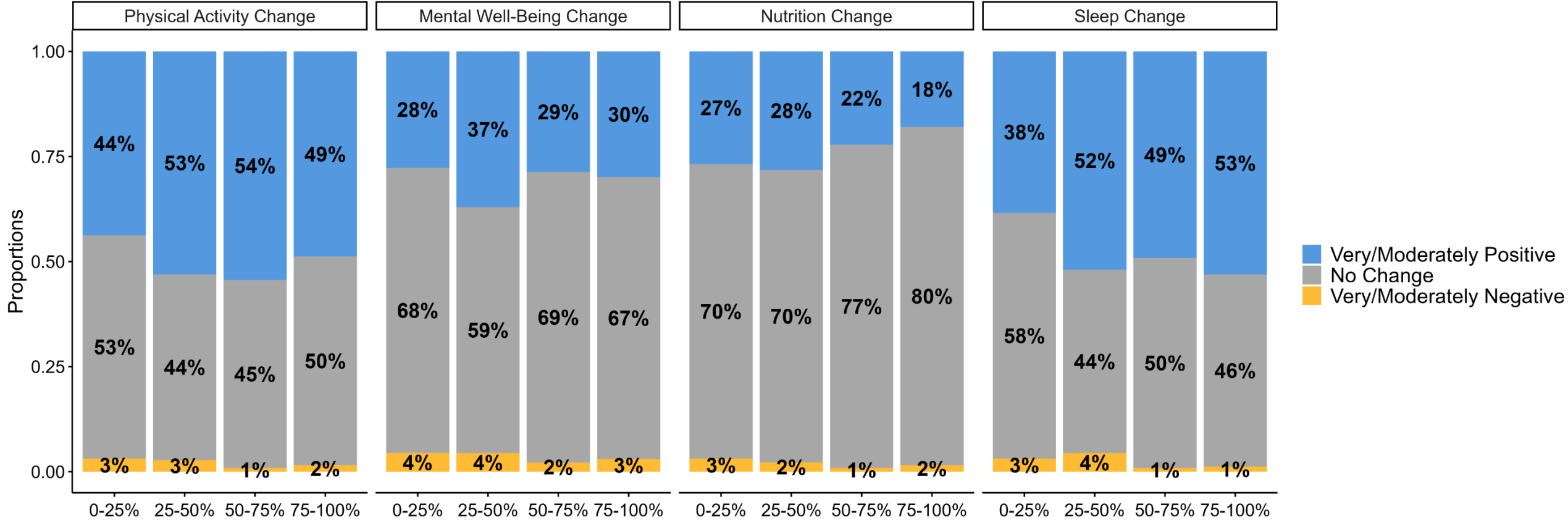
Carrier Strike Group (CSG) 2

CSG 2:
11-month
deployment





MORE DEVICE USE MAY BE RELATED TO MAKING POSITIVE BEHAVIOR CHANGES





QUOTES FROM COMMANDING OFFICERS

“It would be even more beneficial if the data would provide personnel by name so I could direct watchbill changes for an event like a S&A Detail, if, for example, the designated Master Helmsman’s rest had suffered in the proceeding days and that would drive me to make a change.”

“The reports provide empirical data to advocate for schedule changes and allow Sailors to receive the rest they need.”

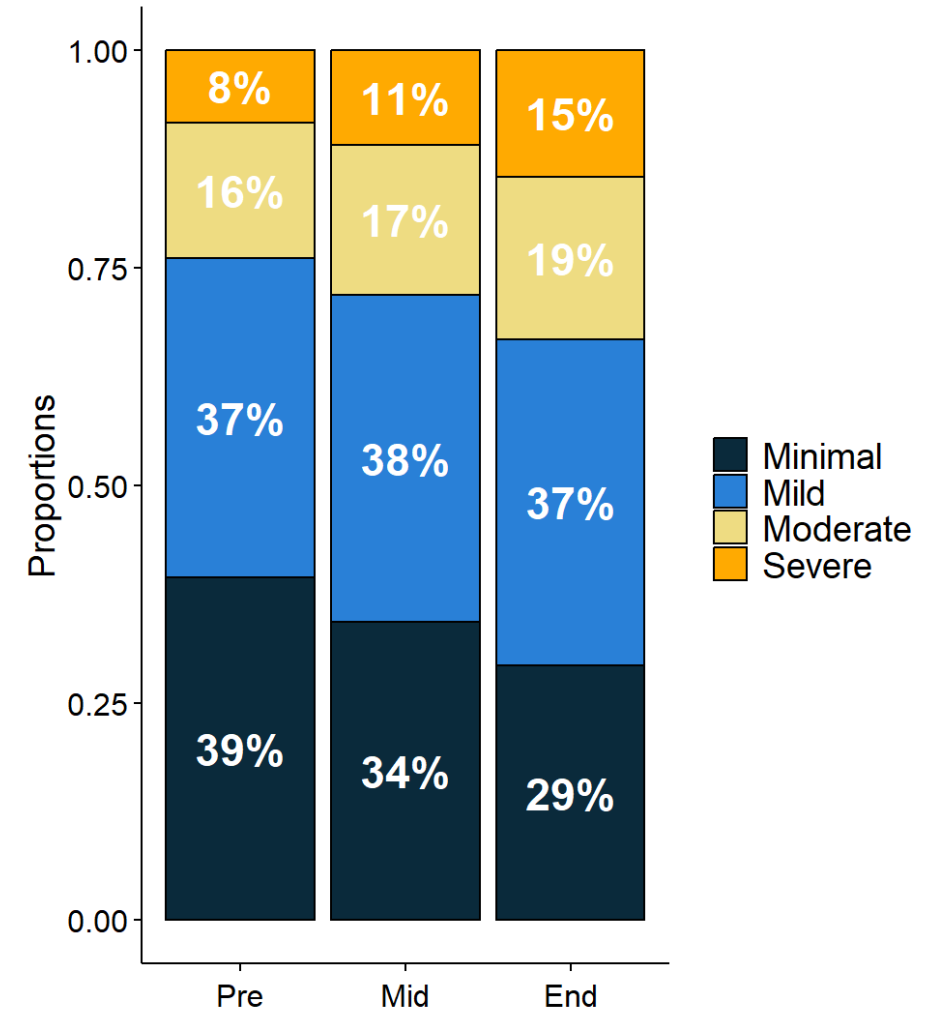
“I like that the reports provide trends associated with events that allow the Triad to make informed decisions for future events. For example, during our high threat transits, we cleared the ship’s internal schedule and POD of any events and stopped routine meetings and evolutions in the two days prior and two days after to allow the crew to rest and fully focus on the mission at hand in terms of preparation and recovery.”



ANXIETY SYMPTOMS INCREASED THROUGHOUT DEPLOYMENT, BY COMMAND

Participants were asked to consider how often in the past 2 weeks they were bothered by:

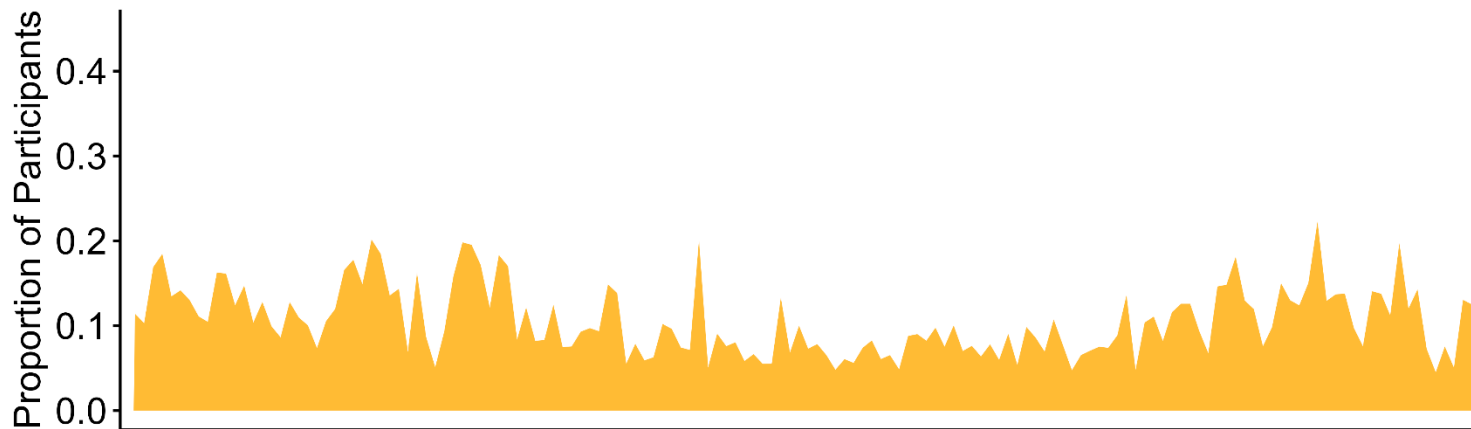
Feeling nervous, anxious or on edge



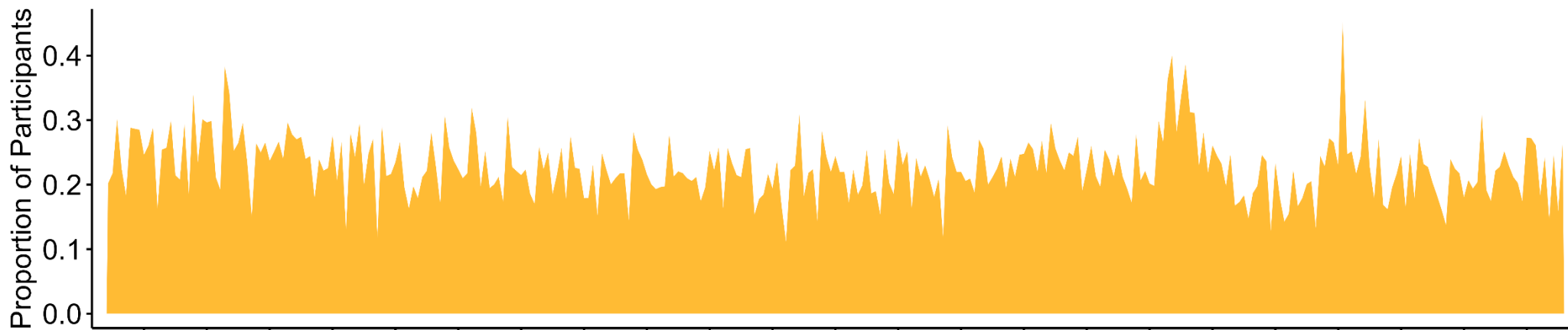


DIFFERENCES IN SHORT SLEEP THROUGHOUT DEPLOYMENT BETWEEN CSG

**CSG 1:
5-month
deployment**



**CSG 2:
11-month
deployment**

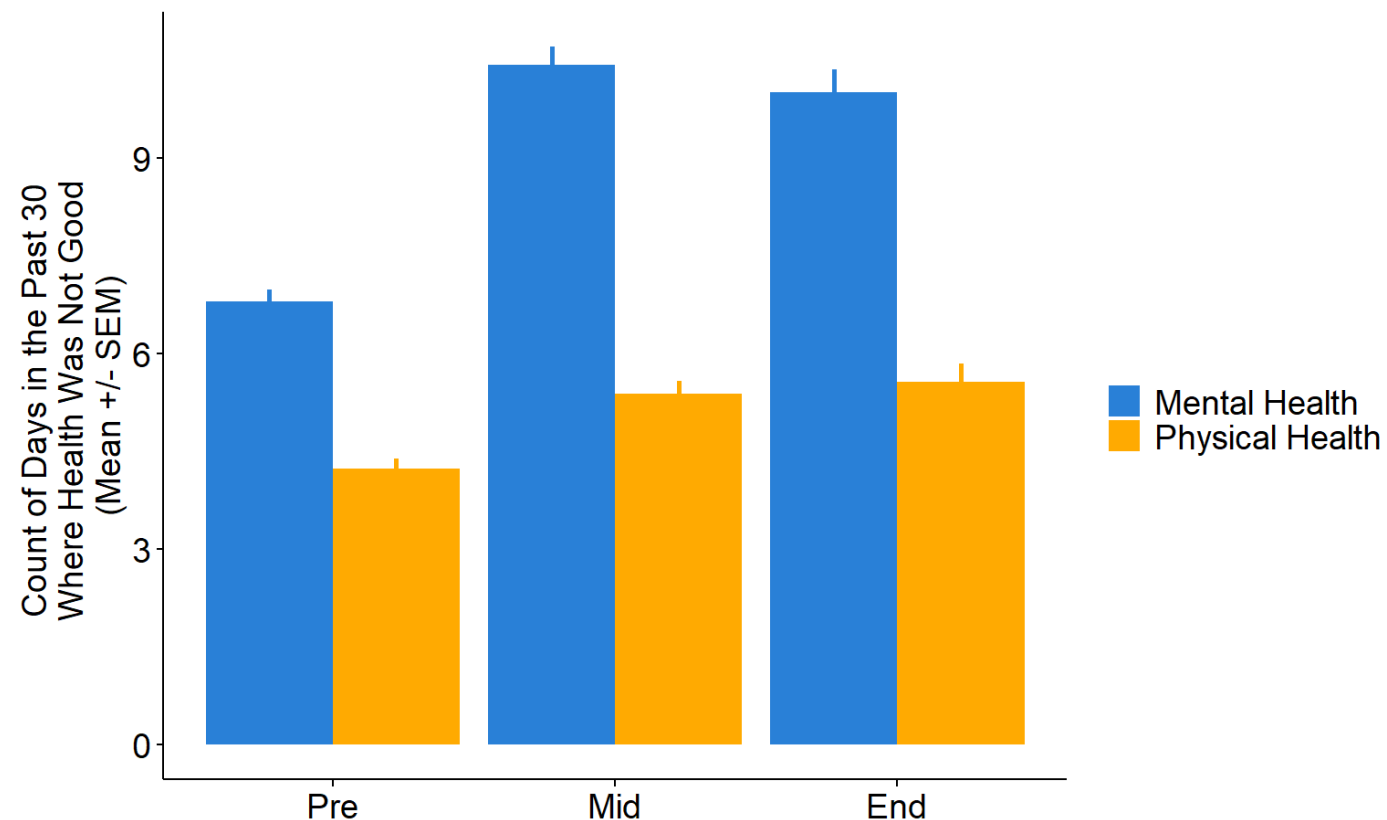




MENTAL AND PHYSICAL HEALTH THROUGHOUT THE DEPLOYMENT

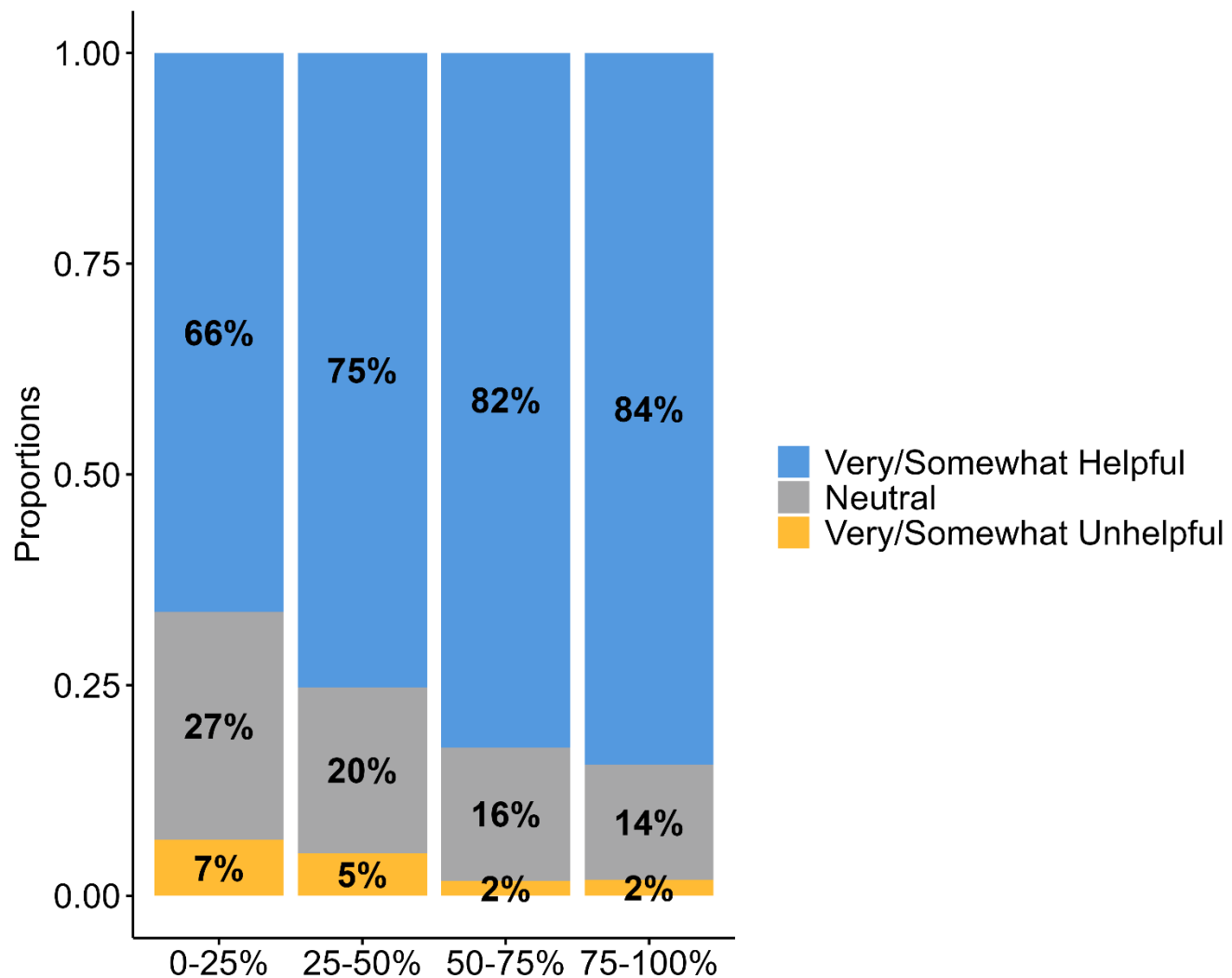
More days of poor mental health are consistently reported than days of poor physical health.

Mental and physical health was worse during the deployment than before the deployment.





MORE DEVICE USE MAY BE RELATED TO MAKING POSITIVE BEHAVIOR CHANGES





CONCLUSIONS ON WEARABLE USE AND VALUE WHILE ON DEPLOYMENT

Individual Value

Sailors largely found device data to be helpful and some reported using the data to improve health behaviors.

Few Sailors reported negative effects of device use on their health and well-being.

Operational Value

Command leadership found the data helpful in understanding deployment impacts on sleep readiness.

A real-time system will increase use and value of wearable data.



USS Gerald R. Ford Homecoming. U.S. Navy photo by Mass Communication Specialist 2nd Class Mike Shen/Released