IMAGINE YOU READ YOUR TEST RESULT THAT IS POSITIVE FOR AN OIE NOTIFIABLE DISEASE?

MSD ANIMAL HEALTH
GHANA TILAPIA ISKNV CASE STUDY

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MSD tilapia market presence (before 2018)

MSD tilapia ISKNV detection (before 2018)

- Positive ISKNV = Indonesia*
- Other markets?
- Stop testing
- Frys and juveniles
- Cumulative mortalities 20-40%

** not true epidemiology data but MSD's internal information based on market access*

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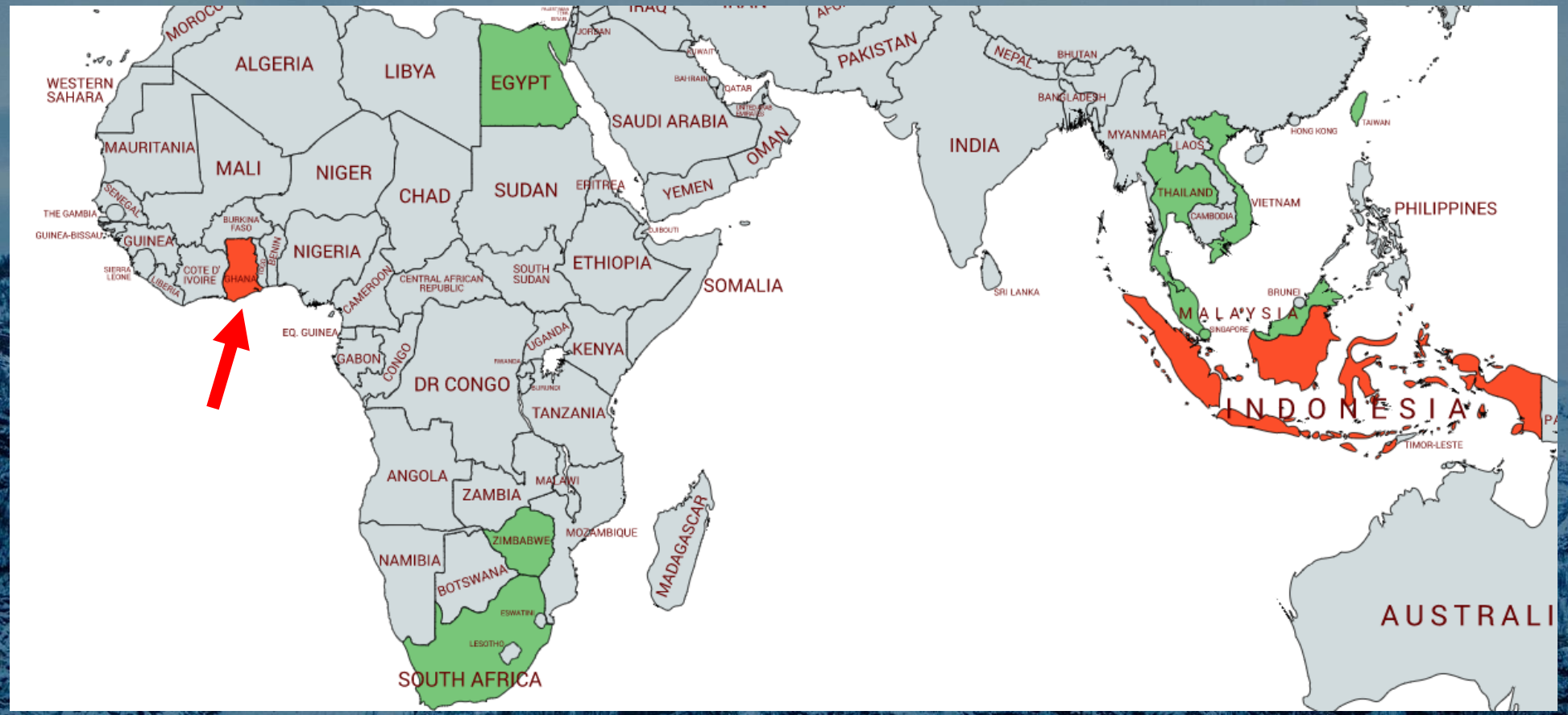
ISKNV detected in Ghana by various labs (late 2018 onwards)



Initial disease outbreak – Ghana Q3 2018

- Sept 2018 as technical visit
- Mass mortalities by coincidence
- 5-10% daily mortality in fry, started less than 2 weeks ago
- Cleaning morts daily
- Mortality spread similar patterns

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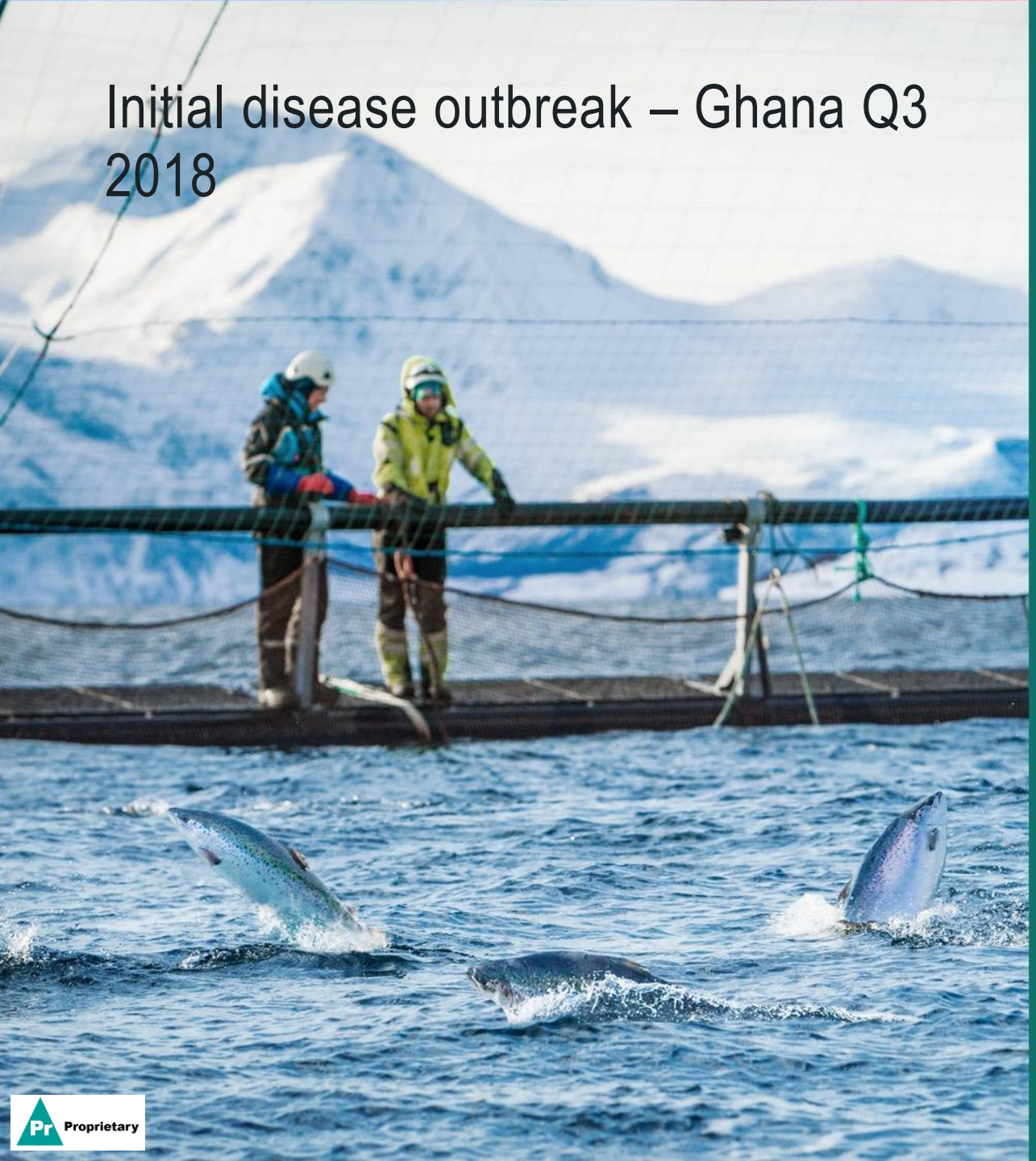
Initial disease outbreak – Ghana Q3 2018

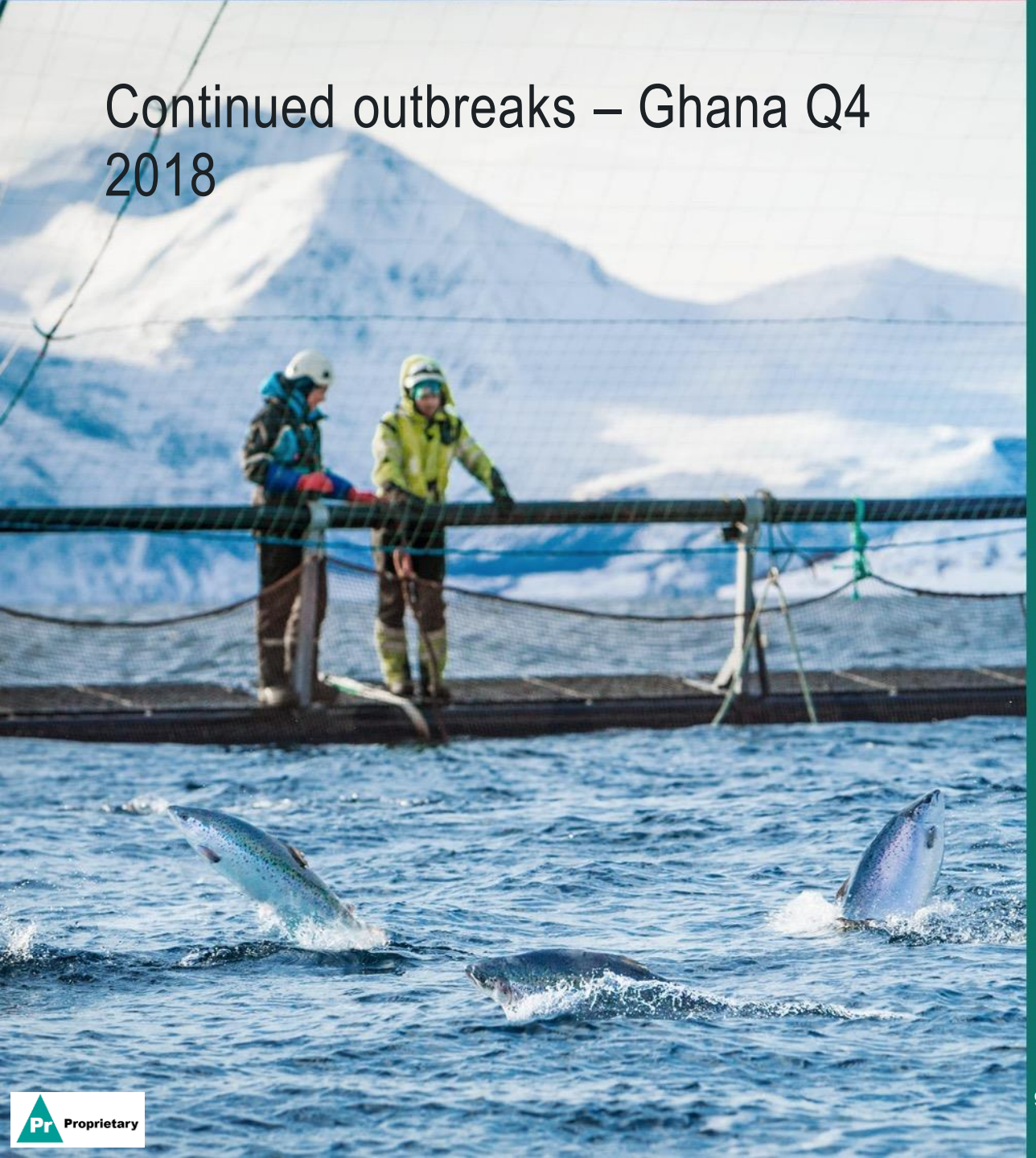


- Biosecurity measures
- Control of entrants
- No external hatchery sources
- Segregation of personnel and equipment in hatchery, nursery, grow-outs operations
- Disinfectants and sanitizers
- Dead management
- Aim to limit mortality losses by reducing pathogen introduction and spread

SYMPTOMS = VIRAL NATURE
TILV ?
SAMPLES ONLY TESTED AGAINST TILV AND STREP.
ISKNV = INDONESIA?

TEST RESULTS: < 20% + TILV
DOES NOT MATCH…

Continued outbreaks – Ghana Q4 2018



- 2 hatchery operators
- 0.2g frys → 90% losses within a week
- ISKNV positive
- Immersion vaccine on frys?
- All Volta affected + wild
- Production down by > 60%
- Prices up > 30%
- Empty cages

ACTIONS

MSD technical support in Ghana 2019

- New samples - ISKNV
- Tested for ISKNV / TiLV / Streps
- Results: >70% + ISKNV, >85% + S. agalactiae serotype Ib (co-infections), TiLV -
- June 2019: Risk mitigating strategy + heat process*

*acknowledgements to Alain Michel (first adopter of heat treatment early '00s) & Allegro-Aqua's Jeffrey Teo for inputs related to heat protocol (adapted for Ghana tilapia)

Allegro Aqua
Incubated by TLA Hatchery

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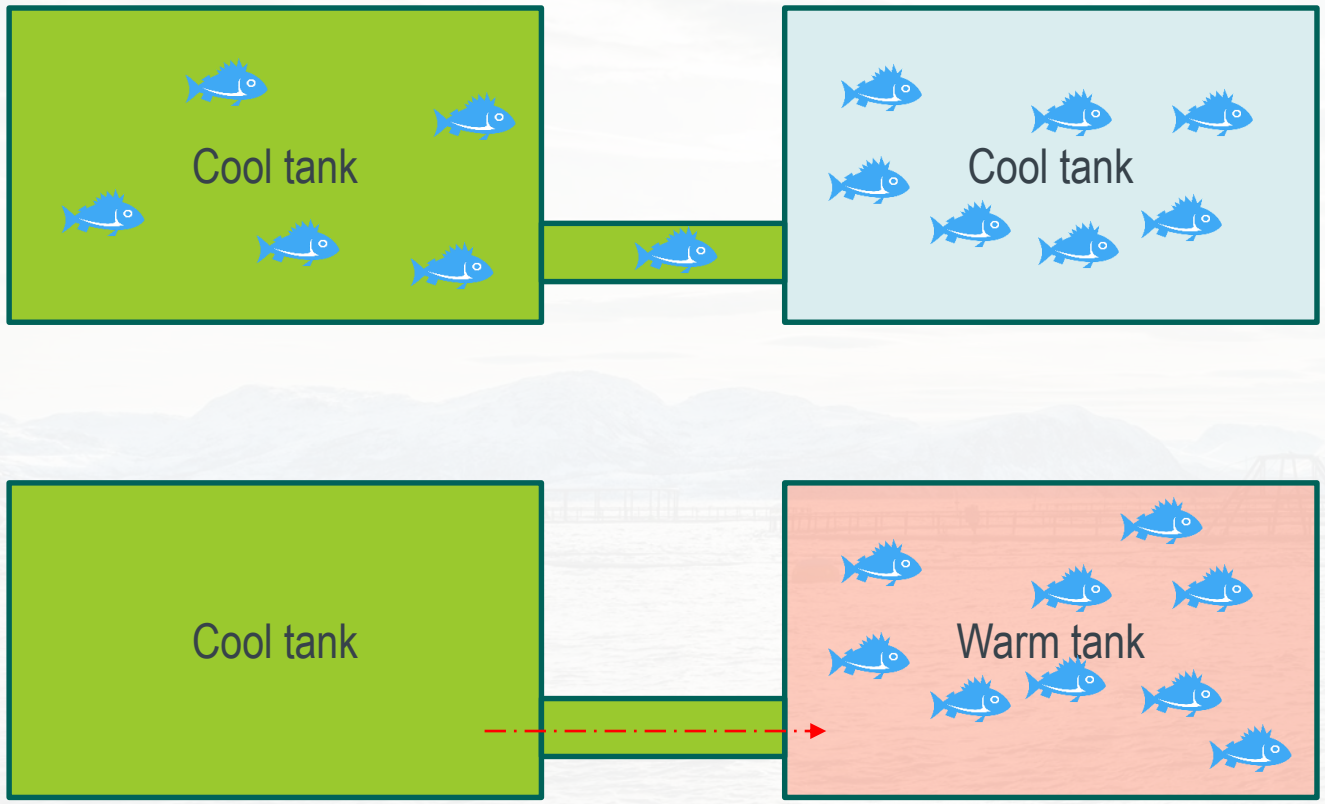
ISKNV risk mitigation strategy

1. Volta Lake water is the source of disease
   - Water in hatcheries
   - ISKNV high concentrations → immature immunity of frys
   - Frys transferred too early
   - Sanitize water in ponds/tanks
   - Delay transfer → immune development

ISKNV risk mitigation strategy



Vanderplasschen A. Presentation at DAA 2017 in Bali, experiment to demonstrate effects of heat in fish vs virus

2. ISKNV pathogenesis
   - ISKNV = 28-32°C Incubation period 7-10 days
   - Frys poor defense mechanism against ISKNV
   - Volta lake = 24-32°C

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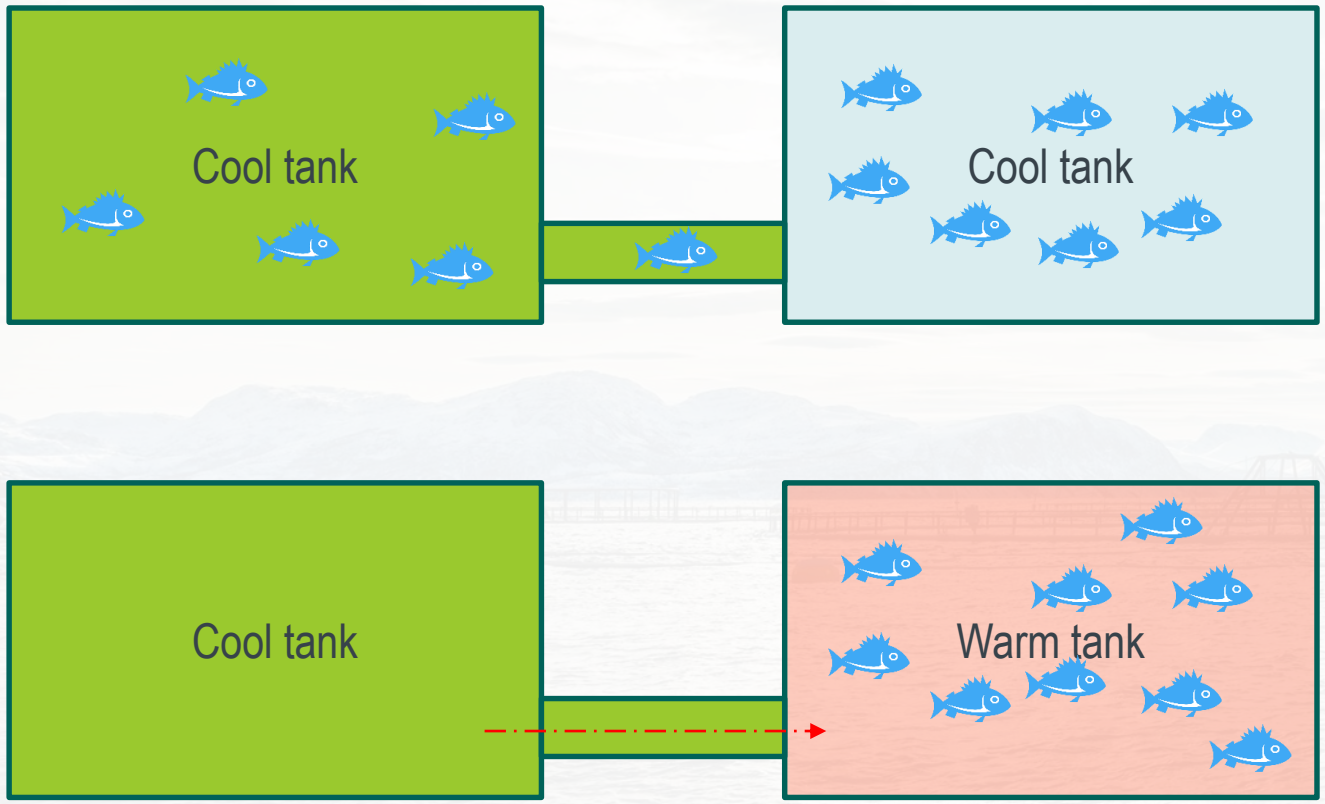
ISKNV risk mitigation strategy



Vanderplasschen A. Presentation at DAA 2017 in Bali, experiment to demonstrate effects of heat in fish vs virus

- Heat > 36°C less viral infectivity
- Every 4-7 days
- ↑ fish metabolism
- ↑ innate immunity → early infections

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ISKNV risk mitigation strategy

3. Nursery Survival

- Fish <10g, 60-90% mortalities
- No supply anymore
- Weekly cyclical heat = Routine
- 4-7 days
- Disrupt viral infection & incubation
- Reduce mortalities

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ISKNV risk mitigation strategy

4. Vaccination

- Heat treatment: 0.2-10g ok larger fish = challenging
- Injection vaccine available
- 10g = routine heating → ready for vaccination
- Protected in Volta remaining period
- MSD's ISKNV vaccine + MSD's Strep vaccines → single dose injection

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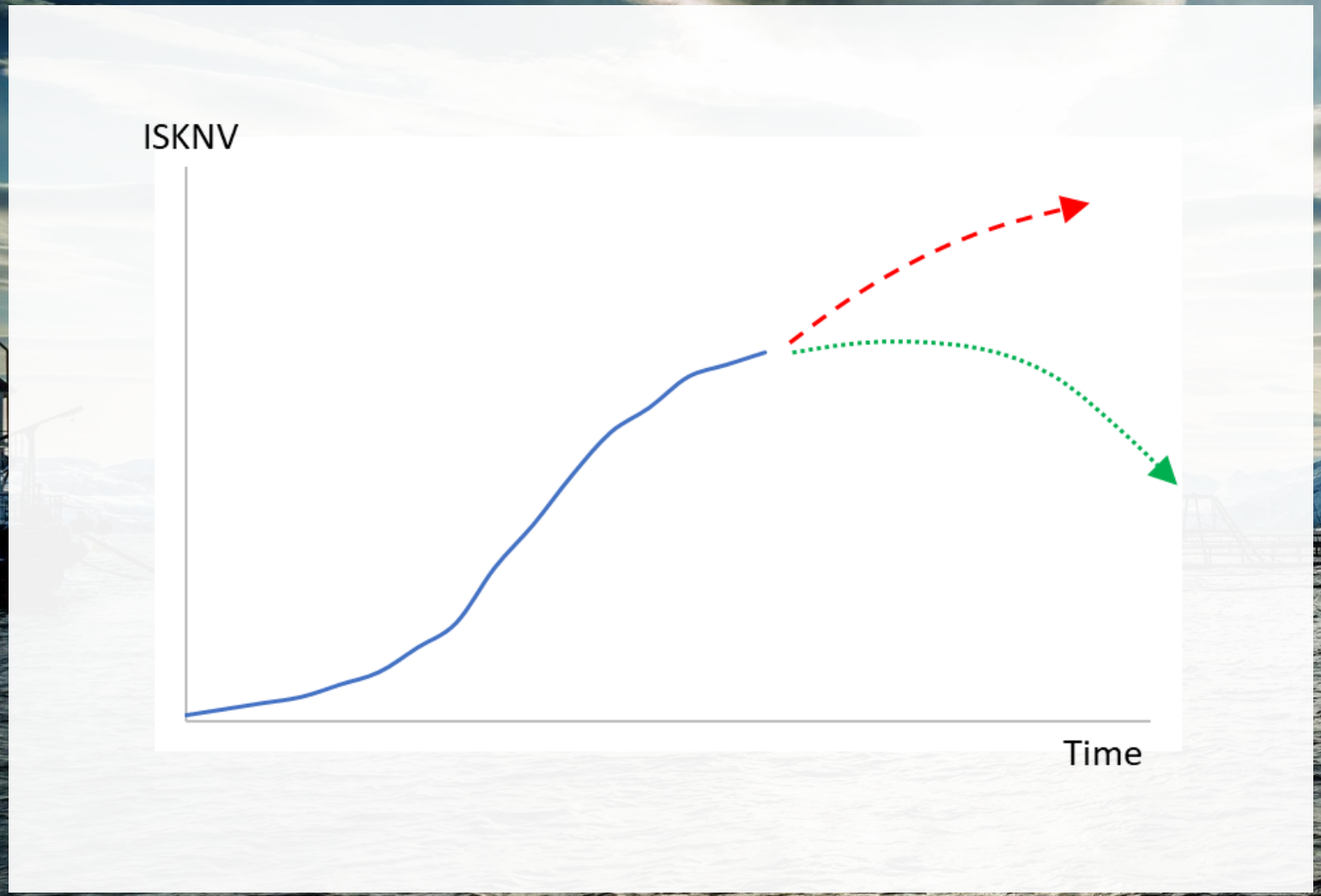
ISKNV risk mitigation strategy



5. Long-term sustainability
   - ISKNV concentration high in all Volta
   - Mortalities ↑ the viral load daily
   - **Collective** measures = **all** tilapia operators
   - Sick and dead fish disposal
   - Heating process + vaccination
   - Reduction of viral load

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IMPLICATIONS

Recommendations vs Current status

Water sanitization in hatchery to reduce viral pressure	No Cost factors Only in early hatchery phase
Heat intervention process	Yes Different protocols, variable results 5g up to 60% survival
Hold fry to larger size on land before stocking in lake	No Capacity issues Fry in lake: lake heating or land transfer
Vaccination against ISKNV	No Cost factors Trials planned: evaluate ROI and commercial benefit

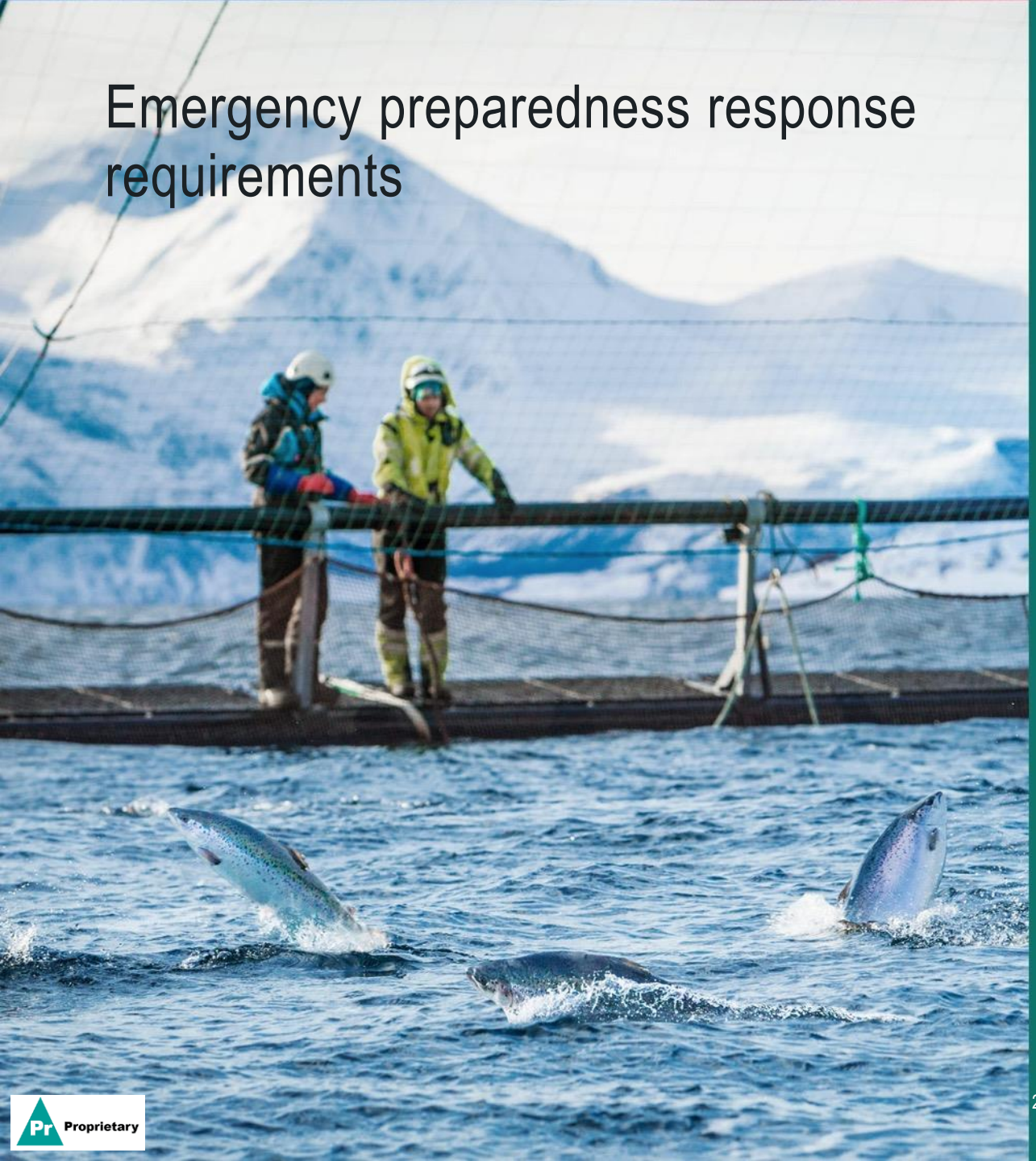
LESSONS LEARNED AND IMPROVEMENT

Key learnings

- Diseases: no rules and geographical boundaries
- Mistake excluding ISKNV
- Maintain global surveillance of **all** disease + new ones
- Early warning system
- Access to diagnostics
- Require global partnerships
- MSD - resource center

EMERGENCY REQUIREMENTS

Emergency preparedness response requirements



1. Timely access to fish health technical services in country
2. Identification of farm biosecurity gaps and improvements
3. Understand disease pathogenicity and characteristics
4. Routine farm or area disease surveillance
5. Seek help with open mind without resistance to change

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Pr Proprietary

Iridovirus background (BACKUP)