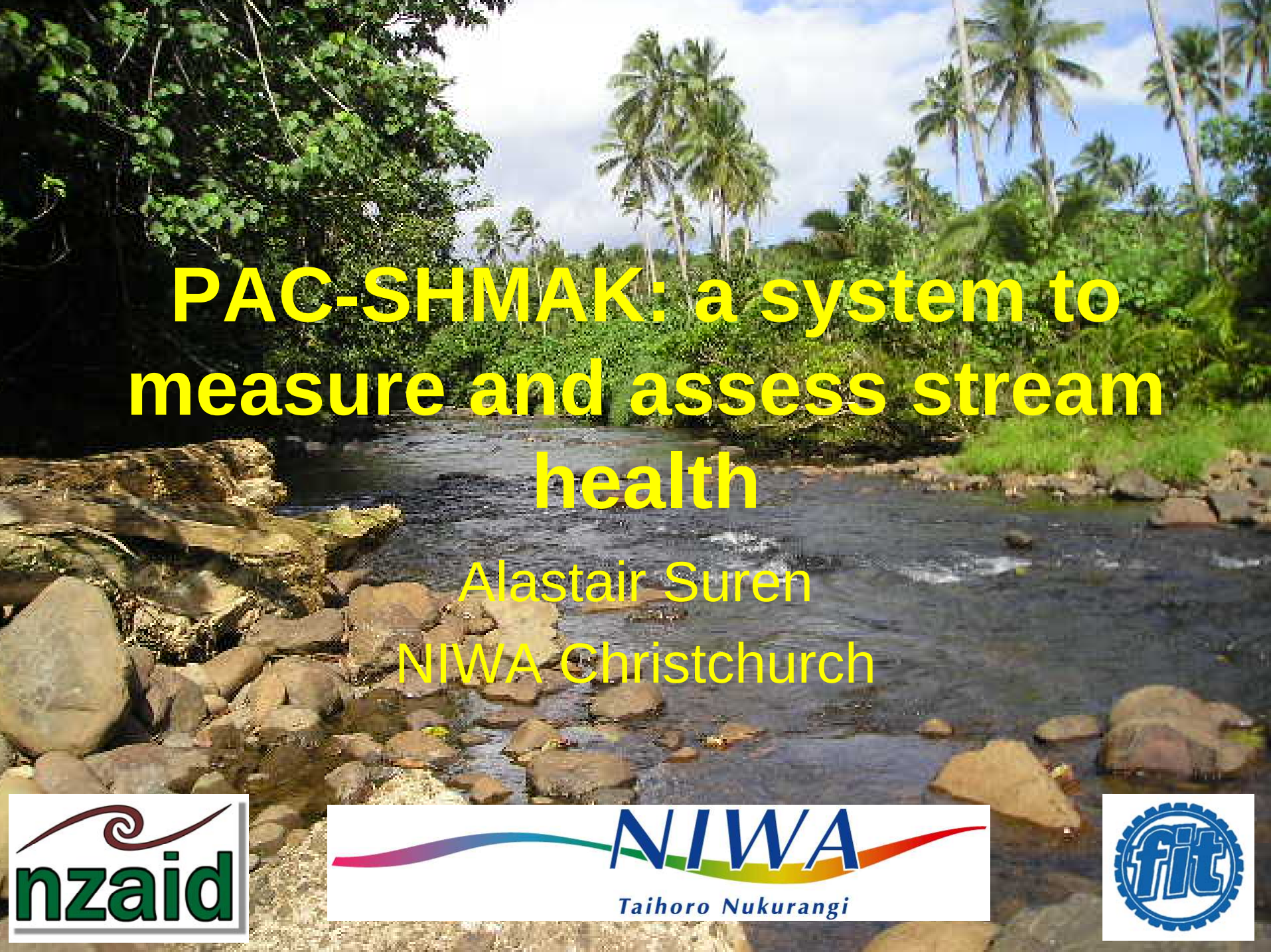

PAC-SHMAK: a system to measure and assess stream health

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What is SHMAK?

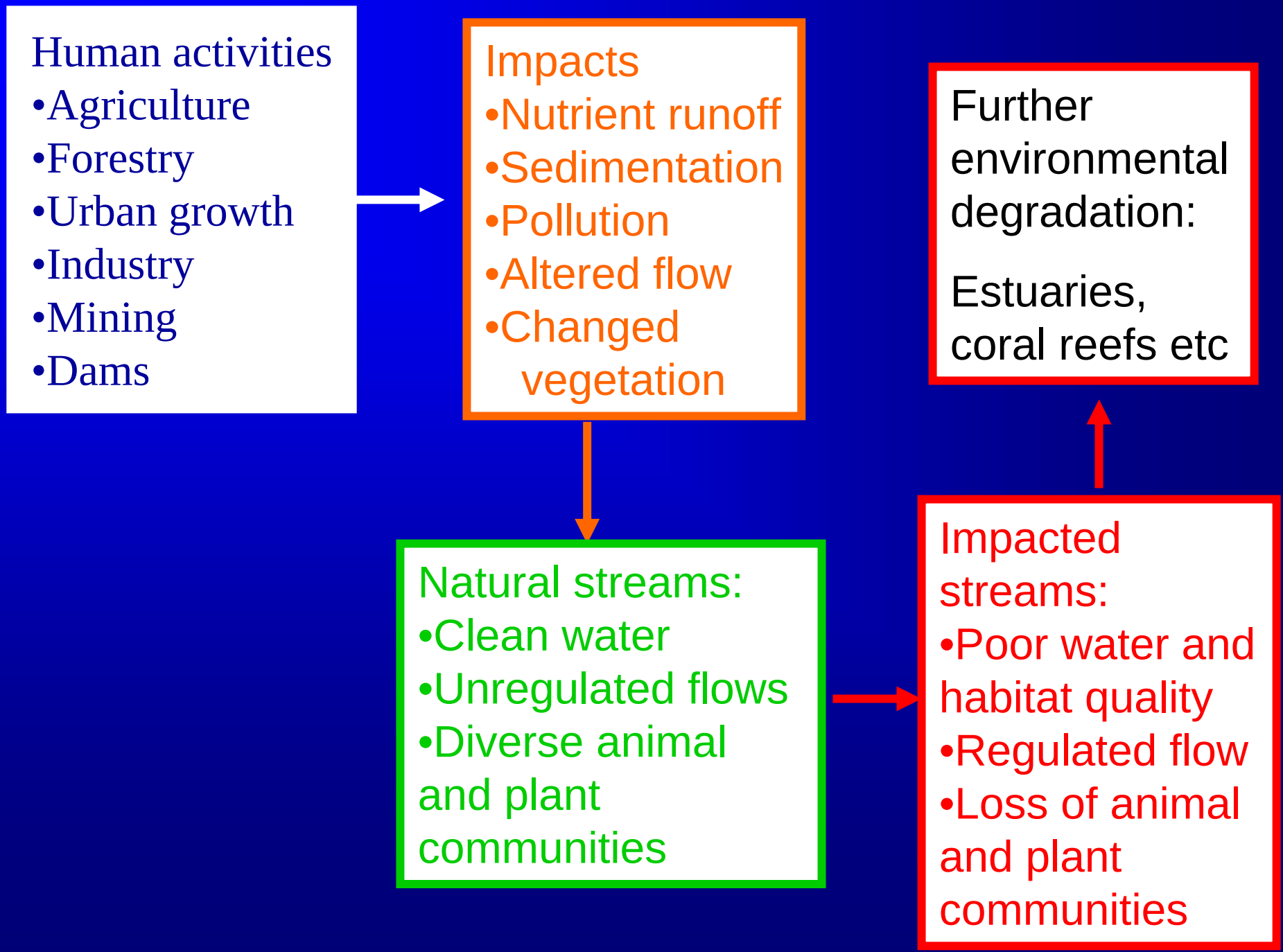
- **S**tream
- **H**ealth – quantifies the health of the stream (physical and biological)
- **M**onitoring – ability to feel the pulse
- **A**ssessment – ability to make diagnosis
- **K**it – a simple self contained tool that with the minimum of training, non-experts can use
- **PAC-SHMAK** = Pacific SHMAK

Talk overview

1. Links to HELP project
2. Concept of Stream Health
3. The original NZ SHMAK
4. Development of PAC-SHMAK
5. The future

1. Links to HELP project

- Streams have various values: drinking water, washing, food, irrigation, hydro-power
- Catchments are modified by agriculture, forestry, urban growth
- Loss of instream values from unsustainable catchment activities
- Conflict between continued human growth & sustainable use of freshwater resources
- UNESCO – IHP: looming world water crisis


Human activities
•Agriculture
•Forestry
•Urban growth
•Industry
•Mining
•Dams
Impacts
•Nutrient runoff
•Sedimentation
•Pollution
•Altered flow
•Changed vegetation
Further environmental degradation:
Estuaries, coral reefs etc
Natural streams:
•Clean water
•Unregulated flows
•Diverse animal and plant communities
Impacted streams:
•Poor water and habitat quality
•Regulated flow
•Loss of animal and plant communities

Values	Healthy streams	Uses and impacts	Impacted (unhealthy) streams
Drinking water		•Agriculture •Dams •Forestry •Urban growth •Industry •Mining	
Washing			
Irrigation			
Food values			

Purpose and Objectives of HELP

- Overarching purpose:
  - *Contribute social, legal, economic and **environmental** benefits to communities through **sustainable** and appropriate use of water*
  - *By developing hydrological science in support of improved integrated catchment management*
- HELP will address 5 global freshwater policy issues, involving water and
  - food
  - human health
  - the environment
  - climate
  - conflicts

Focus of PAC-SHMAK

- Water use in catchments is often regulated by policy, but
- division between water policy, resource management and science
- *Paradigm lock:*
  - *accepted practices are based on outdated knowledge and lack of technology transfer*
- Lack of a global initiative to integrate science with policy and management
- SHMAK helps fill this gap, by creating a science-based monitoring system

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2. Stream Health

- Natural biodiversity threatened by water withdrawal, diversion & pollution
- Balance between protecting ecosystem services and human needs
  - This is the driving concept of ICMPs
- *BUT:* how do we know whether streams are degraded due to human activities?
- It is fundamental to undertake environmental assessments of current and future conditions
- Need a system to assess STREAM HEALTH

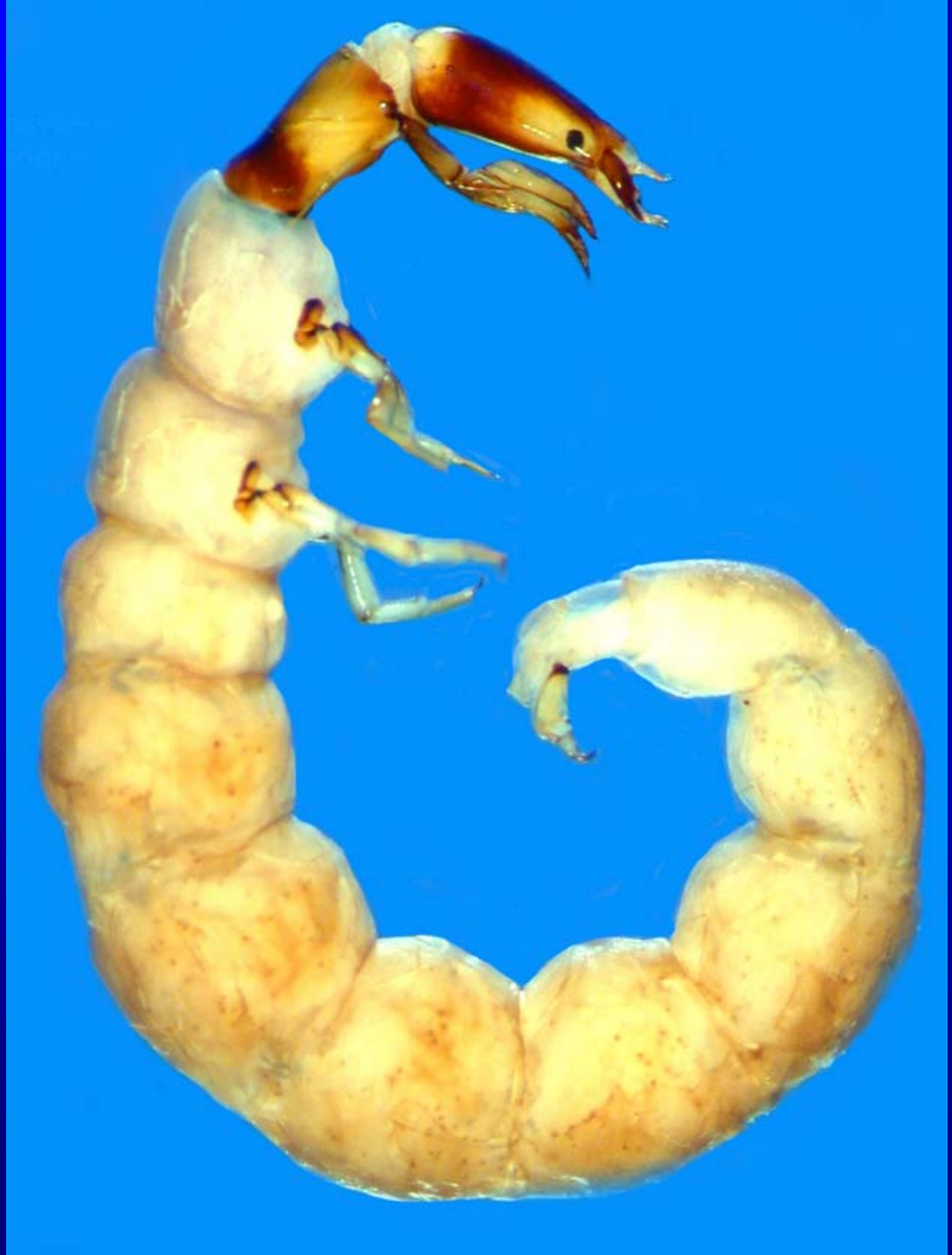
- There is more to a stream than running waters!
- Streams support high biodiversity values: birds, fish, invertebrates and plants
  - Healthy streams: diverse animal communities, complex food webs
  - Degraded streams: few animals, simplified food webs
- Stream health is affected by many things: pollution, water-take, sediments, barriers to migration, dams
- These will lower stream health, reducing biodiversity, water quality and a stream's values

Measuring Stream health

- ***BIOLOGICAL*** and ***PHYSICAL*** health
- *Biological health* assessed by freshwater invertebrates (insects, shrimp, snails, worms)
  - nature's great middlemen, without which most animals on earth could not exist!
  - essential to convert energy from plant material into animal material
  - act as long-term integrators of a stream's condition


Freshwater crays

Freshwater snails



Caddisflies

Damselflies

- Different invertebrates tolerate different conditions
  - Mayflies & caddisflies: clean water, stony sediments Score = 6 - 10
  - Damselflies and shrimp: clean water, soft sediments Score = 4 - 8
  - Snails & worms: enriched water Score = 1 - 4
- Development of "*tolerance scores*"
- By looking at the types of animals, it is possible to tell how healthy the stream is
- Biological score = $\left(\frac{\Sigma \text{ tolerance scores}}{\text{No. of scoring taxa}} \times 20 \right)$

Physical health

- There are many different streams:
  - fast flowing headwater – slow flowing lowland
- Not all streams are equal
- Need to assess the type of stream that we are working in:
- Measure things like:
  - Size of the streambed
  - Water velocity
  - Water quality – turbidity, temperature, pH
  - Altitude
- These correspond to physical health

- Each physical attribute is allocated a score
- Physical health = sum of individual scores
  - –Assessed as Poor, Moderate, Good and Very Good

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3. Development of NZ SHMAK

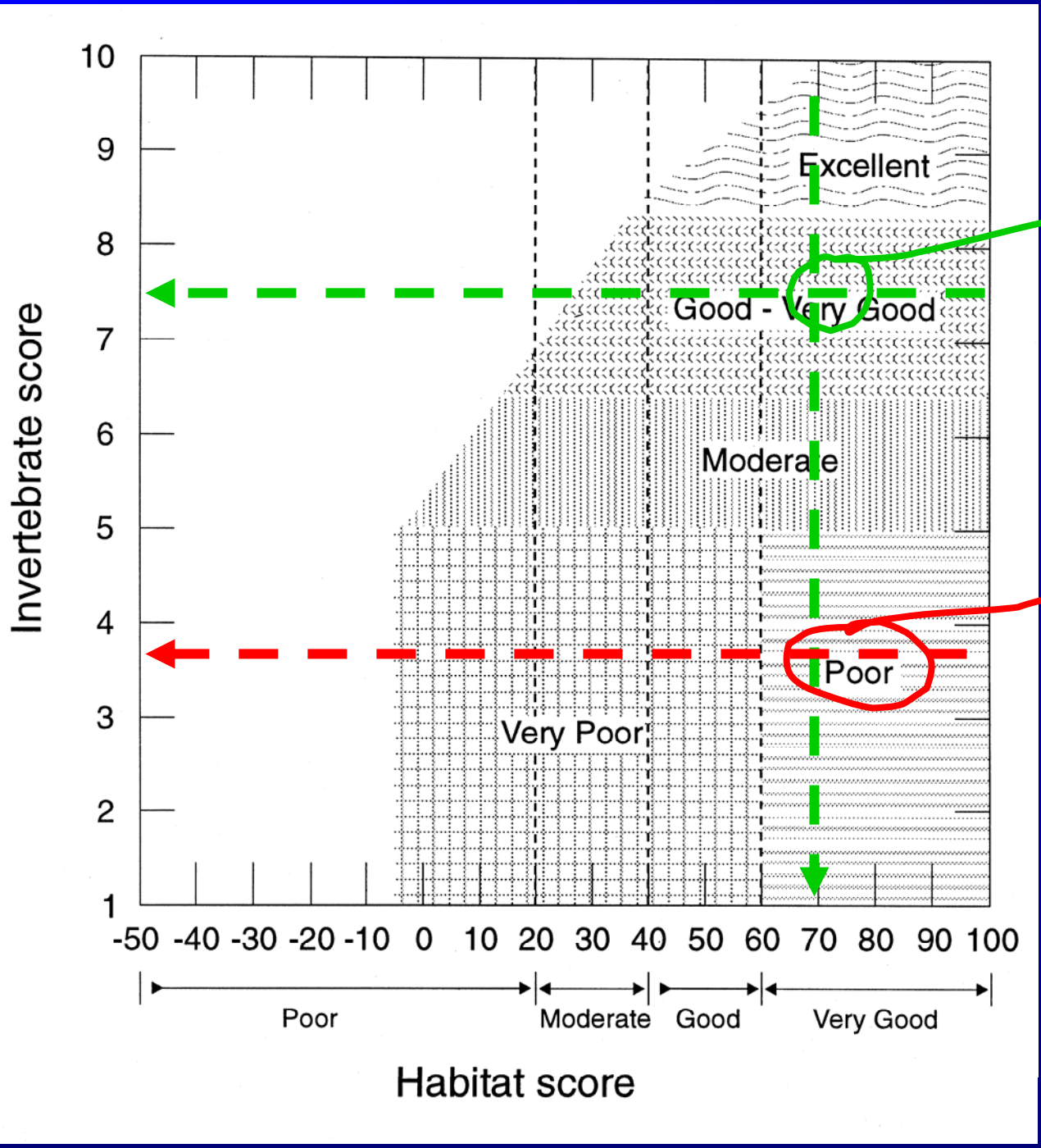
- Federated Farmers approached NIWA to develop a tool to assess stream health, to enable them to
  - take the patient's vital signs (measure stream health)
  - provide a diagnosis (assess stream health)
  - record these consistently, so that changes in the patient's condition can be monitored
- SHMAK allow farmers / community groups to become "freshwater physicians"
- Wide uptake throughout NZ

What the kit is

- Simple, and self-contained
- Contains:
  - instruction manual
  - Things to:
    - identify biological health
    - identify physical health
- Scoring sheets for consistent data entry, storage and retrieval

The Assessment

- Measure biological & physical health
- Make a diagnosis from known relationships between biological and physical health
- From the physical data, can see why the stream is sick
- Can develop practices to help fix up the stream



Overall health: good – v.good

Overall health: Poor

Good habitat, BUT poor biological score – suggests WQ

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4. PAC-SHMAK

- NZ SHMAK: scores developed for NZ inverterbates and physical conditions
- Not valid for other countries
  - Get different invertebrates
  - Physical conditions are different

Water temperature

Measure water temperature in the main flow, in an undisturbed area.

Measured temperature:		°C	Time of day:	

	Under 5 °C	5 to 9.9	10 to 14.9	15 to 19.9	20 to 24.9	25 to 29.9	30 or more	enter score
score:	**5**	**8**	**10**	**8**	**5**	**1**	**-5**	

NZ temps: cold <15°C

Fiji: warmer

Water conductivity

Measure the conductivity of a water sample, using the meter provided.

Measured conductivity:		µSiemens/cm

	Under 50	50 to 149	150 to 249	250 to 399	400 or more	enter score:
score:	**20**	**16**	**10**	**6**	**1**	

NZ streams have low conductivity

Fiji: possibly higher

Water clarity

Measure the clarity of a water sample using the clarity tube (average of three readings).

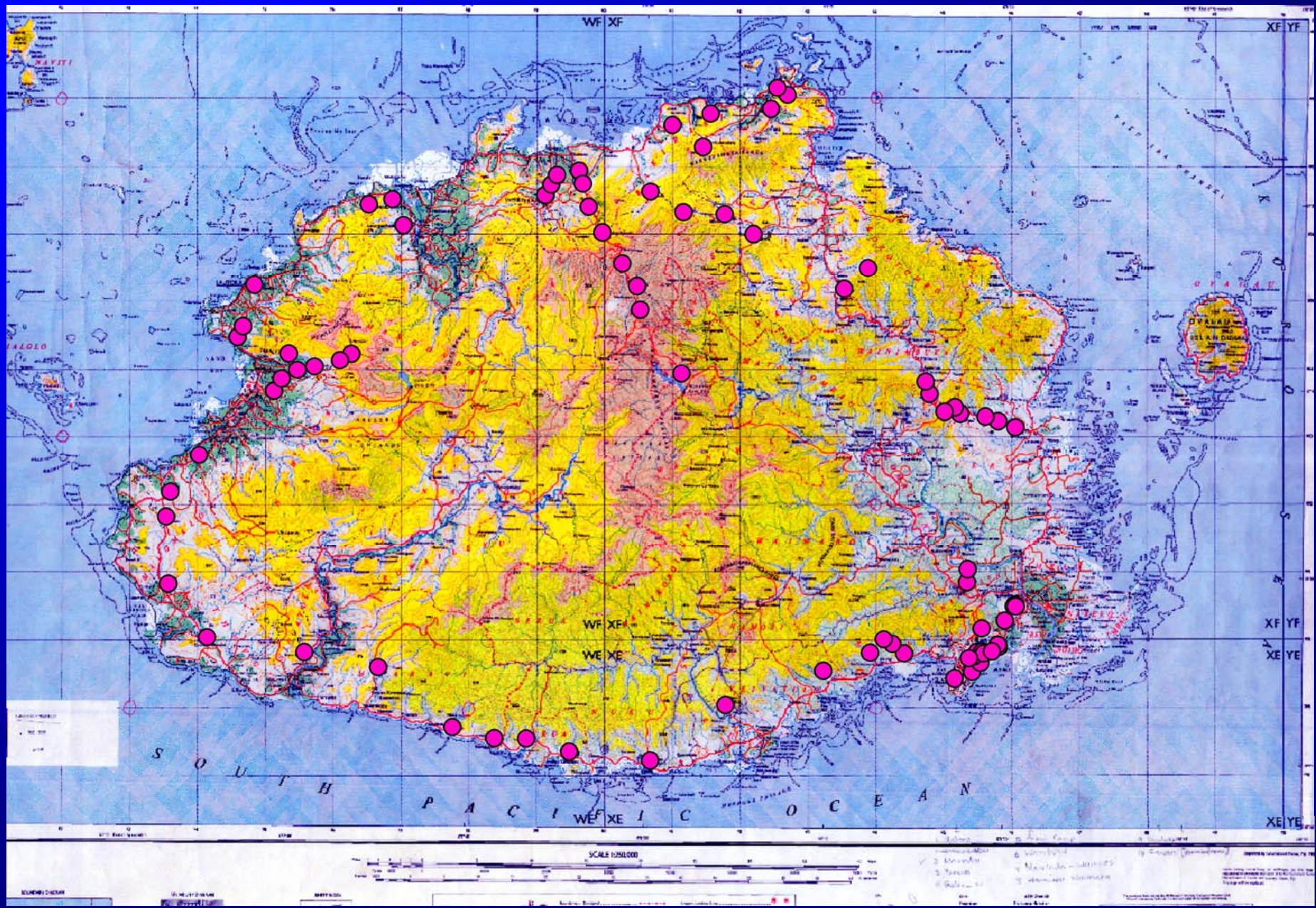
Measured clarity:	1	2	3	cm (from viewing end to disc surface)	Average cm:	

	Clear to bottom (=100)	70 to 99	55 to 69	35 to 54	under 35 cm	enter score:
score:	**10**	**8**	**5**	**3**	**1**	

NZ streams: clear

Fiji: possibly less clear

- NZAID: funded the development of a SHMAK kit for Fiji (PAC-SHMAK)
- Collaboration with FIT and Live and Learn (River Care Project)
- Collected 150 samples from Vanua Levu and Viti Levu
- Described invertebrate communities and summarised physical conditions



Viti Levu: 75 samples collected

Collecting invertebrate samples

Identifying invertebrate animals

Development steps for PAC-SHMAK

- Analyse data to investigate relationships between biological communities and physical environment
- Develop scores for assessing BIOLOGICAL and PHYSICAL health
- Develop diagnostic graphs
- Develop identification guides to invertebrates
- Produce instruction manual & kit
  - simple
  - self contained
  - low technology
  - translated into Fijian

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5. The future

- Live and Learn: major end-user of PAC-SHMAK
- Currently have a River Care programme throughout Fiji
  - want an easy to use kit to allow them to also become freshwater physicians
- Major step in developing PAC-SHMAK for Fijian conditions
- Less major step to take to other Pacific Island countries
- Can develop a PAC-SHMAK kit for the entire region

Links to HELP

- Help break the Paradigm Lock between science and policy
- Provide scientifically based tools to allow monitoring of stream health
- Essential as part of developing ICMPs
- Allows monitoring of:
  - a stream's current state
  - the effectiveness of remedial action on stream health