SUSTAINED OPERATIONS MODE: A NOVEL STRATEGY FOR MANAGING FATIGUE DURING EXTENDED FIREFIGHTING OPERATIONS

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CONTEXTUAL BACKGROUND

Future demand characteristics

- Climate change fueled by global warming is expected to increase the frequency, duration and severity of extreme weather events, including bushfires.

Hasson et al. 2009. Assessing the impact of climate change on extreme fore weather events over southeastern Australia. *Climate Research.*, 39, 159-172.

Lucas et al. 2007. Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts. *Consultancy Report prepared for The Climate Institute of Australia*.

- As a consequence, the frequency and length of firefighting campaigns, and the demands placed on personnel are likely to increase.

- In turn, increased demand on personnel poses a greater likelihood of incidents and accidents caused by fatigue.

CONTEXTUAL BACKGROUND

Future demand characteristics

- **The broad aim of the 'sustained operation mode' project is to:**

1. propose an alternative rostering strategy for managing fatigue within the context of increasing demands, and

2. to compare the fatigue implications of these novel strategies with that of existing practices

Ultimately, we hope to evaluate whether the existing rostering strategy is still the best option to manage fatigue given added demands or if there any alternative or complimentary strategies that might be beneficial.

CONTEXTUAL BACKGROUND

12-hour rotating shifts

Fatigue. Diminished capability to perform mental and/or physical work due to inadequate rest, and in particular lack of sleep.

	Day 1		Day 2		Day 3		Day 4	
Team 1	work	rest	work	rest	work	rest	work	rest
Team 2	rest	work	rest	work	rest	work	rest	work

- The current rostering strategy usually employees two teams who work either continuous 12-hour day shifts or continuous 12-hour night shifts

- This rostering strategy ensures that operations can be staffed round-the clock, but is potentially problematic because it requires some personnel to work continuous night shifts.

CONTEXTUAL BACKGROUND

Sleep during deployments

Industry reports submitted to the 2009 Royal Commission cited fatigue due to inadequate rest as a threat to safety on the fireground and during commute.

Despite little empirical data, this concern has been justified in a study by Cater et al. who interviewed 66 personnel deployed to assist in 2006-2007 firefighting campaigns. Cater, H., D. Clancy, K. Duffy, et al. Fatigue on the fireground: The DPI Experience. *in The Joint AFAC-Bushfire CRC Conference*. 2007. Tasmania, Australia: Australian Fire Authorities and Bushfire CRC.

- **Results:** Personnel working the 12-night shift:

1. were frequently **awake in excess of 24 hours** during the initial deployment:
   - time awake prior to the call for deployment
   - commute time to the fireground
   - the first 12-hour night shift

2. some reported obtaining an **average of only 3-4 hours of sleep** on subsequent days of deployment.

CONTEXTUAL BACKGROUND

Consequences and recovery from sleep loss

- Sleep loss of this magnitude is not sustainable for longer than a few days, and is generally associated with:
  - High levels of subjective fatigue
  - Poor performance on basic neurobehavioural and cognitive tasks
  - Poor safety outcomes
- Recovery from the effects of fatigue requires a minimum of two full-nights of sleep, where roughly 7-8 hours of sleep is obtained on each night
- In the absence of recovery sleep, the extent of performance deficits depends on the extent of ongoing sleep loss
  - if daily sleep is reduced but > 5-6 hours, then performance efficacy will be diminished but remain relatively stable across days
  - if daily sleep loss < 5 hours, then performance efficacy will continue to degrade across days until profound exhaustion is reached

SUSTAINED OPERATIONS ROSTERS

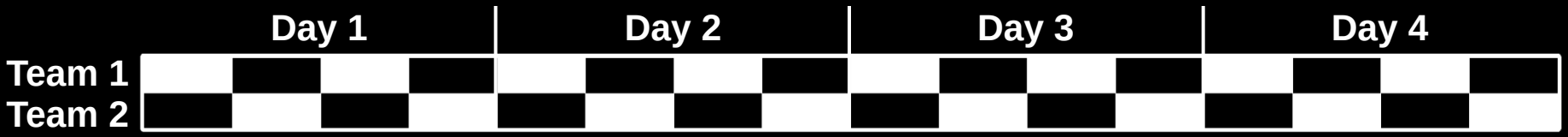
Split-shift systems

bushfire CRC

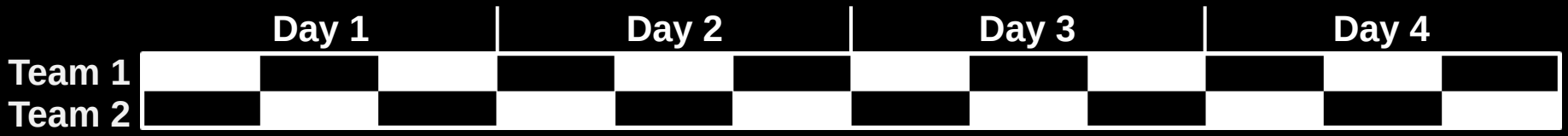
STANDARD 12-HOUR SCHEDULE

SUSTAINED OPERATIONS MODE

6-hour ON, 6-hour OFF



8-hour ON, 8-hour OFF



SUSTAINED OPERATIONS ROSTERS

Split-shift systems

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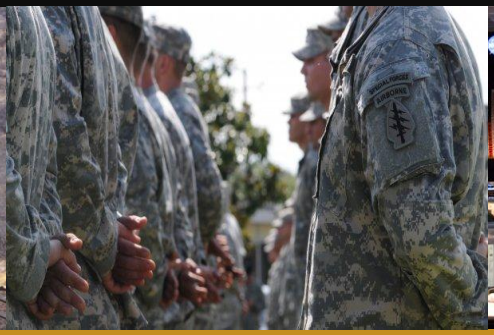
SUSTAINED OPERATIONS:

- **Examples**
  - naval setting (6-hour watch systems)
  - rail industry (8-hour ON, 8-hour OFF)
  - military operations (varied)
- **Under investigation…**
  - space operations (National Aeronautics and Space Administration)
  - truck drivers (Federal Motor Carrier Safety Administration)



SUSTAINED OPERATIONS ROSTERS

Split-shift systyems

- Instead of standard operations, i.e. replacing 12-hour shift system with a 6-hour or 8-hour shift system for specific groups (e.g. incident management teams)

- In conjunction with the standard operations to manage acute fatigue-risks, such as:

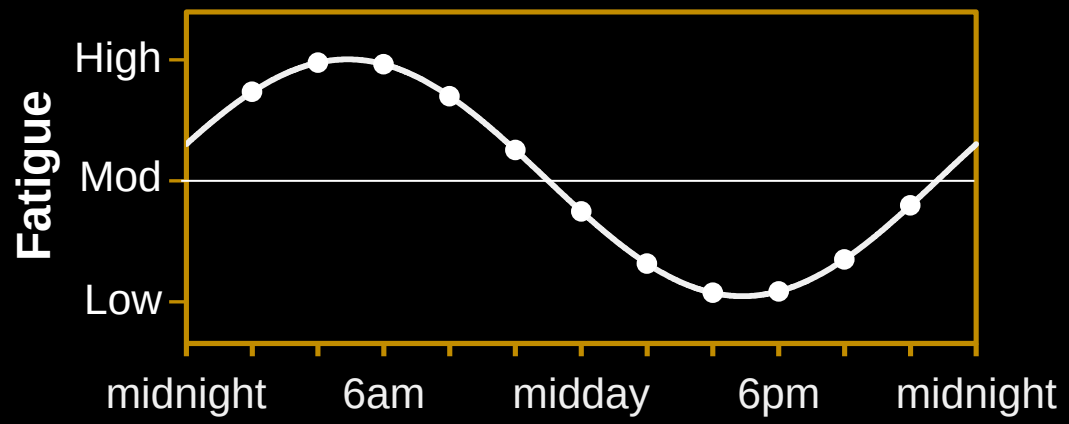
  - the start-up phase of deployments, i.e. getting personnel from home to the fireground and onto a standard shift rotation in a fit state

  - transition personnel between day and night shifts, i.e. managing staff transition due to mental and/or physical fatigue or physical injury

  - the closing phase of deployments, i.e. to ensure personnel are in a fit state prior to leaving for home

CAUSES OF FATIGUE

Basic physiological processes

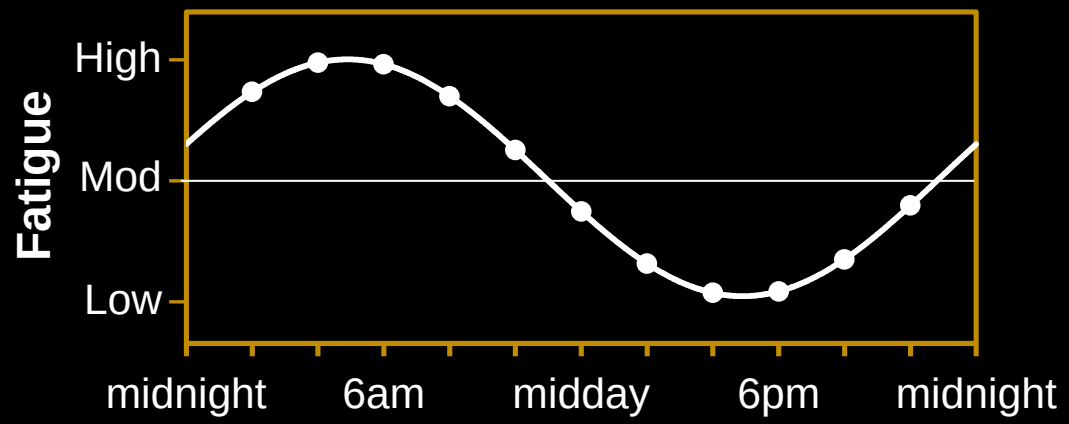


- **Internal body-clock**
  - generates a 24h rhythm in fatigue
  - anchored to the external day/night cycle

- **Sleep/wake cycle**
  - time spent awake

CAUSES OF FATIGUE

Basic physiological processes



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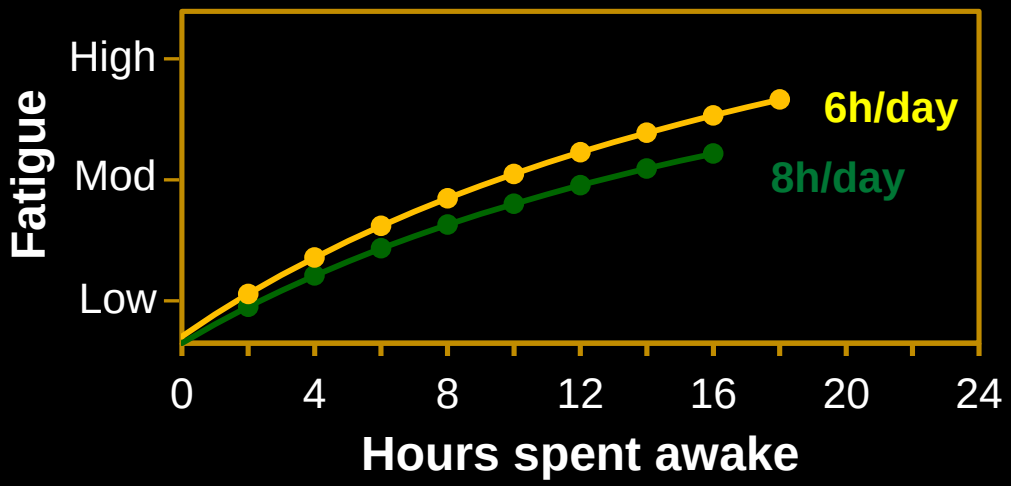

- **Sleep/wake cycle**
  - time spent awake
  - daily sleep amount

CAUSES OF FATIGUE

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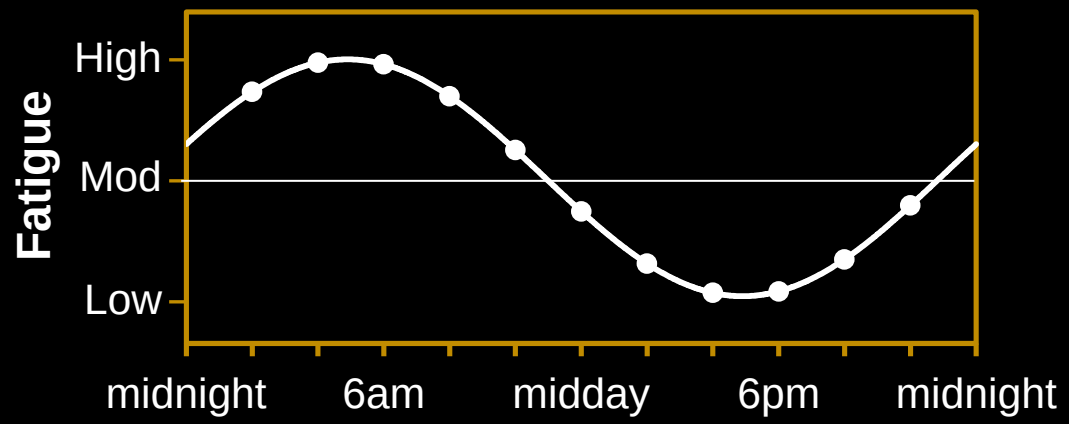

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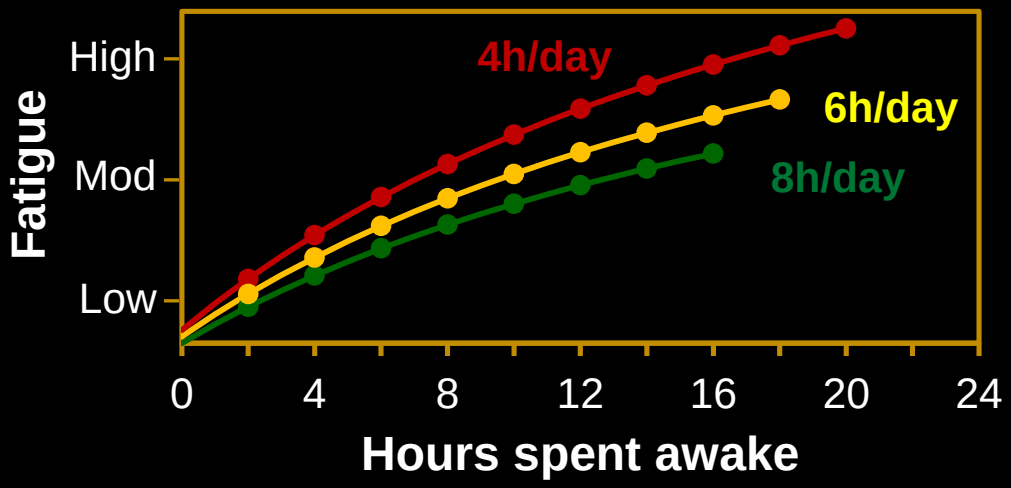

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CAUSES OF FATIGUE

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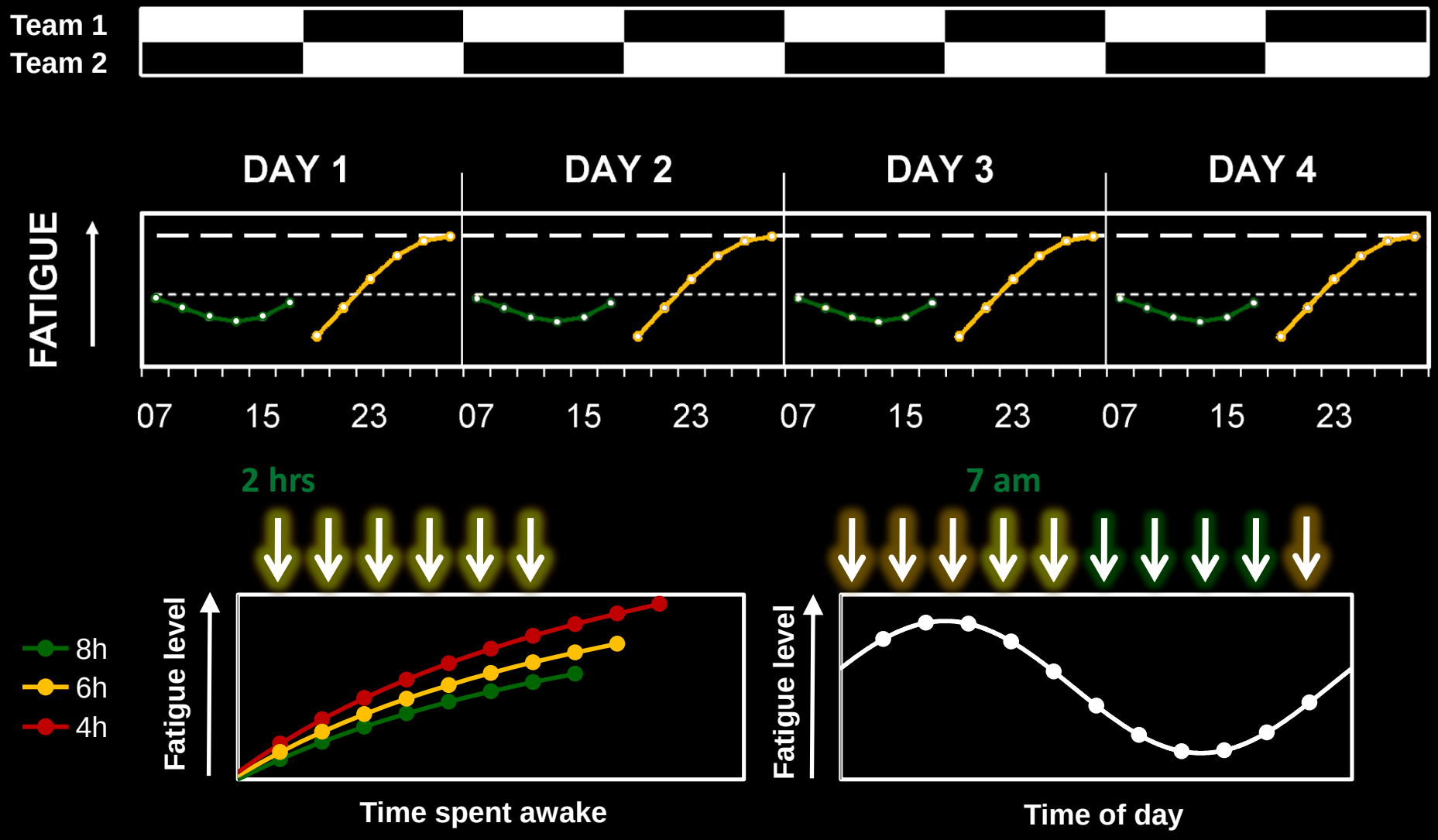

CAUSES OF FATIGUE

Basic physiological processes

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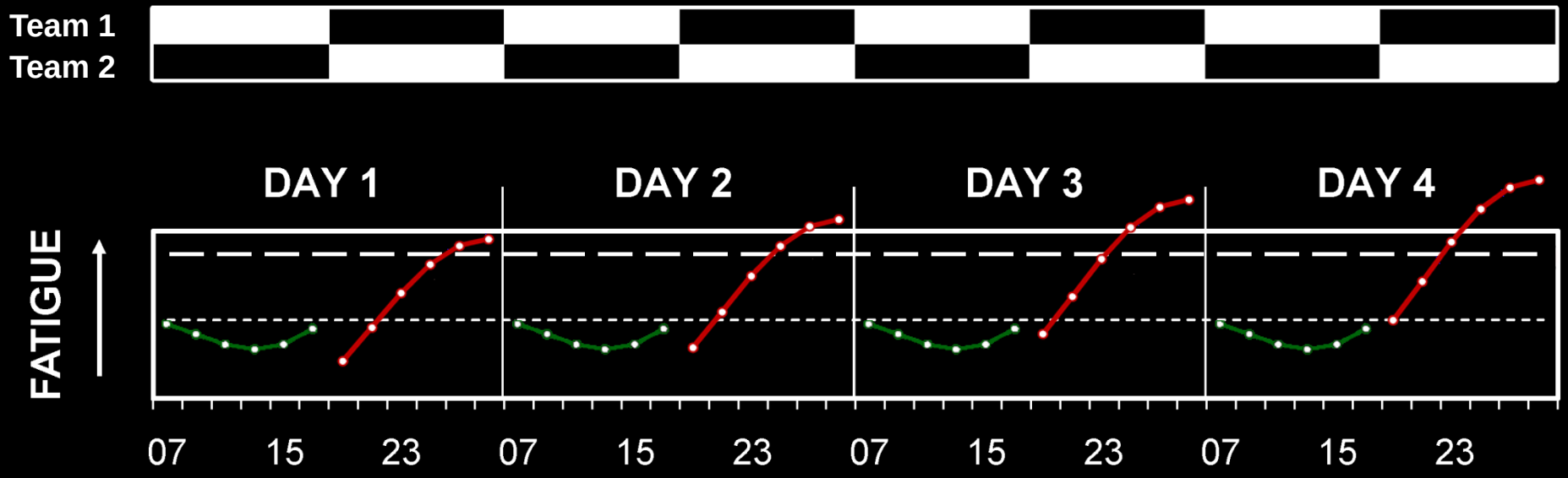

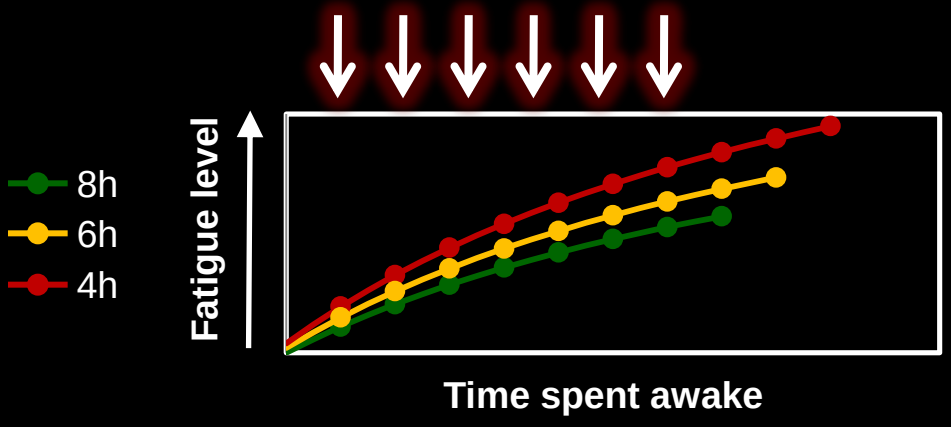

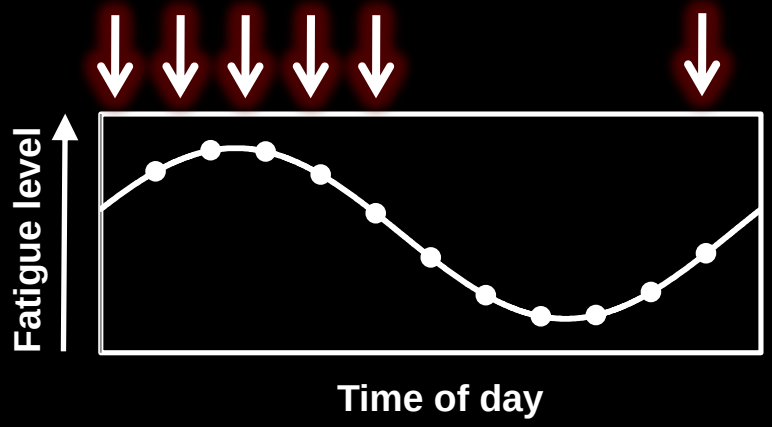

THEORETICAL ADVANTAGE

6-hour split-shift system

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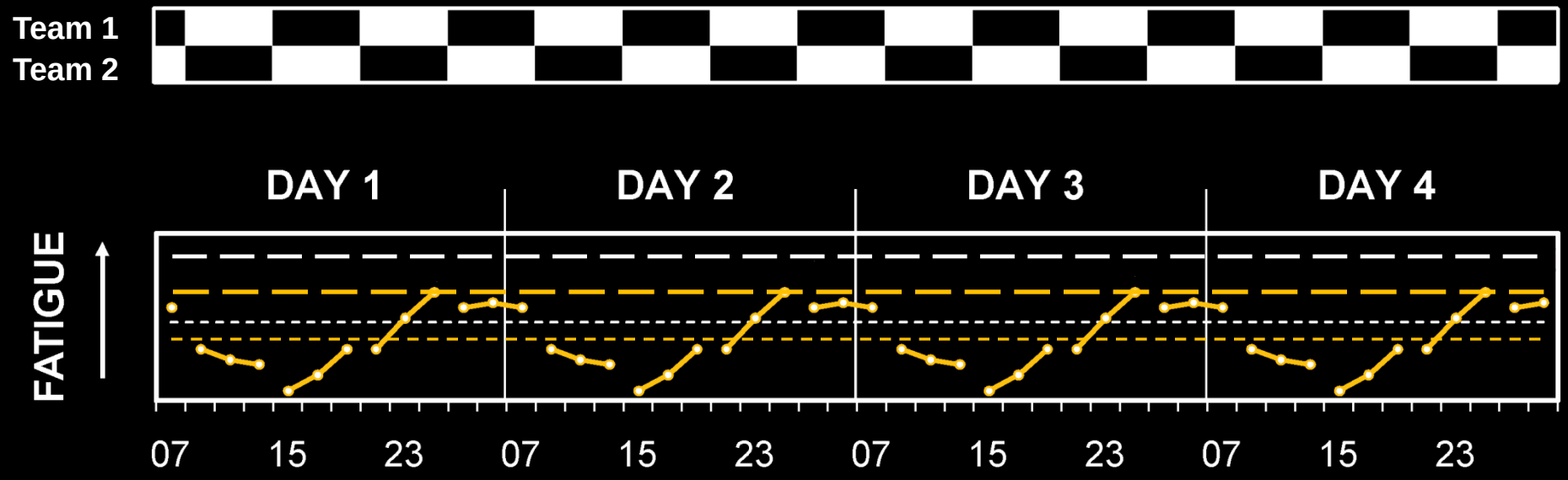

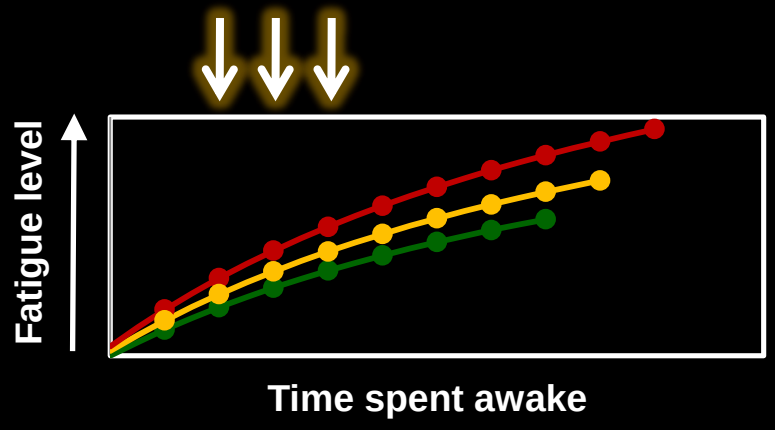

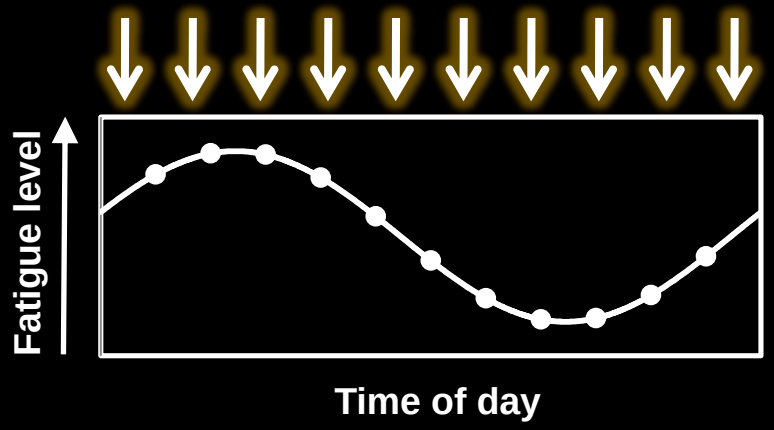

SPECIFIC OBJECTIVES

Investigations of short-shift routines

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SUSTAINED OPERATIONS:

- Any wholesale adoption of short-shift sustained operations mode would require substantial redesign of operation practices.
- This would have implications for fireground logistics and increase the number of staff handovers.
- The specific purpose of this project, therefore, is to establish the basic sleep and fatigue implications of sustained operations rosters

EMPRICAL INVESTIGATIONS

Study protocols

- **Experimental protocol**

A. Investigate the basic sleep and performance outcomes when working in sustained operations mode

- **healthy young adults**
- **performance measures that assess basic neurobehavioural and cognitive functions**

B. Compare sleep and performance during a standard 12-hour and a sustained operations roster

- **firefighters**
- **performance measures that are relevant to firefighting**

EMPRICAL INVESTIGATIONS

Study protocols

bushfire CRC

Research objective A

Determine the sleep and performance outcomes for healthy young adults working sustained operations rosters

Laboratory protocol

Imposed sleep during sustained operations

Repeat ×7

Sleep measured via brain waves

Performance measured via 1-hour test batteries

- Vigilance
- Cognition
- Mood
- Sleepiness
- Balance

EMPRICAL INVESTIGATIONS

Study protocols

bushfire CRC

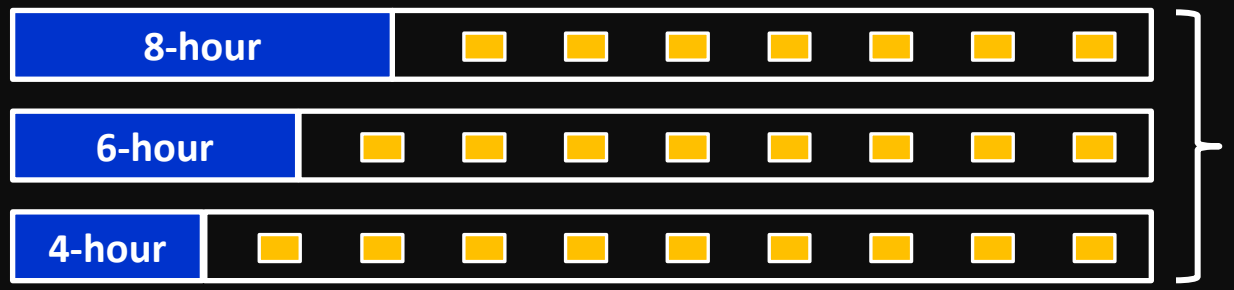
Research objective A

Determine the sleep and performance outcomes for healthy young adults working sustained operations rosters

Laboratory protocol

Imposed sleep during sustained operations

Levels of imposed sleep restriction



Data already collected in a separate study

EMPRICAL INVESTIGATIONS

Study protocols

Research objective A

Determine the sleep and performance outcomes for healthy young adults working sustained operations rosters

Laboratory protocol

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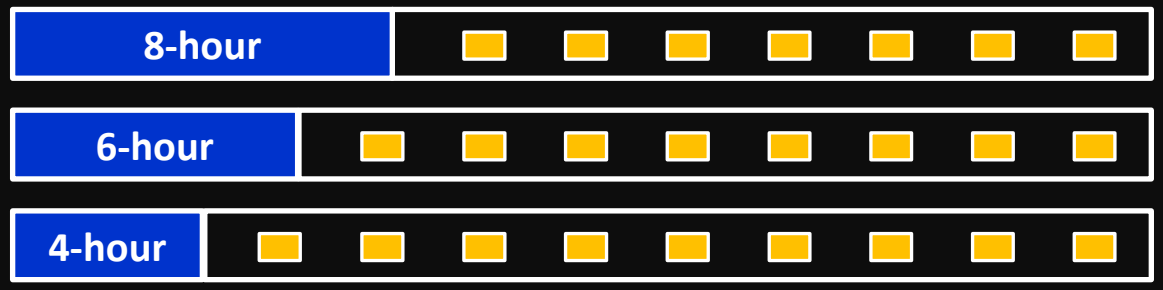
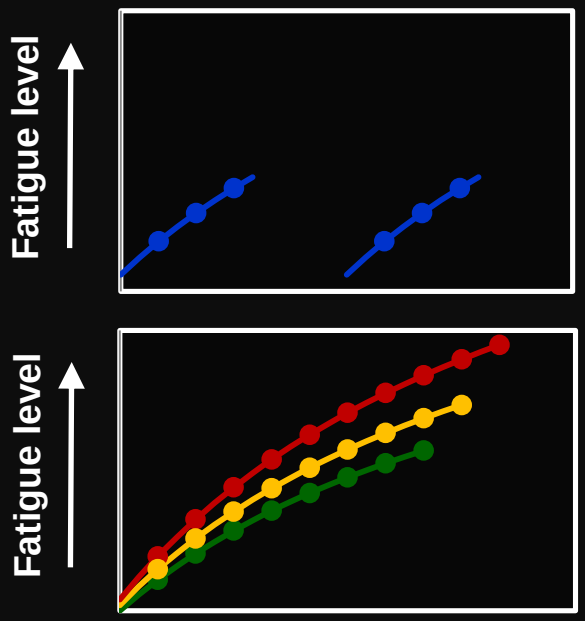
Levels of imposed sleep restriction





EMPRICAL INVESTIGATIONS

Study protocols

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Research objective B

Compare sleep and performance for firefighters during a standard 12-hour and a sustained operations roster

Laboratory protocol

Sustained operations

Repeat ×4

Sleep measured via brain waves

Performance measured via industry relevant tests

?

EMPRICAL INVESTIGATIONS

Study protocols

bushfire CRC

Research objective B

Compare sleep and performance for firefighters during a standard 12-hour and a sustained operations roster

Laboratory protocol

Sustained operations

12-hour ‘day shift’

12-hour ‘night shift’

ANTICIPATED PROJECT OUTCOMES

1. Collect the basic scientific evidence and peer-reviewed publications to support any future safety case for the use, or trial of, a sustained operations mode in firefighting

2. Develop a general mathematical model for predicting the fatigue implications of sustained operations rosters.