

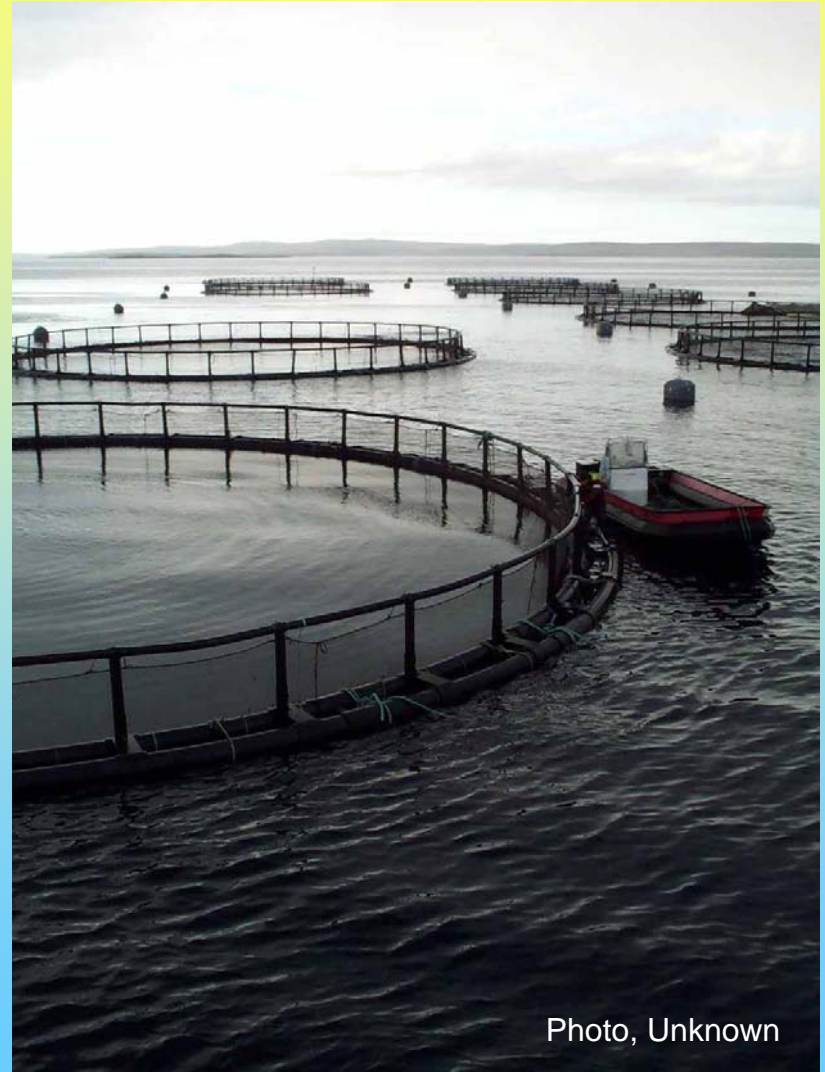
The use of anaesthetics and analgesics to implement the 3 R's: practical examples.

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Höglund, Odd-Ivar Lekang and Bjørn
Olav Rosseland

Reduce



Photo, Matre Aquaculture Research Station, IMR



Photo, Unknown

Predictive enough ?

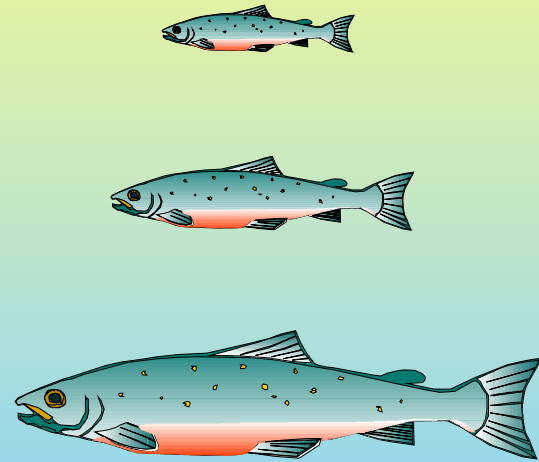
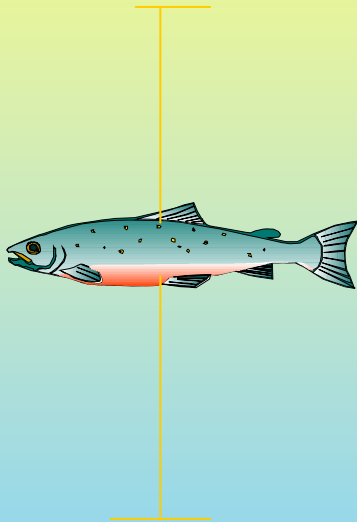
Refine - Simulate



Photo, Matre Aquaculture Research Station, IMR

Sub sample or the individual.

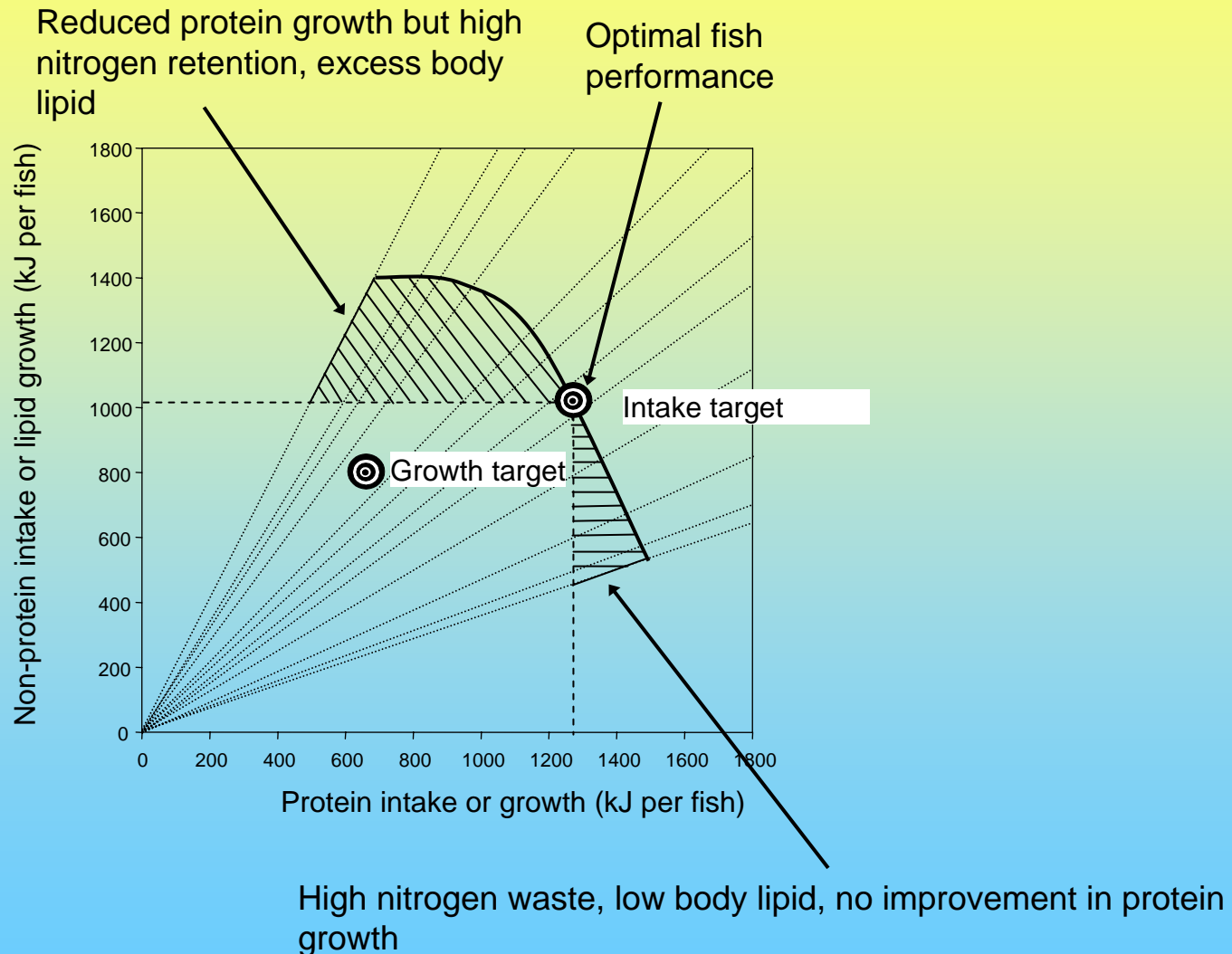
Two complementary designs.



Average

Refine 1. Feed intake

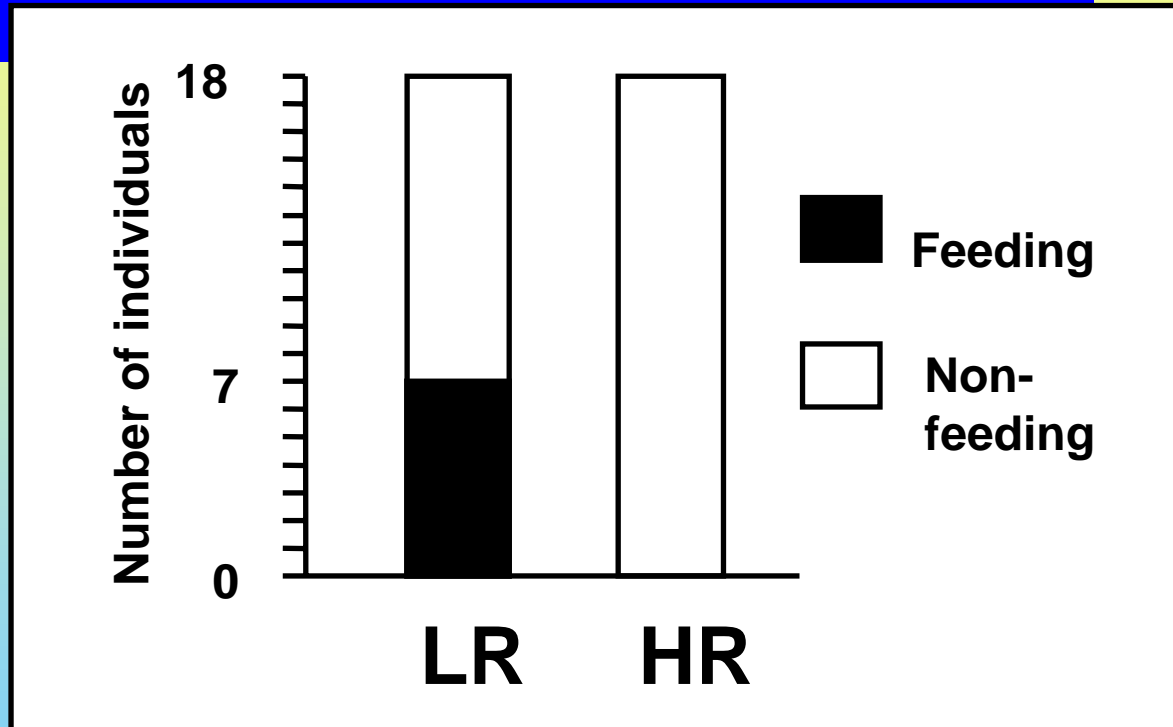
(Optimisation model design and geometrical analysis)



Refine 2. Gene - Environment interaction

Feeding in a novel environment

Feeding in a new environment (adult F1 generation)



A higher frequency of LR than HR fish had regained feed intake one week after transfer to rearing in isolation (40% vs 0%, $p=0.008$)

Refine 3. Physiological measurements

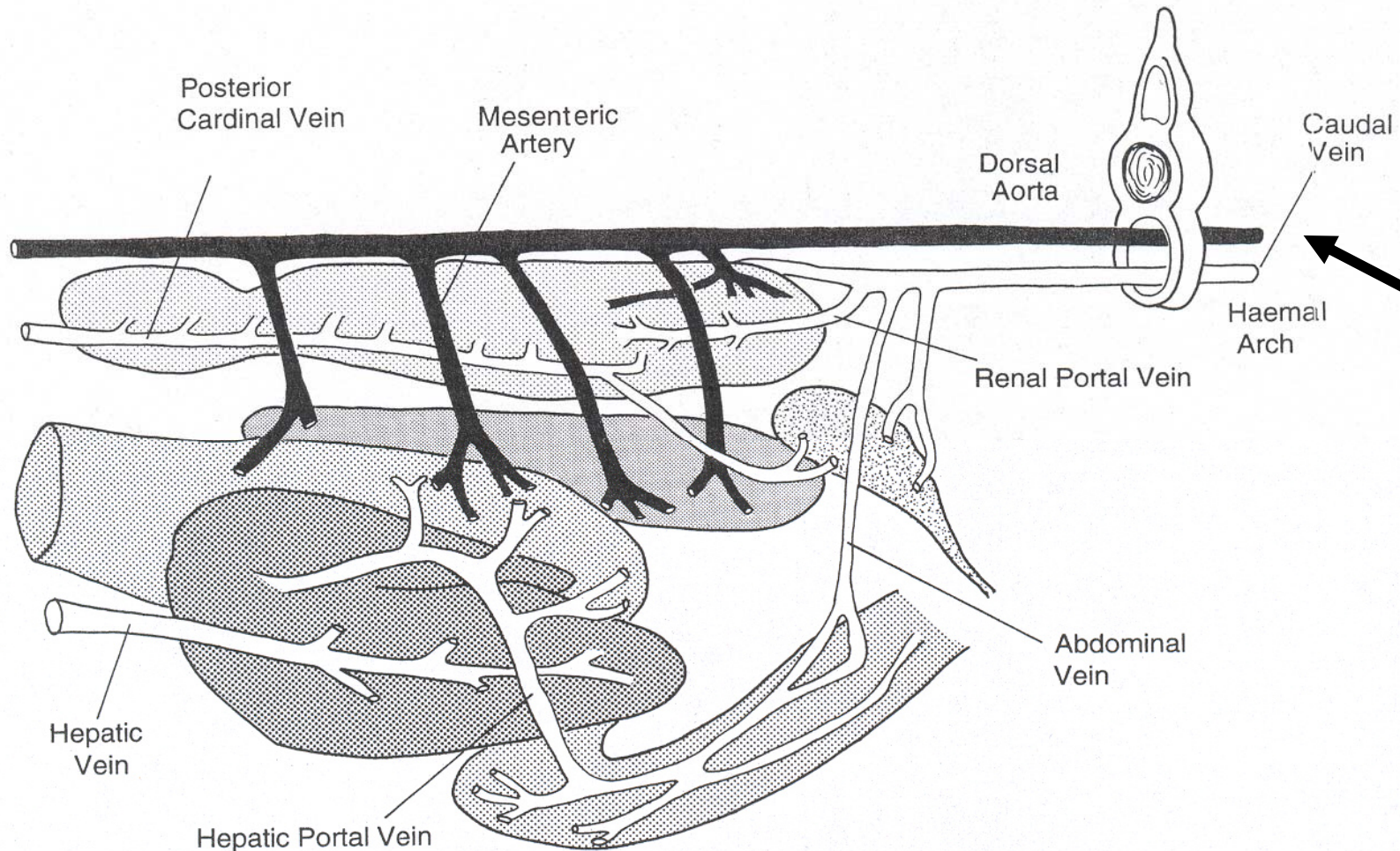


Fig. 4.4 Schematic diagram showing the major blood vessels in the abdominal cavity.

By M.Jobbling

“Recycle”



Photo: Jan Sunde



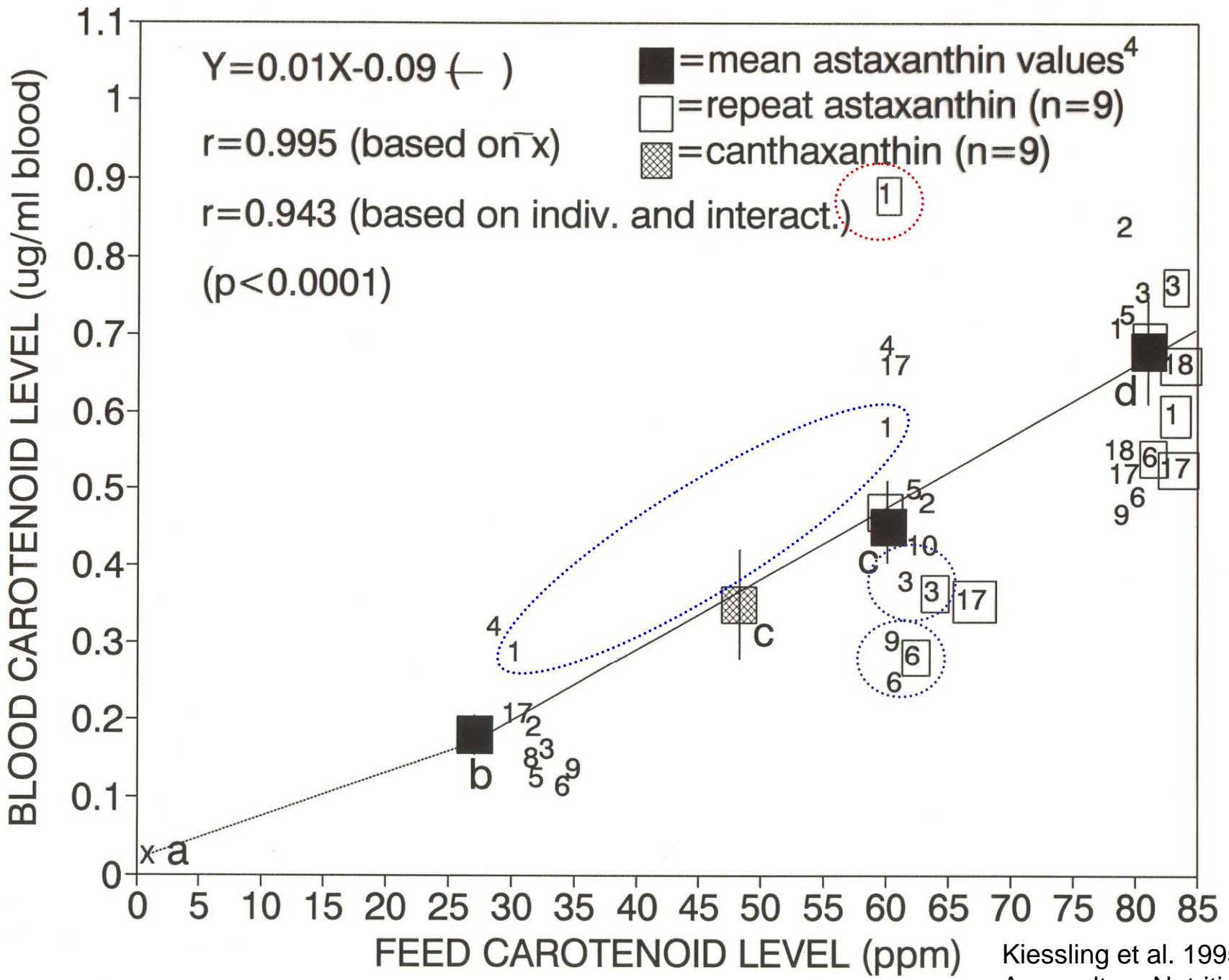
Photo: A.Kiessling

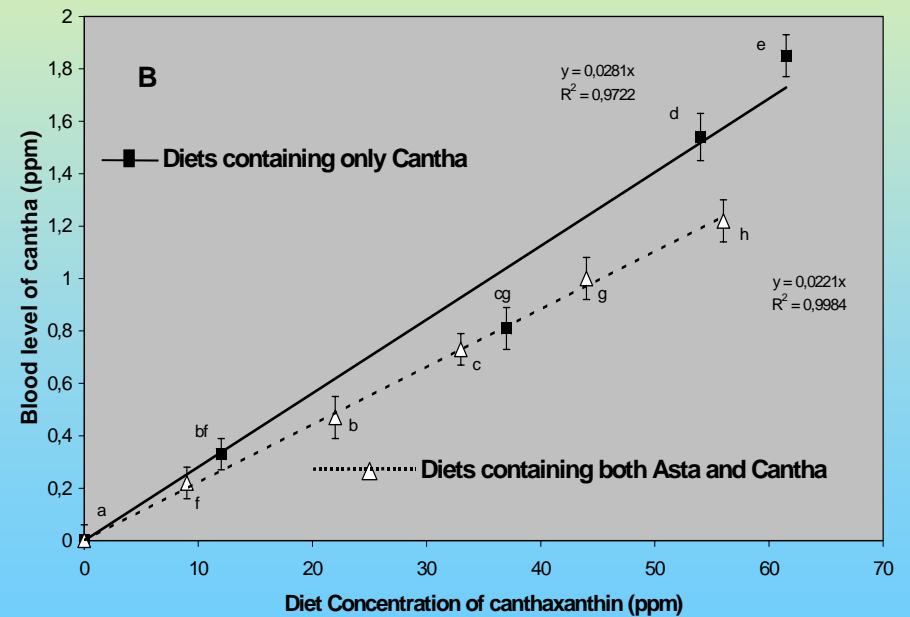
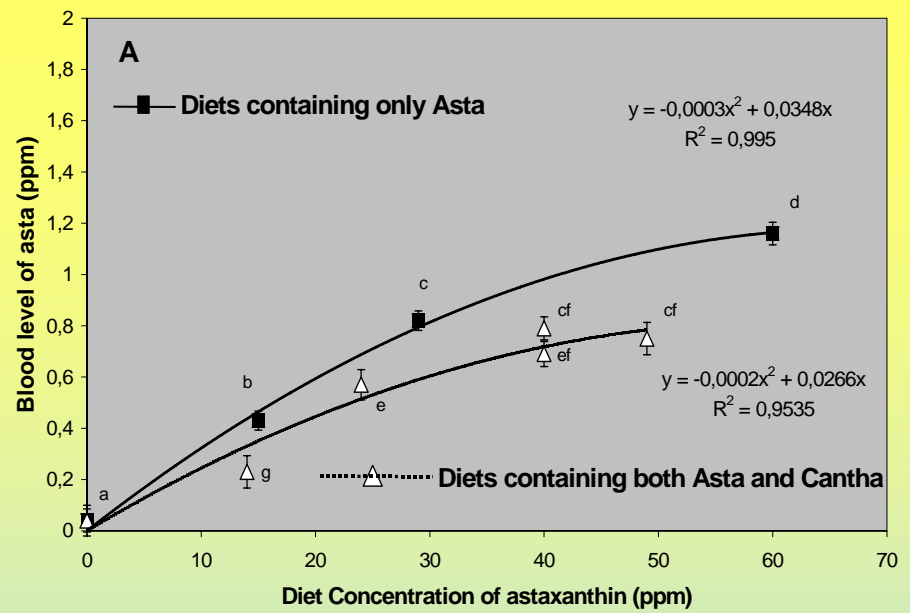
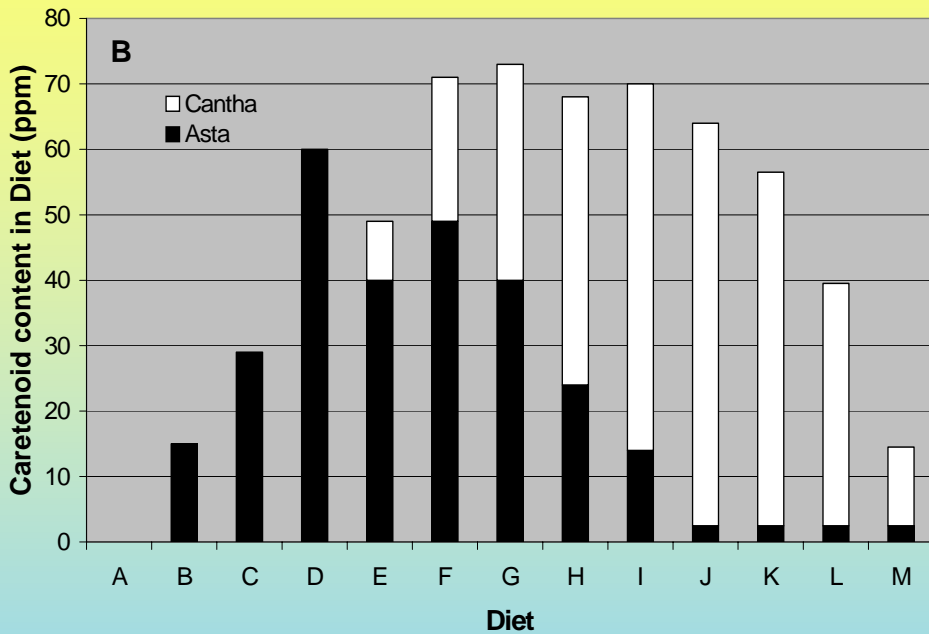


Photo: Jan Sunde



Photo: A.Kiessling





A.Kiessling, HI, R-E. Olsen, HI & Louise Buttle, Ewos Aquaculture Nutrition, 2004

Added value with use of individual fish

- Individual variation can be utilised to create more robust prediction models.
- Gene –environment component can be registered.
- Feed intake can be detailed
- Repeated physiological measurement
- Health and health history can be registered in the animal sampled

The problem of handling

- Handling
- Sedation
- Recovery
- Viability



Stress/anaesthesia	Benzocain	Aqui-S	No Anaesthesia
- 15 min.			5 ±4
15 min.	263 ±21 a	337 ±20 b	431 ±20 c
60 min.	396 ±24 a	404 ±23 a	276 ±24 b
360 min	131 ±24 a	128 ±21 a	139 ±22 a

Kiessling et al.
Fisken og Havet 3-2001

Mechanism of action

Cell wall

→

Methemoglobin

Benzocain is a local anaesthetic. Those are mainly used in humane medicine to produce a local nerve block. Local anaesthetics reversibly block the action potentials responsible for nerve conduction. This is done by blocking the ion channels for Na^+ , K^+ , Ca^{2+} . *Obs.*

To block a Na^+ channel the local anaesthetic binds to a receptor site located inside the channel pore. This makes the gating of the pore close. By doing so the action potential in the cell can not be built up. Now the action potential declines and impulse conduction slows, which leads to a failure of nerve conduction.

Hyper activation

At low concentrations local anaesthetics cause a stimulation to the CNS. This is expressed by restlessness, shivering and convulsions. When the dose increase, it is followed by central depression. Namely lowered respiration and decreased heart rate. If this statement is not reversed, it will be fatal. Goodman & Gilman's (1995), Rang et al. (1999), Foster (1996).

Respiration depression

In Stoskopf ed. (1993) it is said that higher doses of benzocain cause a depression in respiration, which leads to an insufficient water flow over the gills. This is associated with a slowing of heart rate, possibly induced by water with a low oxygen content in the area of the gills, an increase in the resistance to blood flow through the gill lamellae, and erythrocyte swelling that impedes blood passage trough the gills.

Cytotoxic

"Since benzocaine is fat soluble, the duration of anaesthesia may be prolonged (with extended recovery times) in large older fish or females with well developed gonads. Higher doses of benzocaine are required at higher temperatures." Stoskopf ed. (1993)

What is: Anesthesia viz Sedation or curariform immobilization

- **Anesthesia is a state of unconsciousness**

Often obtained by combination of drugs and consists of:

- | | | |
|----|--------------------------|------------------|
| 1. | Analgesia (pain relief) | CNS ↔ Peripheral |
| 2. | Amnesia (loss of memory) | CNS |
| 3. | Immobilization | CNS ↔ Peripheral |

- **Sedation**

- | | | |
|---|---------------|-----|
| – | Tranquilizer | CNS |
| – | Induced sleep | CNS |

- **Curariform -** Peripheral

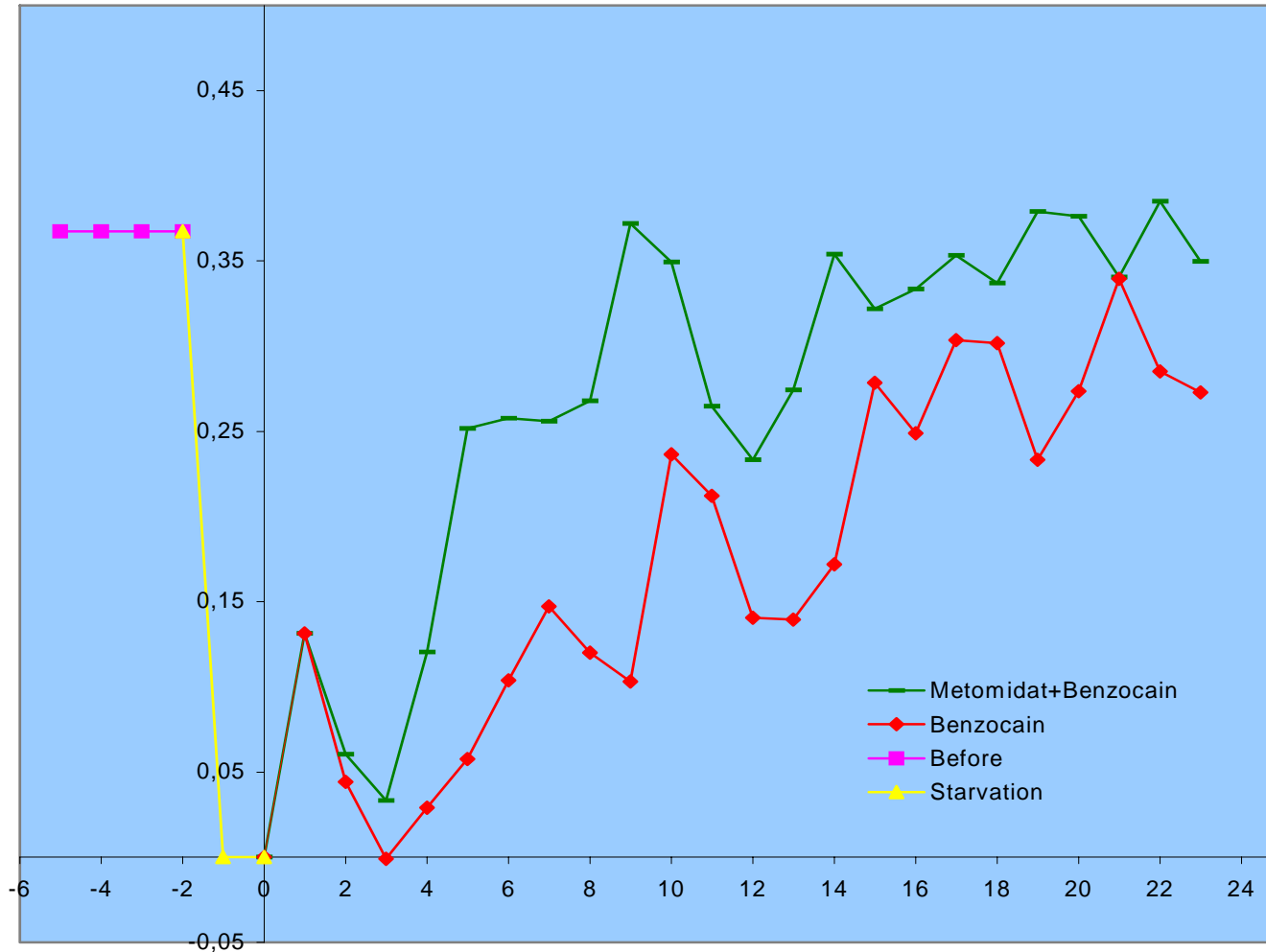
skeletal muscle relaxants (neuromuscular blockers as succinylcholine, decamethonium, curare, gallamine, pancuronium).

– no anesthetic or analgesic effect -

I.v. injections of local anesthetics like lidocain do not abolish nerve response from mechanic stimulation of nociseptors but merely increase the threshold in cat and rat.

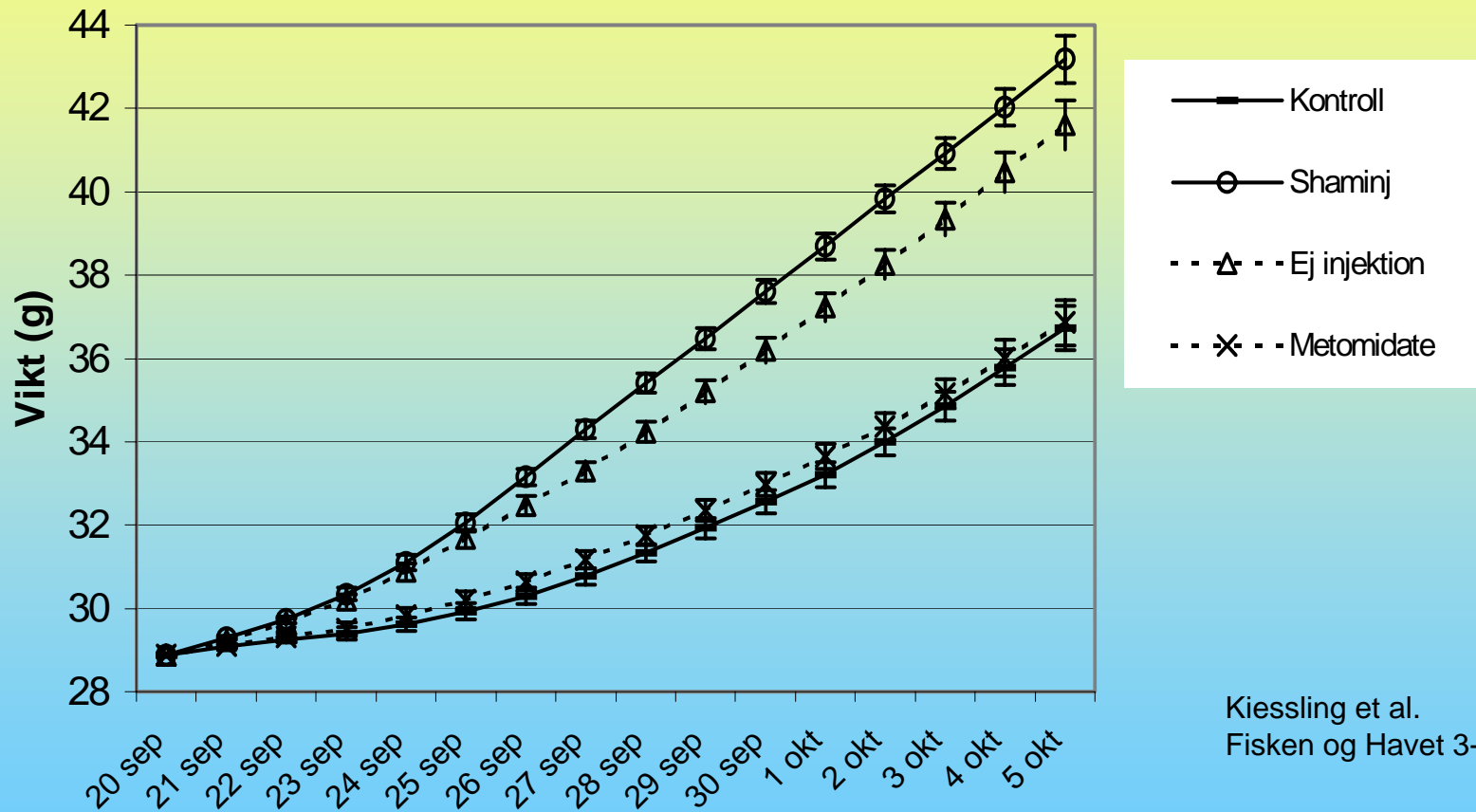
From Smärta, Neurogen
Vol 5, 1999, Glenn Haegerstam

Feed intake after vaccination



Oppedal, Johansson & Kiessling-
Norsk Fiskoppdrett-2000

Growth after vaccination



Kiessling et al.
Fisken og Havet 3-2001

Stages of anaesthesia in fish

Skema 2. Anæsthesistadier og plane

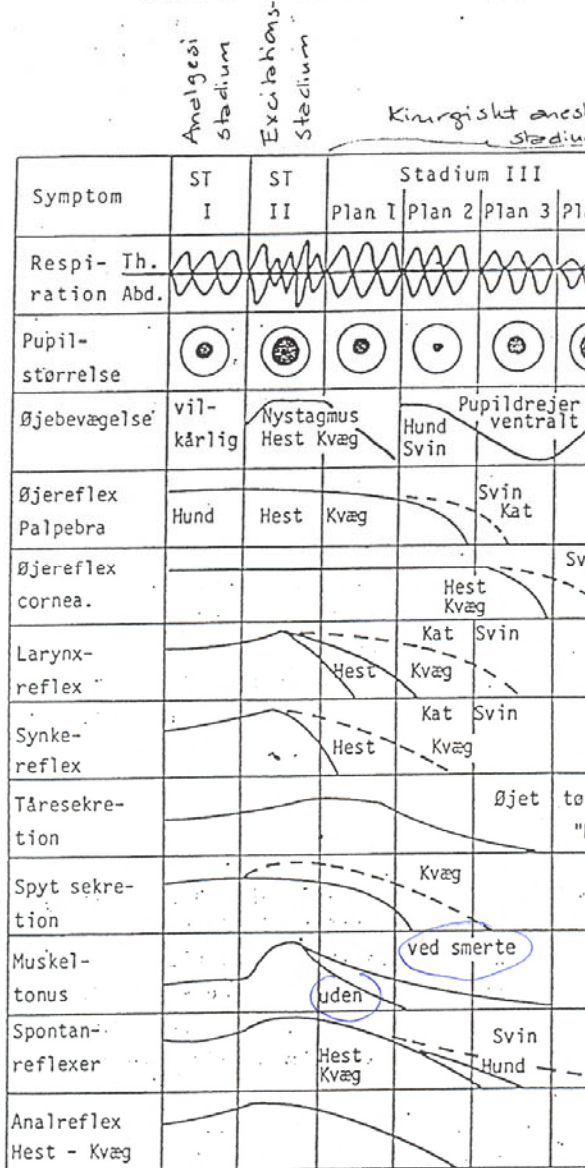


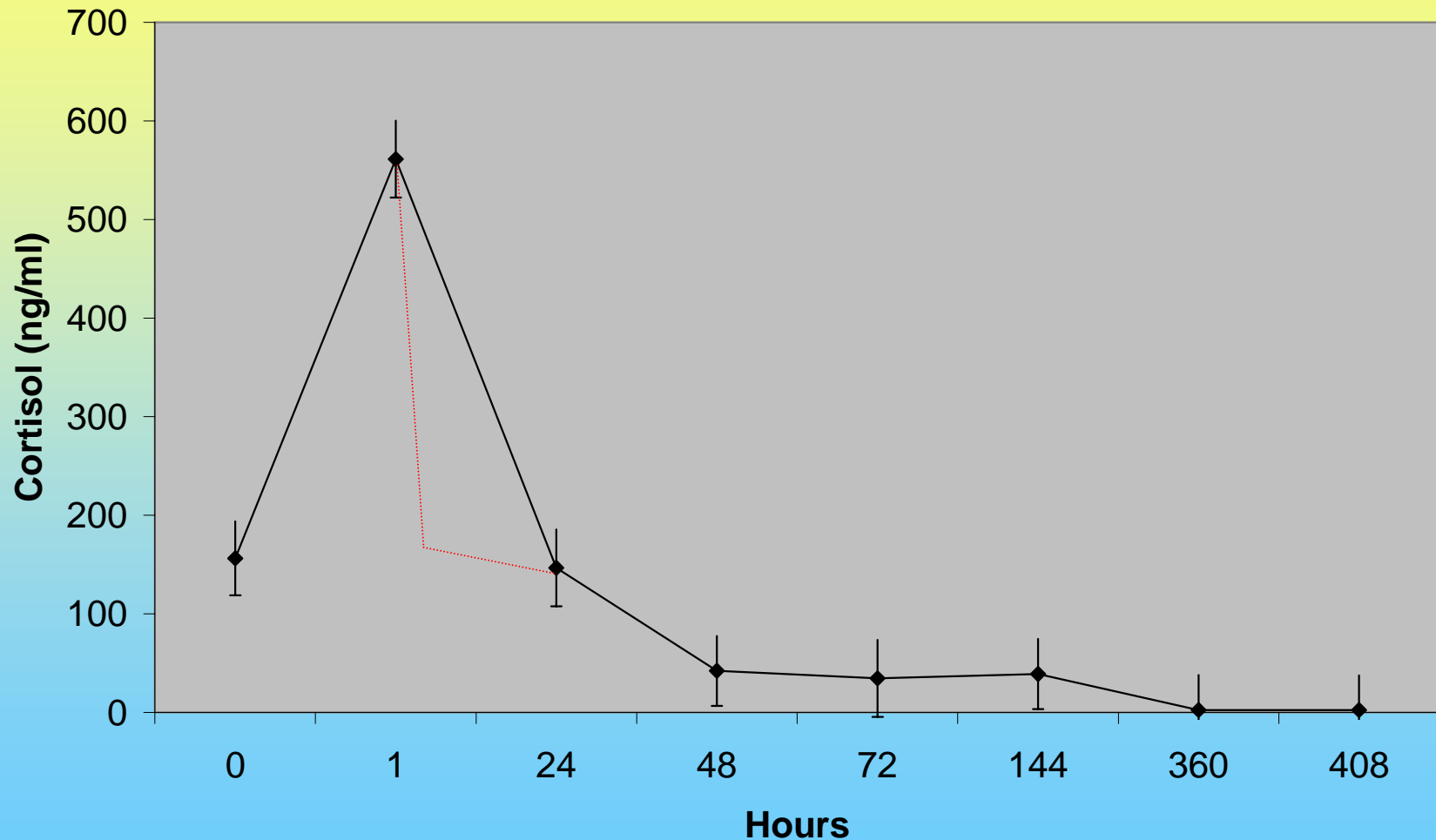
Table 1. Stages of Anaesthesia in Fish

Stage	Plane	Category	Behavioural Response of fish
0		Normal	Swimming activity, Reactive to external stimuli Equilibrium normal, Muscle tone normal
I	1	Light sedation	Voluntary swimming continues Slight loss of reactivity to visual and tactile stimuli Respiratory rate normal, Equilibrium normal, Muscle tone normal
	2	Deep sedation	Voluntary swimming stopped Total loss of reactivity to visual and tactile stimuli Slight decrease in respiratory rate, Equilibrium normal Muscle tone slightly decreased, Still responds to positional changes
II	1	Light narcosis	Excitement phase may precede increase in respiratory rate Loss of equilibrium, Efforts to right itself, Muscle tone decreased Still responds to positional changes weakly
	2	Deep narcosis	Ceases to respond to positional changes Decrease in respiratory rate to approximately normal Total loss of equilibrium, No efforts to right itself Muscle tone decreased, Some reactivity to strong tactile and vibrational stimuli, Suitable for external sampling, fin biopsies, gill biopsies
III	1	Light anaesthesia	Total loss of muscle tone, Responds to deep pressure Further decrease in respiratory rate, Suitable for minor surgical procedures
III	2	Surgical anaesthesia	Total loss of reactivity, Respiratory rate very low, Heart rate slow
IV		Medullary collapse	Total loss of gill movements followed in several minutes by cardiac arrest.

We postulate that the use of pre anaesthesia sedation and local anaesthetics has enabled reduced anaesthetic depth and risk of wind up leading to a much faster recovery and a more viable preparation.

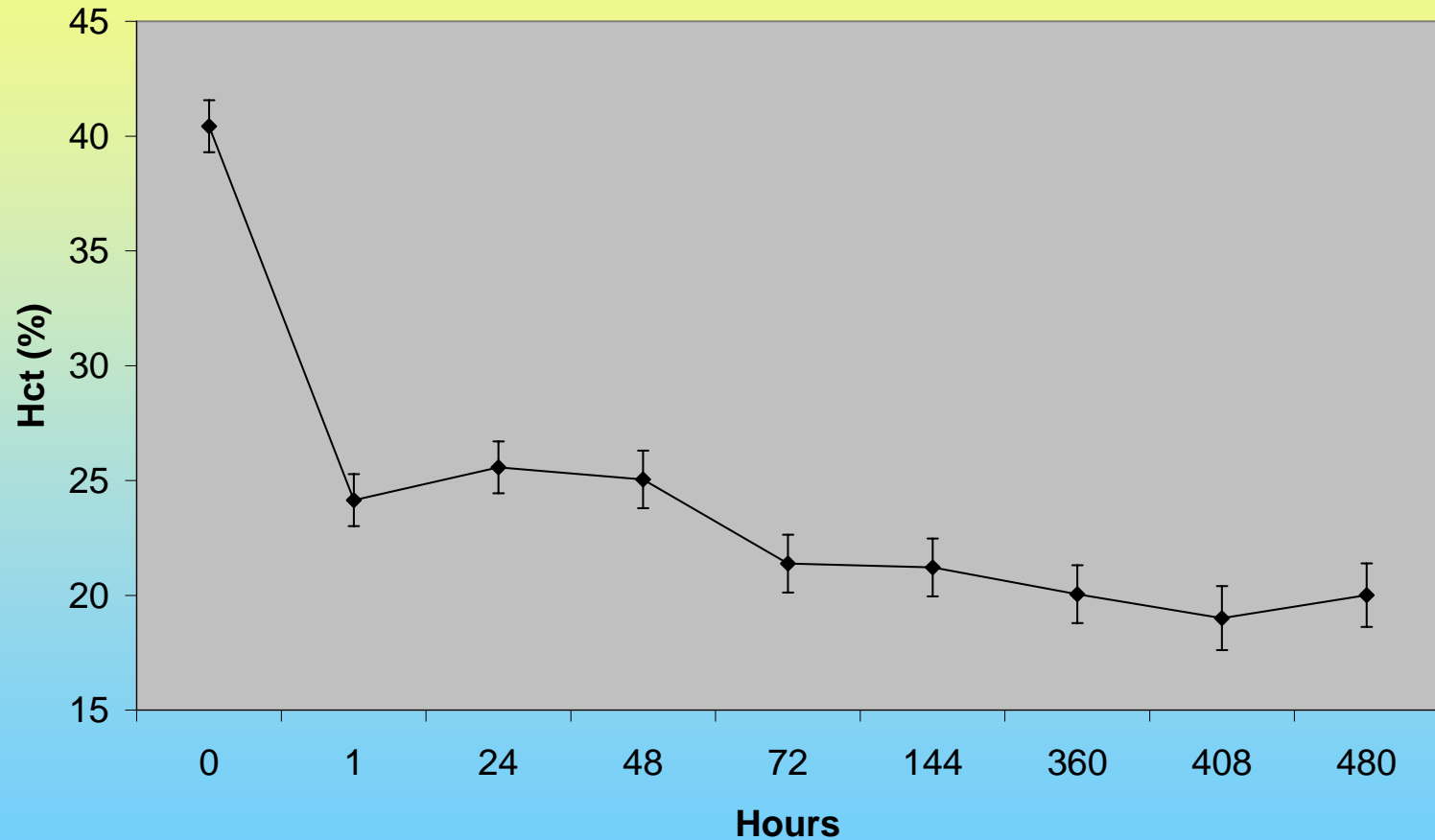
Recovery after surgery, salmon

(with pre anaesthetic sedation and local anaesthetics)



Kiessling et al. in prep

Hct in Salmon after surgery



Similar pattern in plasma: Na⁺, K⁺, Glucose, pH, pCO₂ etc

Kiessling et al. in prep