

A. OVERALL COVER PAGE

Project Title: Assessments of Sleep Deprivation and Associated Health and Cognitive Impacts in Commercial Fishermen	
Grant Number: 1U01OH011899-01	Project/Grant Period: 09/01/2019 - 08/31/2021
Reporting Period: 09/01/2019 - 08/31/2021	Requested Budget Period: 09/01/2019 - 08/31/2021
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Change of Contact PD/PI: NA	
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Human Subjects: NA	Vertebrate Animals: NA
hESC: No	Inventions/Patents: No

B. OVERALL ACCOMPLISHMENTS

B.1 WHAT ARE THE MAJOR GOALS OF THE PROJECT?

Sleep deprivation and its impact on occupational health and safety have been studied in a number of industries where work hours and work schedules routinely interfere with workers ability to get sufficient, sustained sleep. For example, long-haul truckers, emergency room physicians, medical residents, pilots and factory night-shift workers, have all been identified as at-risk occupations in studies of sleep debt impacts on worker health. Although sleep deprivation is a constant reality for many of these workers, the environments they work in tend to be fairly safe. This makes it possible to not only control their exposures to other risks, but to monitor sleep patterns and collect cognitive and health assessment data. Unfortunately, this has not been the case for commercial fishermen. These workers arguably suffer from the most extensive sleep debt, experience wildly fluctuating sleep schedules and work in an environment where the risk of injury or death is constantly present. As far back as 1991, the National Research Council Committee on Fishing Vessel Safety indicated sleep deprivation has been a widely recognized and chronic problem. Despite the recognized need to understand the impact of sleep debt and develop viable solutions for fishermen, there is an almost complete lack of research that has been conducted on this topic.

Long-Term Goal of the Project. The long-term objectives for this research will be to develop a broader base of knowledge regarding how sleep debt impacts fishermen's health and injury/fatality risk, and to develop viable, evidence-based practices to reduce these risks.

Objective of This Application. This study proposes to close the current gap in sleep studies research by developing and trialing the technology, data collection tools, methods and protocols that are necessary for advancing sleep studies research in commercial fisheries in the years to come. In addition, the data generated from the proposed research activities will be used to generate hypotheses that can be further tested in expanded commercial fisheries sleep deprivation research in future. The rationale for this research is that once the tools, methods, protocols and hypotheses have been developed, it will be possible to remove a primary barrier to progress on this issue. We plan to successfully achieve our objectives by completing the following specific aims:

Specific Aim #1: In order to develop data collection tools that will be essential for completing the various phases of our proposed research, as well as future sleep debt studies, we will conduct qualitative interviews with commercial fisheries workers in Alaska (Salmon), Oregon (Dungeness Crab), Massachusetts (Scallop) and Massachusetts (Inshore Lobster). These same fisheries will also be invited to participate in sea trials of wrist actigraphy to assess the reliability of these devices for documenting sleep profiles in commercial fisheries workers. This data will be vital for completing the activities described in Specific Aim #2. **THIS AIM HAS BEEN COMPLETED.**

Specific Aim #2: Using data from qualitative interviews and actigraphy sea trials the research team will develop and pilot data collection instruments and protocols that will capture health assessment, cognitive functioning and sleep profile data from fisheries workers in all three study regions (AK, OR and MA). These tools will be assessed for accuracy, while protocols will be developed to maximize subject recruitment success and participation rewards. These activities will lead to the successful completion of Specific Aim #3 activities. **THIS AIM HAS BEEN COMPLETED.**

Specific Aim #3: Once tools, methods and protocols have been developed and tested, Regional Investigators will work with an occupational health nurse to collect health and cognitive assessment data, as well as data on sleep patterns and quality. This information will be analyzed and prepared for Aim #4 activities. **THIS AIM HAS BEEN COMPLETED.**

Specific Aim #4: Data summaries and researcher experiences will be used to generate hypotheses and develop recommendations for conducting future commercial fishing sleep debt studies. Information will be shared with other occupational health and safety researchers and with the fishing populations in each of the study regions. Data, methods and protocols will also be used to prepare an R01 application that will focus on more expansive research on this topic, as well as developing or testing evidence-based practices to mitigate the harmful effects of sleep debt in commercial fisheries workers. **THIS AIM HAS BEEN NEARLY COMPLETED.**

B.1.a Have the major goals changed since the initial competing award or previous report?

No

B.2 WHAT WAS ACCOMPLISHED UNDER THESE GOALS?

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B.3 COMPETITIVE REVISIONS/ADMINISTRATIVE SUPPLEMENTS

For this reporting period, is there one or more Revision/Supplement associated with this award for which reporting is required?

No

B.4 WHAT OPPORTUNITIES FOR TRAINING AND PROFESSIONAL DEVELOPMENT HAS THE PROJECT PROVIDED?

NOTHING TO REPORT

B.5 HOW HAVE THE RESULTS BEEN DISSEMINATED TO COMMUNITIES OF INTEREST?

Ten presentations on study methods and results have been shared at either academic gatherings, occupational health and safety conferences or industry events (for example, presentations have been shared at the Massachusetts Lobstermen's Association meetings and the Maine Fishermen's Forum). In addition to these efforts, the research team is working to complete a final study report, which will be sent to all fishermen who participated in the study, study partners and industry partners. Dr. Laurel Kincl will also be distributing copies of the report to West Coast fishermen in her visits with commercial fishermen that are scheduled in the fall of 2023. Northeast Center staffer Liane Hirabayashi will also be distributing copies of the report at the upcoming Pacific Marine Expo, scheduled in November of 2023. This information will also be presented at the upcoming IFISH6 Conference to be held at the Food and Agriculture Organization of the United Nations in Rome in January of 2024. Most importantly, the research team developed a podcast series in coordination with NIOSH and other academic and industry partners. This podcast series featured late breaking research on sleep and health for commercial fishermen with a total of 18 episodes featured in the series. This allowed the research team to immediately disseminate information and recommendations for keeping fishermen "ship-shape in the fishing industry". See: Podcast Series: <https://coastalroutes.org/fishingforwardpod>

B.6 WHAT DO YOU PLAN TO DO DURING THE NEXT REPORTING PERIOD TO ACCOMPLISH THE GOALS?

Not Applicable

B2: What was accomplished under these goals?

Over the past three years much has been accomplished in our efforts to better understand sleep deprivation and the associated health and safety impacts on fishermen. Major activities have included:

Aim #1 Collecting Preliminary Data for Developing Data Collection Tools. A key component of the proposed research was focused on trialing wearable technology for tracking fishermen's sleep schedules and quality at sea. Comparisons of commercially available sleep tracking wearable devices was also conducted to look at the reliability of each device and assess the consistency of results across devices. This data has been shared in several academic and professional presentations and has also been submitted for publication in a peer-reviewed journal. In addition to this activity, the research team sought to develop surveys and organize health assessments with fishermen to capture data on sleep schedules, nutrition, caffeine and alcohol consumption, as well as any health concerns they experience relative to sleep deprivation. To develop these surveys, the research team conducted interviews with fishermen and scanned the literature to identify any existing data collection tools that might be adapted for the study. Overall, twenty-two interviews were conducted with fishermen in the AK Salmon, OR Dungeness Crab, MA Scallop and MA Lobster fishing industries. These interviews were analyzed and used to develop the survey instruments used in the study. This data was also published in Marine Policy, a peer-reviewed journal. The scan of the literature led to the identification of a study conducted by Deb Cherry, MD on health and sleep and some of the questions used in this study were adapted for our study with Dr. Cherry's permission.

Aim #2: Develop and Pilot Data Collection Instruments and Protocols. Over the past few years, multiple data collection tools, protocols and databases have been developed. These include a 42 question survey that captures information on demographics, work schedules, sleep schedules, alcohol, caffeine and tobacco use, diet, sleep, physical and emotional health and fishing related injuries. Additionally, a sleep log was created to compare reported sleep routines with wearable technology sleep schedule documentation. For health assessments, an occupational tech data collection form was created to capture data on height/weight, vision, peak flow, blood pressure, random glucose, cholesterol, Framingham Scores, urinalysis, PTSD and sleepiness. A data collection form was also created for physicians to capture information generated from physical exams, HEENT data, respiratory health, edema, pulse, missing digits, skin disorders, neurological conditions, MSDs and memory and concentration abilities. All data collection forms were developed with associated protocols.

Aim #3: Collecting Sleep, Health and Cognitive Assessment Data. Survey data was collected from 262 fishermen in the Dungeness Crab, Salmon, Scallop and Lobster fishing industries. For 162 of these fishermen, a comprehensive health assessment was also conducted. Our health assessment teams facilitated 31 clinic days for the 162 fishermen in AK, OR and MA (ten locations in all). This required bringing medical equipment, sufficient support staff, data collection instruments and medical supplies to all ten locations. The teams were composed of a physician or nurse practitioner,

technician and an assistant. Health assessments were well-received by fishermen, and extensive outreach was conducted via radio, social media, dissemination by partners, word of mouth and dockside engagement with the population to boost the sample size. 1,645 contact attempts were required to achieve targeted recruitment and sample size numbers. However, all data collection and recruitment goals were achieved and the data collected from these activities represents the most comprehensive data set on fisheries sleep patterns, diet, nutrition and mental/physical health in the country.

Aim #4. Data Summaries, Reports and Next Steps. Over the course of the study, three peer-reviewed articles have been published, several more are in process and a Final Report is being compiled which will be shared with research participants, industry and academic partners and health professionals. Additionally, study methods and results have been shared in ten presentations with academic partners, industry representatives and occupational safety and health professionals. Information on the study is also featured on the Northeast Center for Occupational Safety and Health website (see www.necenter.org)

Significant Results. Although it will likely take years to analyze and publish all of the data collected in this study, there are several initial findings that are worthy of noting. For example, the average total hours of daily sleep that fishermen report is around five, regardless of fishery. On average, fishermen also report that experience the least hours of daily sleep for roughly 5 consecutive days, although the highest number of consecutive days with minimal sleep was reported by Dungeness Crab fishermen. Sleep hygiene, in general (i.e. whether it be sleep onboard a fishing vessel or at home), was not ideal for a significant number of fishermen. Two out of every five fishermen in the study reported chronic pain so severe that it interfered with their sleep and nearly half indicated they did not have great sleep quality either on or off the boat.

Looking at diet both on and off the boat, 17.8% of fishermen said their diet was poor both on and off the boat, 33.7% said their diet was good at home, but poor on the boat, 5.3% of fishermen said their diet was good on the boat but poor at home and 43.3% said their diet was good at home and good on the boat. This indicates a little over half feel their diet on the boat is poor, while most feel their diet at home is good.

In addition to the physical health assessments, each of the fishermen were screened for PTSD using a PTSD screener used in most clinical settings. This screener poses several questions relating to a traumatizing event or events. Answering yes to three or more questions results in a positive diagnosis for PTSD. According to our results, 12% of the men participating in health assessments screened positive for PTSD. This is compared to just under 5% for the general population of men in the U.S. as reported by the U.S. Dept of Veterans Affairs.

Key Outcomes or Achievements. This study has led to the most comprehensive data set on commercial fisheries workers sleep schedules, health and health concerns in the country. It has also provided a solid foundation for further studies on sleep and health concerns among commercial fishermen.

C. OVERALL PRODUCTS

C.1 PUBLICATIONS

Are there publications or manuscripts accepted for publication in a journal or other publication (e.g., book, one-time publication, monograph) during the reporting period resulting directly from this award?

Yes

Publications Reported for this Reporting Period

Public Access Compliance	Citation
N/A: Not NIH Funded	Sorensen J, Echard J, Weil R. From Bad to Worse: The Impact of COVID-19 on Commercial Fisheries Workers. Journal of agromedicine. 2020 October;25(4):388-391. PubMed PMID: 32921274; DOI: 10.1080/1059924X.2020.1815617.
N/A: Not NIH Funded	Sorensen JA, Kincl L, Weil R, Dzugan J, Cristel D. Fisheries governance and associated health implications: Current perspectives from US commercial fishermen. Marine Policy. 2022 July;141.

C.2 WEBSITE(S) OR OTHER INTERNET SITE(S)

Category	Explanation
Audio or video	Podcast Series: https://coastalroutes.org/fishingforwardpod
Other	https://necenter.org/portfolio/catching-zs-in-commercial-fishing/

C.3 TECHNOLOGIES OR TECHNIQUES

NOTHING TO REPORT

C.4 INVENTIONS, PATENT APPLICATIONS, AND/OR LICENSES

Have inventions, patent applications and/or licenses resulted from the award during the reporting period? No

If yes, has this information been previously provided to the PHS or to the official responsible for patent matters at the grantee organization? No

C.5 OTHER PRODUCTS AND RESOURCE SHARING

Category	Explanation
Audio or video	Podcast: meche/episodes/Engineering-for-occupational-health-and-safety-e26sfcg
Audio or video	Fishing Forward Podcast Series: https://coastalroutes.org/fishingforwardpod
Data or Databases	Sleep assessment surveys (n=262)
Data or Databases	Sleep health assessments: (n=162)
Evaluation Instruments	Sleep assessment / health survey

Evaluation Instruments	Sleep health assessment occ tech screener
Evaluation Instruments	Sleep health assessment physician screener
Evaluation Instruments	Sleep pre-health assessment survey
Other	Sleep log for tracking sleep and comparing self-report data to wearable technology data designed to track sleep
Protocols	Protocols have been developed for all associated surveys and health assessments listed

D. OVERALL PARTICIPANTS

D.1 WHAT INDIVIDUALS HAVE WORKED ON THE PROJECT?

Commons ID	S/K	Name	Degree(s)	Role	Cal	Aca	Sum	Foreign Org	Country	SS
JULSOR	Y	Sorensen, Julie Ann	MA,PHD	PD/PI	0.7	0.0	0.0			NA
PAUJEN	Y	Jenkins, Paul		Statistician	0.2	0.0	0.0			NA
	N	Graham, Judy	RN	Occupational Health Nurse	1.2	0.0	0.0			NA
	N	Weil, Rebecca	MS	Project Coordinator	0.1	0.0	0.0			NA

Glossary of acronyms:

S/K - Senior/Key
 Cal - Person Months (Calendar)
 Aca - Person Months (Academic)
 Sum - Person Months (Summer)

Foreign Org - Foreign Organization Affiliation
 SS - Supplement Support
 RS - Reentry Supplement
 DS - Diversity Supplement
 OT - Other
 NA - Not Applicable

D.2 PERSONNEL UPDATES

D.2.a Level of Effort

Not Applicable

D.2.b New Senior/Key Personnel

Not Applicable

D.2.c Changes in Other Support

Not Applicable

D.2.d New Other Significant Contributors

Not Applicable

D.2.e Multi-PI (MPI) Leadership Plan

Not Applicable

E. OVERALL IMPACT**E.1 WHAT IS THE IMPACT ON THE DEVELOPMENT OF HUMAN RESOURCES?**

Not Applicable

E.2 WHAT IS THE IMPACT ON PHYSICAL, INSTITUTIONAL, OR INFORMATION RESOURCES THAT FORM INFRASTRUCTURE?

NOTHING TO REPORT

E.3 WHAT IS THE IMPACT ON TECHNOLOGY TRANSFER?

Not Applicable

E.4 WHAT DOLLAR AMOUNT OF THE AWARD'S BUDGET IS BEING SPENT IN FOREIGN COUNTRY(IES)?

NOTHING TO REPORT

G. OVERALL SPECIAL REPORTING REQUIREMENTS SPECIAL REPORTING REQUIREMENTS

<p>G.1 SPECIAL NOTICE OF AWARD TERMS AND FUNDING OPPORTUNITIES ANNOUNCEMENT REPORTING REQUIREMENTS</p> <p>NOTHING TO REPORT</p>
<p>G.2 RESPONSIBLE CONDUCT OF RESEARCH</p> <p>Not Applicable</p>
<p>G.3 MENTOR'S REPORT OR SPONSOR COMMENTS</p> <p>Not Applicable</p>
<p>G.4 HUMAN SUBJECTS</p> <p>G.4.a Does the project involve human subjects?</p> <p>Not Applicable</p> <p>G.4.b Inclusion Enrollment Data</p> <p>File(s) uploaded: Cumulative Inclusion Enrollment Report.pdf</p> <p>G.4.c ClinicalTrials.gov</p> <p>Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?</p>
<p>G.5 HUMAN SUBJECTS EDUCATION REQUIREMENT</p> <p>NOT APPLICABLE</p>
<p>G.6 HUMAN EMBRYONIC STEM CELLS (HESCS)</p> <p>Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?</p> <p>No</p>
<p>G.7 VERTEBRATE ANIMALS</p> <p>Not Applicable</p>
<p>G.8 PROJECT/PERFORMANCE SITES</p> <p>Not Applicable</p>

G.9 FOREIGN COMPONENT

No foreign component

G.10 ESTIMATED UNOBLIGATED BALANCE

Not Applicable

G.11 PROGRAM INCOME

Not Applicable

G.12 F&A COSTS

Not Applicable

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Assessments of Sleep Deprivation and Associated Health and Cognitive Impacts in Commercial Fishermen

Comments:

Racial Categories	Ethnic Categories									Total
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native										0
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported							13	252	16	281
Total	0	0	0	0	0	0	13	252	16	281

I. OVERALL OUTCOMES

I.1 What were the outcomes of the award?

The long-term objectives for this research were to develop a broader base of knowledge regarding how sleep debt impacts fishermen's health and injury/fatality risk, and to develop viable, evidence-based practices to reduce these risks. The immediate objective for this research project was to close the current gap in sleep studies research by developing and trialing the technology, data collection tools, methods and protocols that are necessary for advancing sleep studies research in commercial fisheries in the years to come. Further, the data generated from the proposed research activities was designed to generate hypotheses that can be further tested in expanded commercial fisheries sleep deprivation research in future. Over the course of the past three years, much has been accomplished in regards to these objectives. Data collection tools and protocols have been developed to capture sleep schedule, sleep hygiene, nutrition and health/injury data. Additionally, data on sleep, health and injuries was gathered from 262 fishermen and health assessments were provided for 162 of these fishermen. These data collection activities have led to the most comprehensive data on sleep routines, health concerns and health outcomes for commercial fishermen in the country. The research team also conducted at-sea trials of wearable devices to see if it was possible to accurately track sleep data from fishermen while they are onboard fishing vessels. These trials indicate that sleep times recorded across multiple devices were remarkably similar, providing evidence of the reliability of these data capture methods. However, time spent in various sleep stages was not found to be accurate across devices. In addition to these data sets, 22 interviews were conducted with fishermen to identify the factors that affect their sleep quality and their concerns about the long-term exposures to sleep debt. Information from the study has been shared with other occupational health and safety researchers and with the fishing populations in each of the study regions through peer-reviewed publications, podcasts, press releases and a final summary report, which will be shared with research participants, partners, industry representatives and on the Northeast Center website.