MANAGING FATIGUE AND SHIFT WORK

Prof Philippa Gander
PhD, FRSNZ

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

SLEEP/WAKE RESEARCH CENTRE
MOE TIKA~MOE PAI

Outline

- Legal requirements
- What is fatigue?
- Causes of fatigue
- Managing fatigue risk
- Conclusions
- Discussion

HSE Amendment Act (2002)

- Fatigue is a hazard than can cause harm
  - Employers must:
    - take all practicable steps to prevent harm occurring to employee
    - adopt a systematic approach to identifying, assessing, and controlling hazards at work.
  - Employees must:
    - Arrive fit for work.
    - Behave safely in the workplace
    - Cooperate in safety, report hazards

HSE Amendment Act (2002)

- Shift work is a cause of fatigue
  - Any work pattern that displaces sleep time

- New Health and Safety at Work Act
  - In force ??
    - Broader attribution of responsibility
    - More enforcement approaches and stronger penalties

What is fatigue?

- Fatigue is:

  a physiological state of reduced mental or physical performance capability

  resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity)

  that can impair a person's alertness and ability to work safely and efficiently

  (from ICAO 2011)

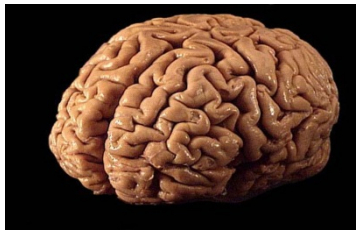
- Fatigue is:

  Not enough sleep to recover from energy expenditure (mental, physical emotional) of all waking activities (not just work)

Shared responsibility for managing the hazard

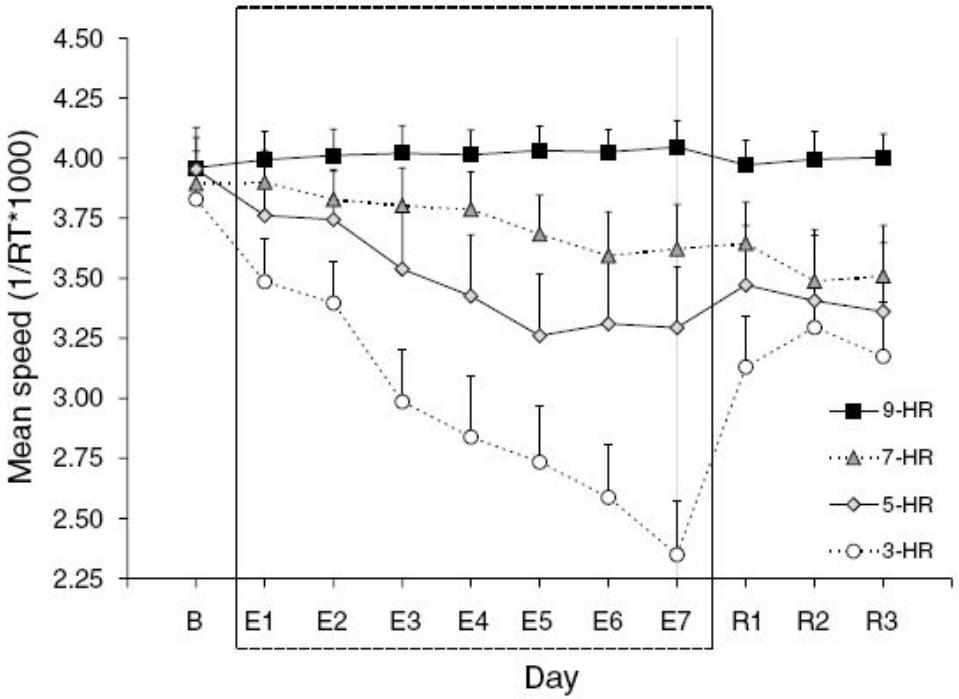
Why sleep matters

- Brain needs to go ‘off-line’ for essential recovery and maintenance
  - Ignores (mostly) inputs from the senses (light, sound, smell)
  - complex series of processes
    - dreaming (REM) and non-dreaming (non-REM)
    - memory consolidation, learning
    - repair of tissue wear-and-tear
    - growth
    - recharge immune system
    - regulate appetite, metabolism …
  - wake up as an updated version of yourself!



A third of life

Not enough sleep



- Effects of sleep loss are:
  - cumulative
    - get progressively worse day-after-day until recovery sleep is taken
  - dose-dependent
    - shorter time allowed for sleep = faster decline in function

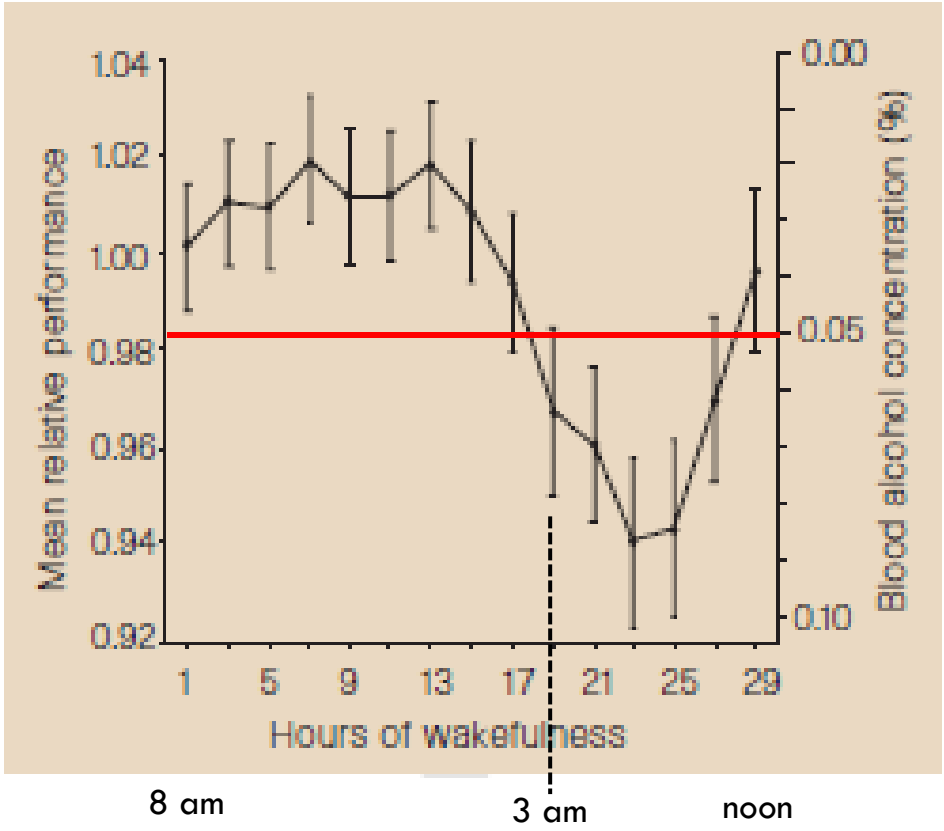
Belenky et 2003

Not enough sleep

- Restricted sleep leads to:
  - feeling sleepier, irritability, degraded alertness, slower reaction times, poorer coordination, slower thinking, loss of situation awareness, less creative problem-solving
  - uncontrolled sleep
    - sleepiness → microsleeps → established sleep

- Recovery is not hour-for-hour:
  - deeper, more consolidated sleep on 1st recovery night
  - recovery usually takes <u>at least 2 nights of unrestricted sleep</u>
    - 1st night – recover deep non-REM (slow-wave sleep)
    - 2nd night – recover REM
    - **not 48 hours off**
    - waking function can take <u>more than 2 full nights of sleep</u> to recover

Awake too long



- 40 participants
  - hand/eye coordination (unpredictable tracking task)
- Protocol 1 - stay awake for 26 h from 8 am, tested every 2 h
- Protocol 2 – drink 10-15 g alcohol every 30 min to a blood alcohol level of .10%

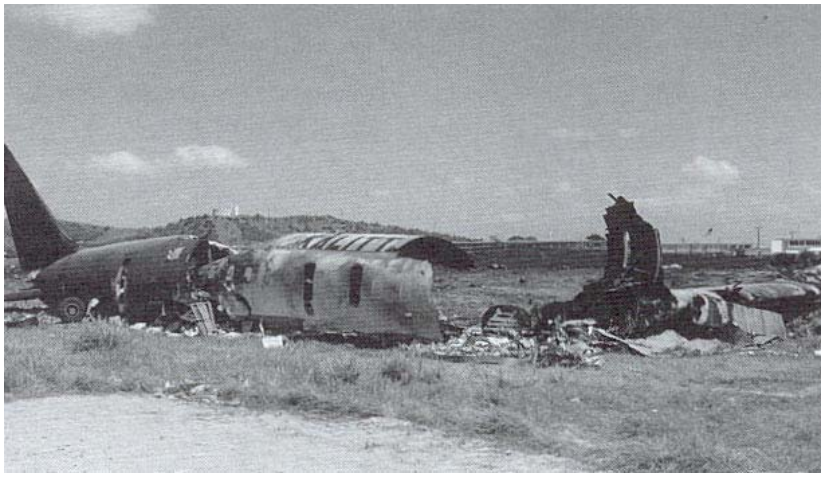
Dawson and Reid, Nature 1997

Time awake and pilot error

37 aircraft accidents (1978-1990) where pilot actions or inactions caused or contributed

- Median time awake: captains=12 hours, 1st officers=11 hours
  - 6 high time awake crews, median captains=13.8 hours, 1st officers=13.4 hours
  - 6 low time awake crews, median captains=5.3 hours, 1st officers=5.2 hours
- High time awake crews made:
  - More errors in total (median 12.2 versus 8.7)
  - More errors of omission (5.5 versus 2.0)
  - More procedural errors and tactical decision errors

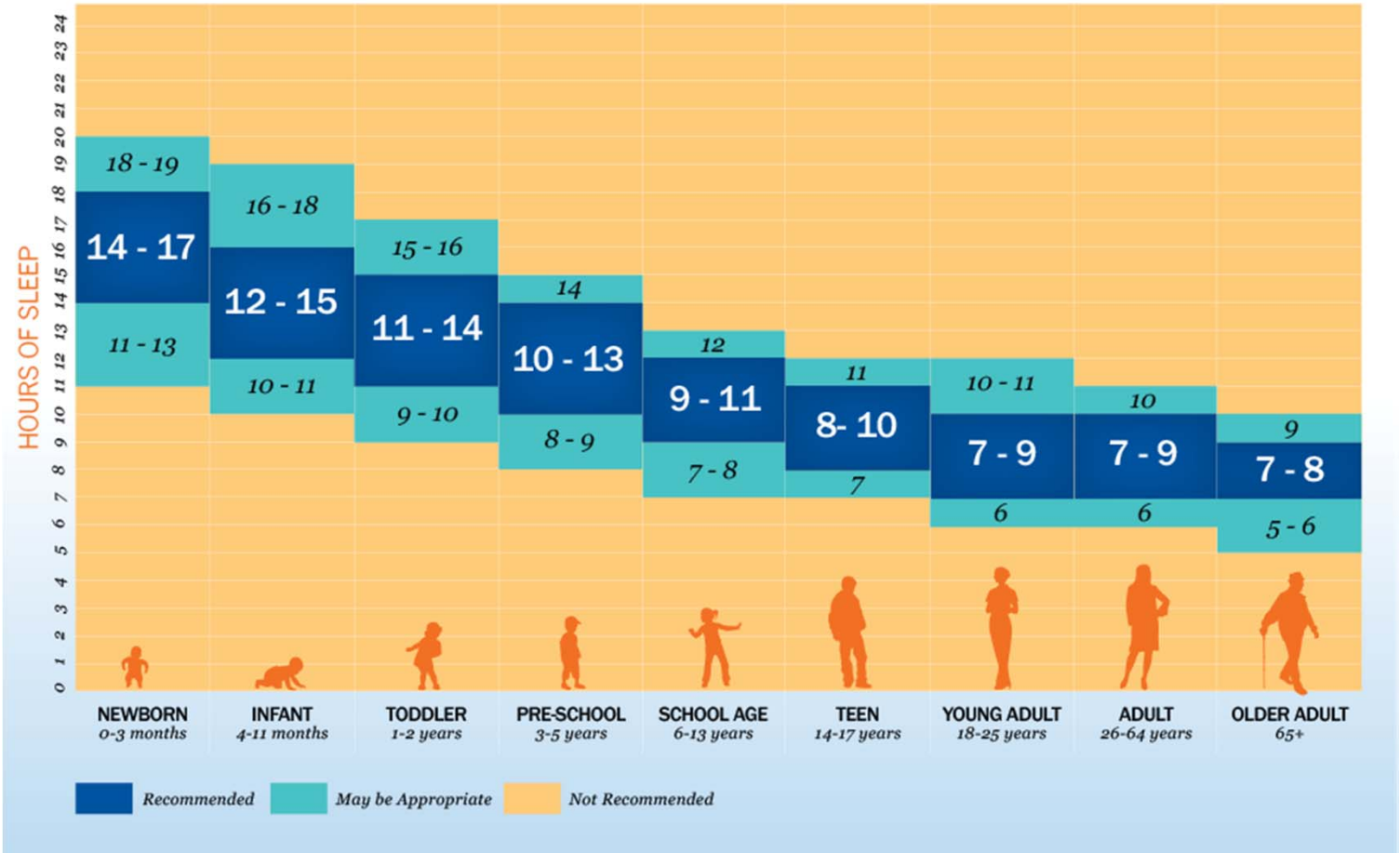
US National Transportation Safety Board Safety Study 94/01



Guantanamo Bay, Cuba
18/08/83
Captain awake 23.5 hours
1st officer awake 19.0 hours
Flight engineer awake 21.0 hours

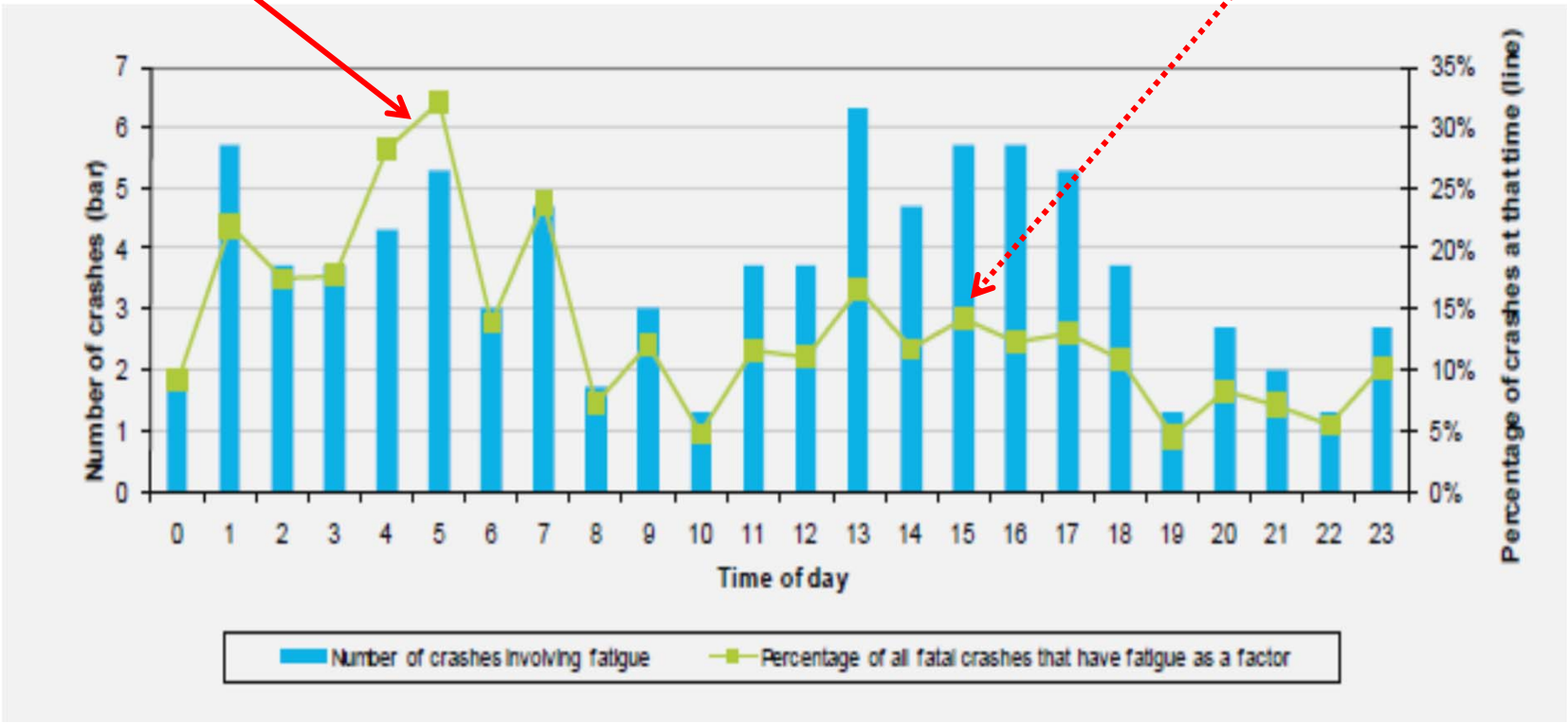
Recommended sleep

(US National Sleep Foundation Consensus 2015)



When are we sleepy?

NZ roads: fatigue-related fatal crashes
(annual average 2005-2010)



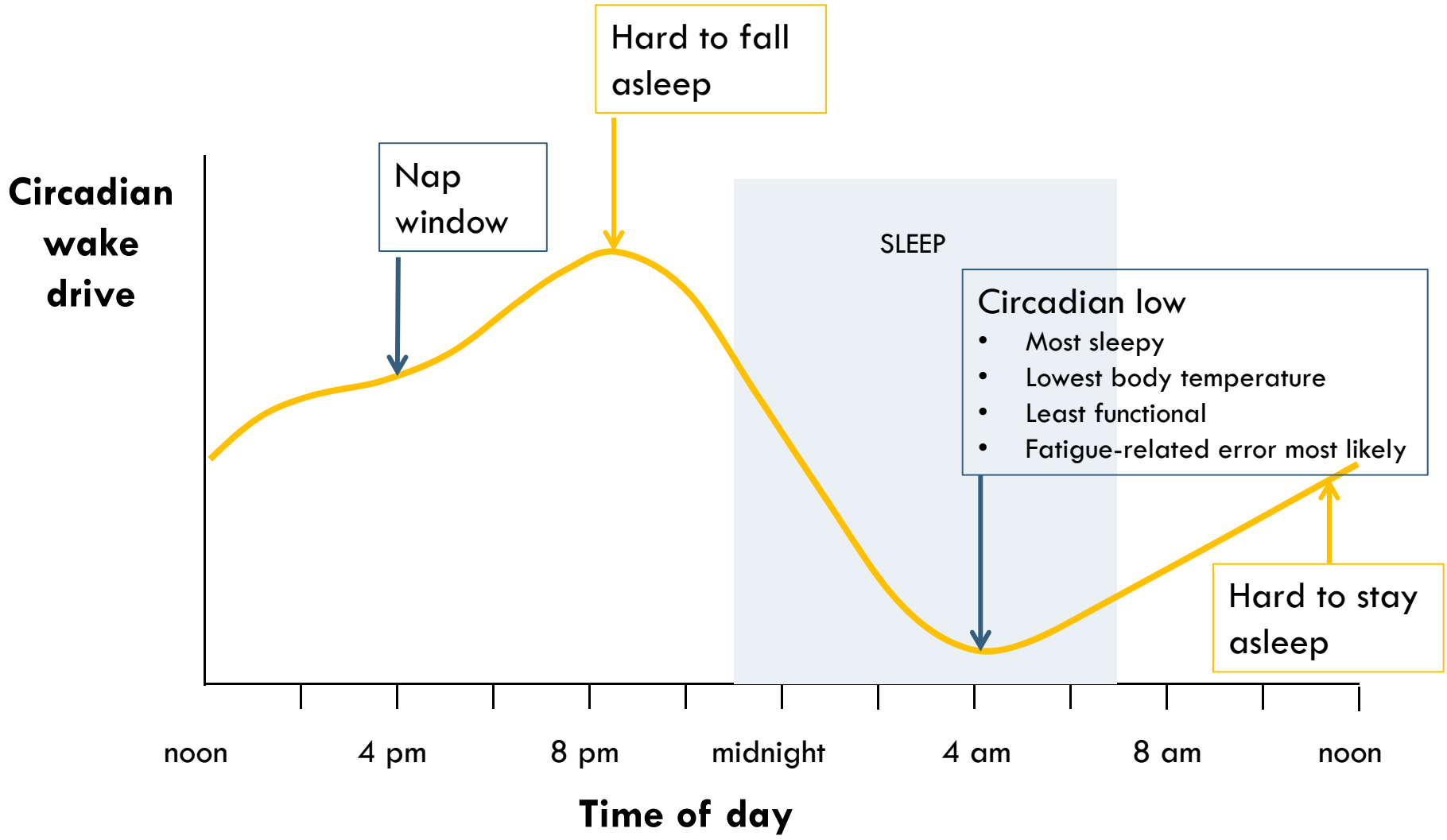
Why do we sleep at night?

Circadian body clock

- Pacemaker in the brain that drives daily cycles (circadian rhythms) in
  - How you function
    - body functions – hormones, heart rate, digestion …
    - ability to do physical and mental work
  - How you feel
    - mood, sleepiness, fatigue …
- Tracks light intensity even through closed eye lids
  - designed to keep us in step with the day/night cycle
  - connected to sleep-promoting centres and wake-promoting centres in the brain

A feature of life on earth

Circadian rhythm basics



Social time versus biological time

Light sensitive circadian body clock doesn't adapt to shift work

- Trying to work when least functional
- Eating at physiologically inappropriate times
- Trying to sleep when primed for wake
  - other time demands, noise, light, heat …

Fatigue versus safety risk

- Risk depends on
  - What a fatigued person is doing
  - Other hazards present
  - Safety defences present

Solo truck driver at night
Driving at 100 km/hour
Desert Road vs Auckland motorway

Airline pilot in 4-pilot crew
In-flight sleep in crew bunk
Mid-cruise versus landing

Managing fatigue risk

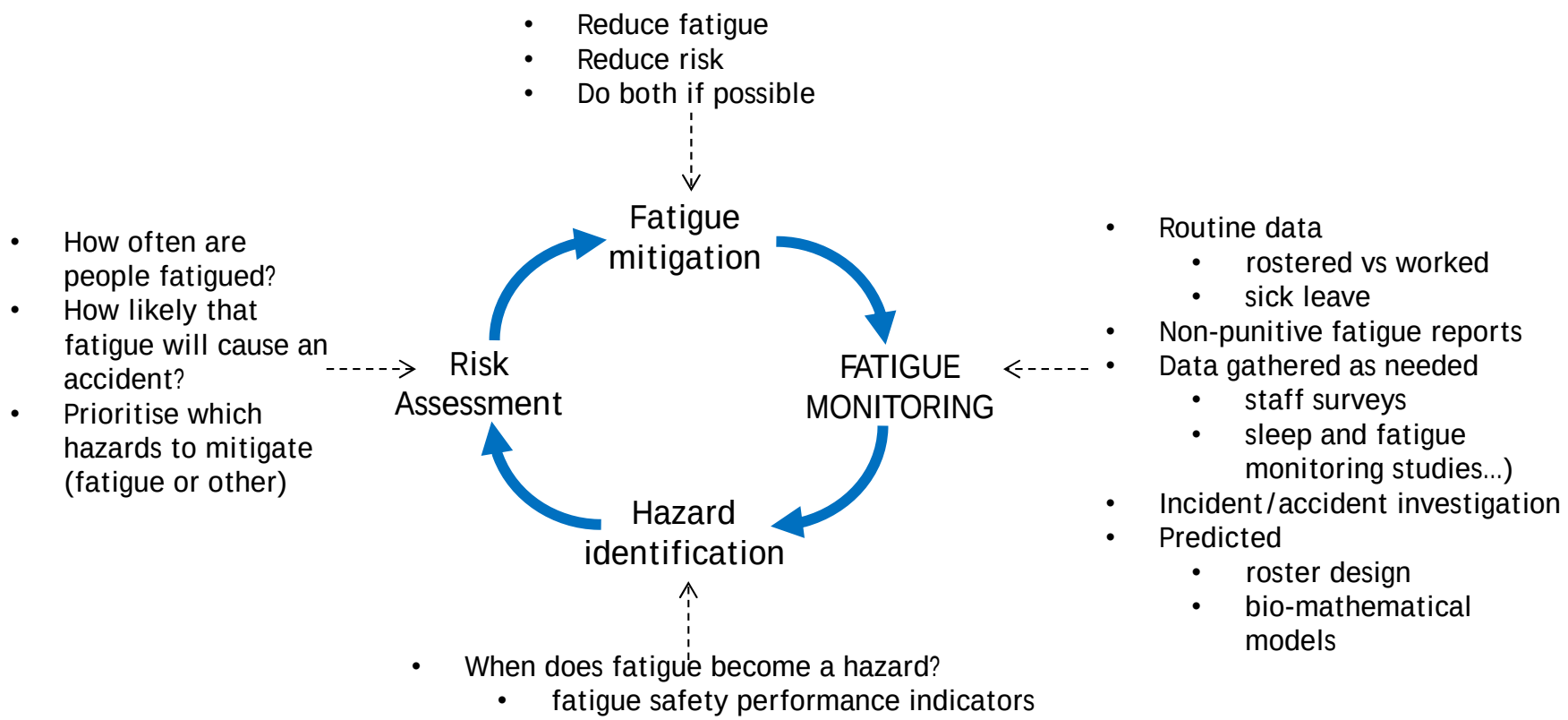
- Traditional approach – limits on:
  - Maximum work hours
  - Minimum breaks within and between shifts
  - Frequency of 24-h breaks
  - Regulatory or by industrial contract
  - Most don't address circadian variation
  - Don't address risk
- Alternative approach – data-driven fatigue risk management systems based on:
  - New science and workplace expertise
  - Shared responsibility
  - Effective safety reporting culture
  - Ongoing monitoring and management of actual risk
  - Multiple strategies to reduce risk

Do Prescriptive Limits Work?

- Introduced in the USA
  - Rail, 1907
  - Trucking, 1937
  - Aviation, 1938

- 2011 NTSB's most wanted safety improvement list
  - '*address human fatigue*' was number 2 across all modes

The fatigue risk management cycle



Fatigue monitoring

- HSE Act requires staff to report hazards
  - What? Where? Why? Possible mitigations
  - Identify hazards before they grow into accidents
- Non-punitive must distinguish between
  - Intentional violation – disciplinary response
  - Unintentional human error – safety response
    - Normal part of human behaviour
    - Fatigue increases the likelihood of unintentional error
- Effective safety reporting culture
  - Reports have to be analysed and acted on if necessary
  - Staff need feedback on what happens as a result of reports (if nothing, why?)

Reducing fatigue

- Fatigue management education
  - Who? - shift workers, schedulers, dispatchers, line managers, OSH staff, … CEO
  - What?
    - causes of fatigue and safety issues in your workplace
    - personal strategies to use at home (how to get better sleep)
    - personal strategies to use at work (strategic use of caffeine, napping, …)
    - company policies related to fatigue management (for calling in too fatigued, how to report fatigue hazards …)
- Reduce workload
- Improve skill level
- Healthy workforce

Reducing fatigue

- The perfect roster is permanent day work with unrestricted sleep at night
- Better roster design
  - adequate sleep opportunities
    - how fast is sleep debt building up?
    - how long 2 full nights of sleep in a row?
  - limits on continuous work (time awake, time-on-task fatigue)
    - Shift length
    - Breaks during shifts (workplace naps?)
  - predictable rosters, plan for covering on-call or call back
    - knowing ahead of time helps people to arrive at work better-rested
  - getting people home safely
  - fair distribution of weekends off
    - work/life balance matters

Reducing fatigue-related risk

- Are task-related hazards greater for fatigued people?
  - Different mitigations on the night shift?

- Are other workplace hazards greater for fatigued people?
  - moving machinery vs slower reaction time and decision making ….

Reducing fatigue-related risk

- Policies/protocols/procedures for
  - calling in fatigued
  - workplace napping (when, where, how)
  - managing staff with chronic sleep problems
  - analysis of data for monitoring fatigue
    - acting on data, feedback to staff and management
  - linking fatigue management to other hazard management
    - risk assessment
    - cost of mitigations
    - who decides about the $$?
  - getting home safely? – risk to self and others on the road

Who is responsible?

- Mr F was a printer who had been undergoing retraining for 2 weeks
  - usual work pattern 07:00 – 14:30
  - 1-hr drive to and from work
- Day before the crash
  - 07:00-14:30 (shift length 7.5 hrs)
  - Call back (no sleep) 21:45-11:30 (shift length 13.5 hrs)
- 30 hrs awake after 4 days with 05:30 wakeup
  - killed when his car hit a bridge
- Told a workmate
  - *was feeling stuffed but had asked if he could do the overtime as he had a zero bank account*
- Several staff raised concerns about Mr F's state during the night shift
- Told a service station attendant on his way home
  - *He told me that he couldn't do the full day. He was absolutely knackered and was going home*
- Union took a case against the company for failure to manage fatigue

Conclusions

- Managing fatigue and shift work requires
  - workforce/management collaboration
    - whole-of-life issues
    - regulatory requirement
    - fatigue is inevitable in 24/7 operations
  - Shared knowledge base
    - education/training on causes of fatigue, management strategies
    - clear communication, policies, and procedures
  - Monitoring fatigue levels in your workplace
  - Pooling scientific/workplace/organisational expertise to come up with better solutions
  - Integration with management of other hazards

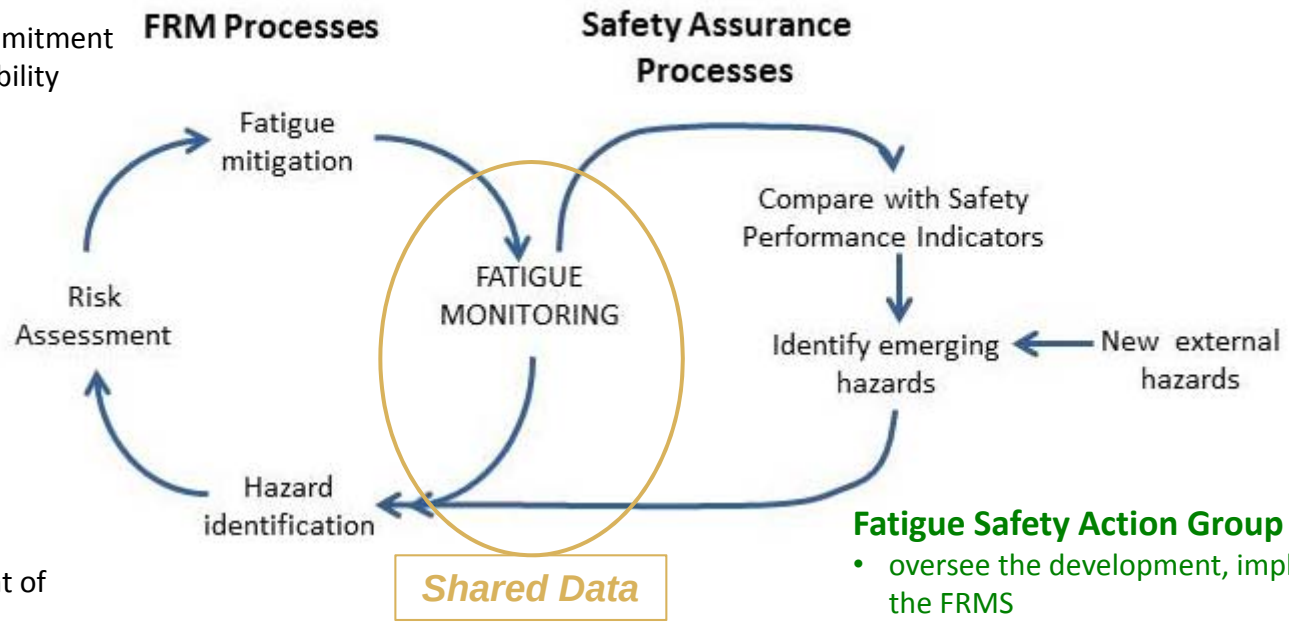
- The complexity of the systems you need depends on the complexity of your operation and the level of fatigue-related risk

Questions?

Fatigue Risk Management Systems

FRMS Policy
- Identifies FRMS elements
- Identifies FRMS operations (scope)
- Reflects shared responsibility
- States safety objectives
- Declares management commitment
- Identifies lines of accountability

Promotion Processes
- Training program
- Communication plan



Documentation
- Policy and objectives
- Processes and procedures
- Accountabilities, responsibilities and authorities
- Mechanism for involvement of all stakeholders
- FRMS training records
- Planned and actual times worked
- Outputs (findings, recommendations, actions)

Fatigue Safety Action Group
- oversee the development, implementation of the FRMS
- oversee the ongoing operation of the FRM processes
- contribute as appropriate to the FRMS safety assurance processes
- maintain the FRMS documentation
- be responsible for ongoing FRMS training and promotion

Discussion: your work environment(s)

- what are the main causes of workplace fatigue?
- what are safety risks posed by fatigued people?
- what mitigations are available to reduce fatigue?
- what mitigations are available to reduce the safety risks associated with fatigued people?

- what data do you have available for routine tracking of fatigue hazards?
- what other data might be useful?
- do you analyse for the role of fatigue in safety events? If yes, how?
- who is responsible for:
  - fatigue hazard identification?
  - fatigue risk assessment?
  - choosing and implementing fatigue mitigations?

- who checks that you are meeting your obligations under the HSE Act?