Catch-and-release management of fish populations: supported by science or social conscience?

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Recreational Fisheries

- Global participation is 220 – 700 million
- Catches are generally increasing
- Affects freshwater & marine spp.
- In 2004 it was estimated that **47 billion** fish were captured
- Roughly 2/3 were released

What tools can we use to encourage or enforce C&R?

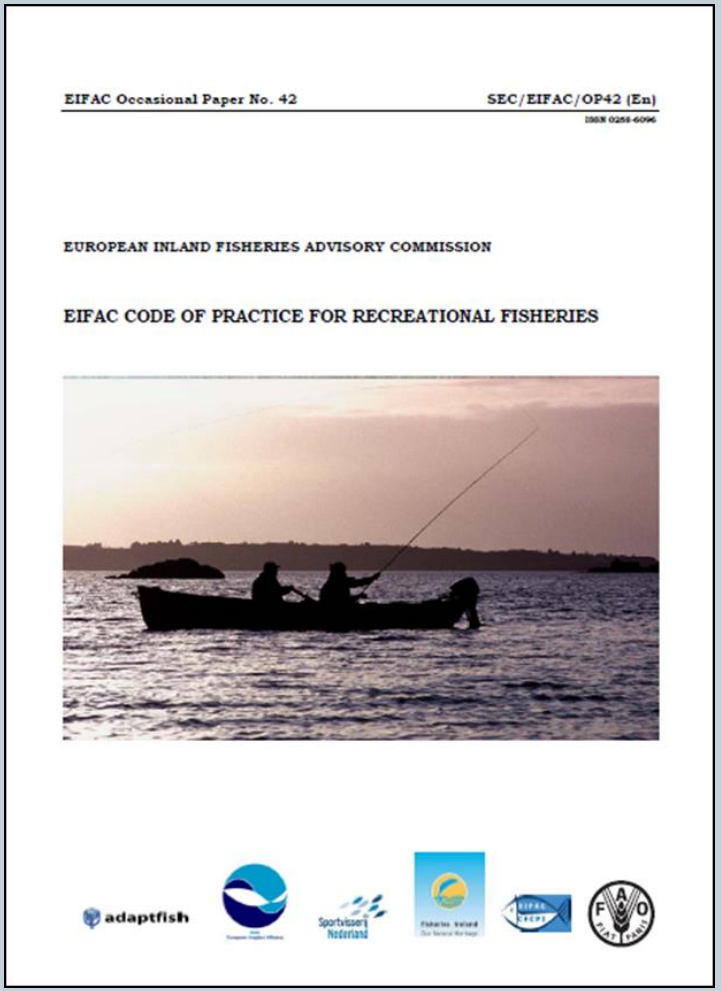
Regulatory tool	Commercial fisheries	Recreational fisheries
Closed areas	Protected areas and nursery habitats	Protected areas and nursery habitats
Closed season	linked to spawning periods or vulnerable periods during migration	Usually linked to spawning periods
Catch limit	Quotas	Bag limit
Effort regulation	Licensing	Partially in some jurisdictions (e.g., UK)
Type of gear	To minimise damage to stocks through, for example, mesh size or highly efficient, destructive gears	Usually only in specialist fisheries
Size of fish	Minimum size limits usually linked to size at maturity	Minimum size retained in some fisheries
Species of fish	Quotas	At specific times and in specific places
Code of conduct	FAO CCRF	National guidelines in some countries; international guidelines linked to FAO CCRF in preparation

from Cooke & Cowx (2006), *Biological Conservation*

Code of Practice for Recreational Fisheries (2008)

- Involved stakeholders from Europe, North America & Oceania
- Describes minimum standards of:
  - environmentally friendly
  - ethically appropriate
  - socially acceptable

recreational fishing and its management



How useful are these suggestions?

Catch a fish, put it back	But it swam away, it's fine…
• Low post-release survival renders regulation ineffective ➢ Why put "dead" fish back? • Conflict between mandated and voluntary practitioners • Is this ethically sound advice? ➢ unnecessary suffering	• "*good welfare means that an individual fish is in good health, with its biological systems functioning properly and with no impairment of fitness*" ➢ What fitness do we mean; physical or 'evolutionary'?

Outline

- Factors affecting initial mortality rates
  - Total mortality
  - Anatomical hooking location
  - Hook type
  - Air exposure
  - Barotrauma
- Factors with sub-lethal consequences (delayed mortality)
  - Physiological impairment
  - Multiple C&R events
  - Behavioural disturbance
- Summary

Total mortality

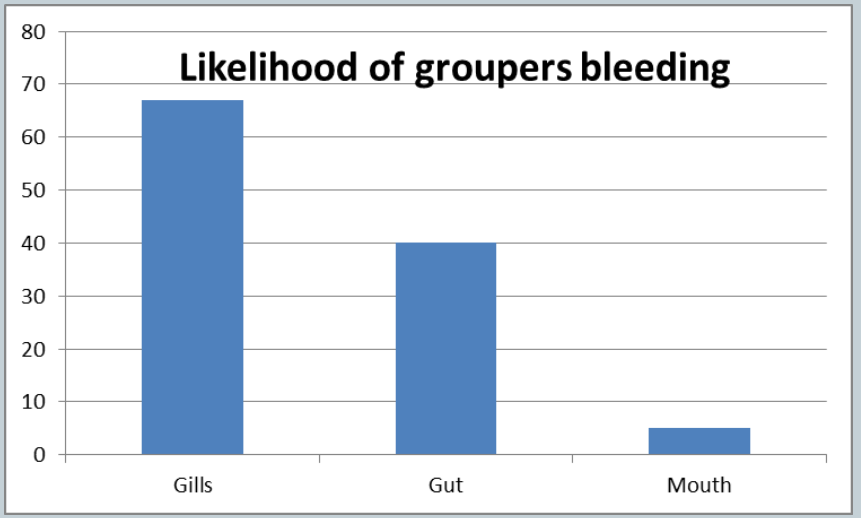
- Several factors are major causes of mortality:
  - Anatomical hook location
  - Bait type
  - Removing deep hooks
  - J-hooks
  - Capture depth
  - Water temperature
  - handling times
- **Average mortality is 18%** across all species (274 studies)

Species	Common name	Mortality Rate (%)	Citation
Acanthopagrus butcheri	black bream	15.5	Grixti *et al.* (2008)
Centropomus undecimalis	common snook	2.1	Taylor *et al.* (2001)
Centropristis striata	black sea bass	4.7	Bugley & Shepherd (1991)
Cynoscion nebulosus	spotted seatrout	4.6 - 11	Murphy *et al.* (1995); Stunz & McKee (2006)
Cynoscion regalis	weakfish	2.6	Malchoff & Heins (1997)
Epinephalus morio	red grouper	20	Burns *et al.* (2012)
Glaucosoma hebraicum	west Australian dhufish	51	St John & Syers (2005)
Lutjanus campechanus	red snapper	20 - 49.1	Render & Wilson (1994); Burns *et al.* (2012)
Macquaria ambigua	golden perch	0	Hall *et al.* (2010)
Macquaria novemaculeata	Australian bass	0 - 6	Hall *et al.* (2009); Dowling *et al.* (2010)
Megalops atlanticus	tarpon	3.7	Edwards (1998)
Micropterus dolomieu	smallmouth bass	0 – 8.9	Jackson & Willis (1991); Hartley & Moring (1995); Dunmall *et al.* (2001)
Micropterus punctulatus	spotted bass	8.5	Muoneke (1992)
Micropterus salmoides	largemouth bass	1.42 - 38	Meals & Miranda (1994); Hartley & Moring (1995); Kwak & Henry (1995); Weathers & Newman (1997); Neal & Lopez-Clayton (2001); DeBoom *et al.* (2010)
Morone saxitilis	striped bass	31	Millard *et al.* (2003)
Oncorhynchus mykiss	rainbow trout	16	Schill (1996)
Platycephalus bassensis	sand flathead	1 - 6	Lyle *et al.* (2007)
Pomatomus saltatrix	bluefish	8 - 25	Fabrizio *et al.* (2008); Broadhurst *et al.* (2012)
Pomoxis annularis	white crappie	9.3	Muoneke (1992)
Salmo salar	Atlantic salmon	8 – 12	Brobbel *et al.* (1996); Dempson *et al.* (2002)
Salmo trutta	brown trout	5	Boyd *et al.* (2010)
Salvelinus leucomaenis	white-spotted charr	6.7	Tsuboi *et al.* (2002)
Salvelinus namaycush	lake trout	24	Persons & Hirsch (1994)
Sander vitreus	walleye	0 - 54	Reeves & Bruesewitz (2007); Schramm *et al.* (2010)
Sciaenops ocellatus	red drum	2	Vecchio & Wenner (2007)
Sparus aurata	gilthead seabream	11.7	Veiga *et al.* (2011)
Sphyraena barracuda	great barracuda	0	O'Toole *et al.* (2010)
Spondyliosoma cantharus	black seabream	2.8	Veiga *et al.* (2011)
Tetrapturus albidus	white marlin	12.5	Horodysky & Graves (2005)
Thunnus thynnus	Atlantic bluefin tuna	1.7	Stokesbury *et al.* (2011)

Anatomical hooking location

Anatomical hooking location

- Mortality is greater when hooked anywhere but the mouth
- **Approx. 12-times more likely to die**
- Severe trauma (bleeding) is correlated with hook location
- Deep hooking (gut or oesophagus) is highly traumatic



adapted from Bacheler & Buckel (2004), *Fisheries Research*

Deeply set hooks

In general…

- Deeply hooked fish require greater handling times
- Risk of severe damage to organs
  - Worse when attempting to remove
- Can be caused by:
  - Natural baits
  - Naïve anglers
  - Small hooks
  - J-hooks

A deeply hooked black bream

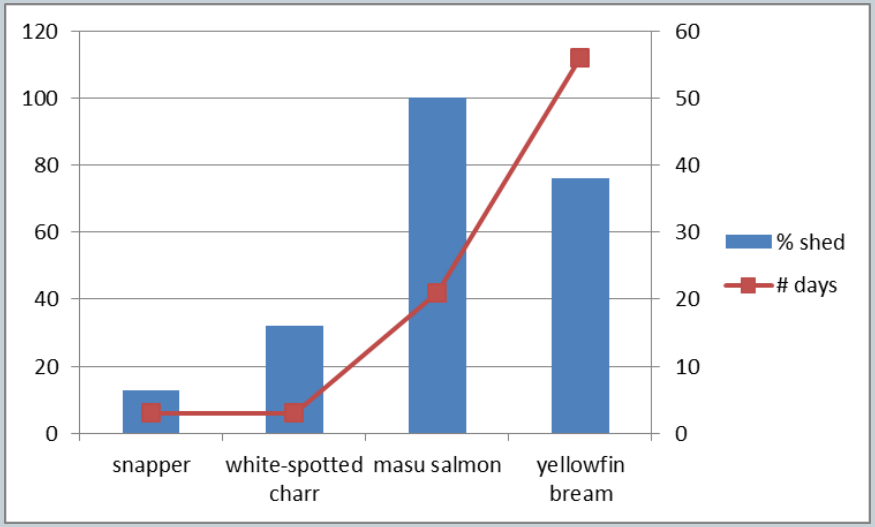
from Grixti *et al.* (2008), *Fisheries Research*

Should we cut the line?

In general…

- **50 - 90% reduction in mortality** of deeply-hooked fish
- Some species are able to shed deep hooks naturally
  - Takes 3 – 56 days

Frequency of shedding hooks



Hook type: single *vs*. treble

Single hooks	Treble hooks
	

Hook type: single *vs.* treble

In general…

- **Treble hooks cause fewer mortalities**
  - Less likely to set in critical locations
- **Small single hooks cause high rates of mortality**
  - They are more likely to result in deeply-hooked fish

Treble hook in action

Hook type: circle *vs*. J-hook

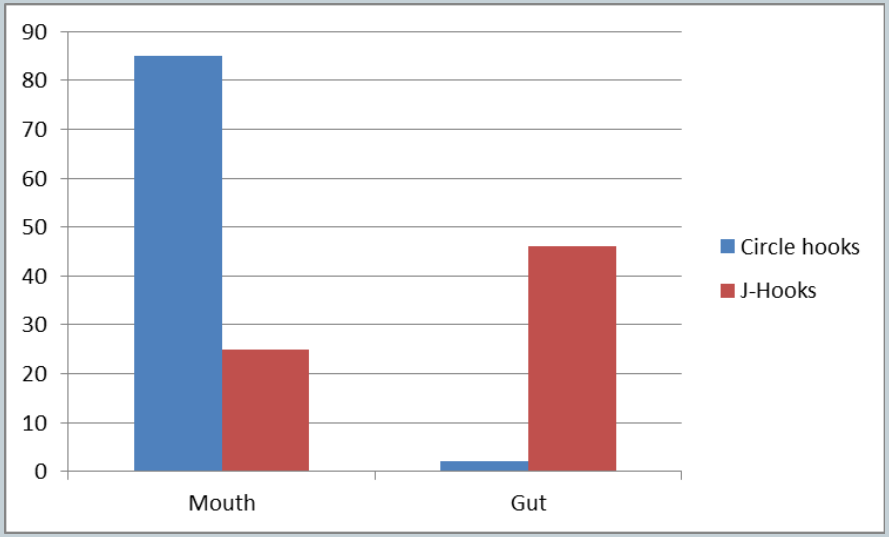
Circle hook	J-hook
	

Hook type: circle *vs.* J-hook

In general…

- Circle hooks are more likely to set in the mouth
  - This reduces handling times
- J-hooks are more likely to be swallowed
  - These will set in the gut or oesophagus
- **Mortality rates appear consistently lower when using circle hooks**

Atlantic & Pacific sailfish hooking locations



adapted from Prince *et al.* (2002), *AFSS*

Hook type: barbed *vs*. barbless hooks

Barbed hook	Barbless hook
	

Hook type: barbed *vs.* barbless hooks

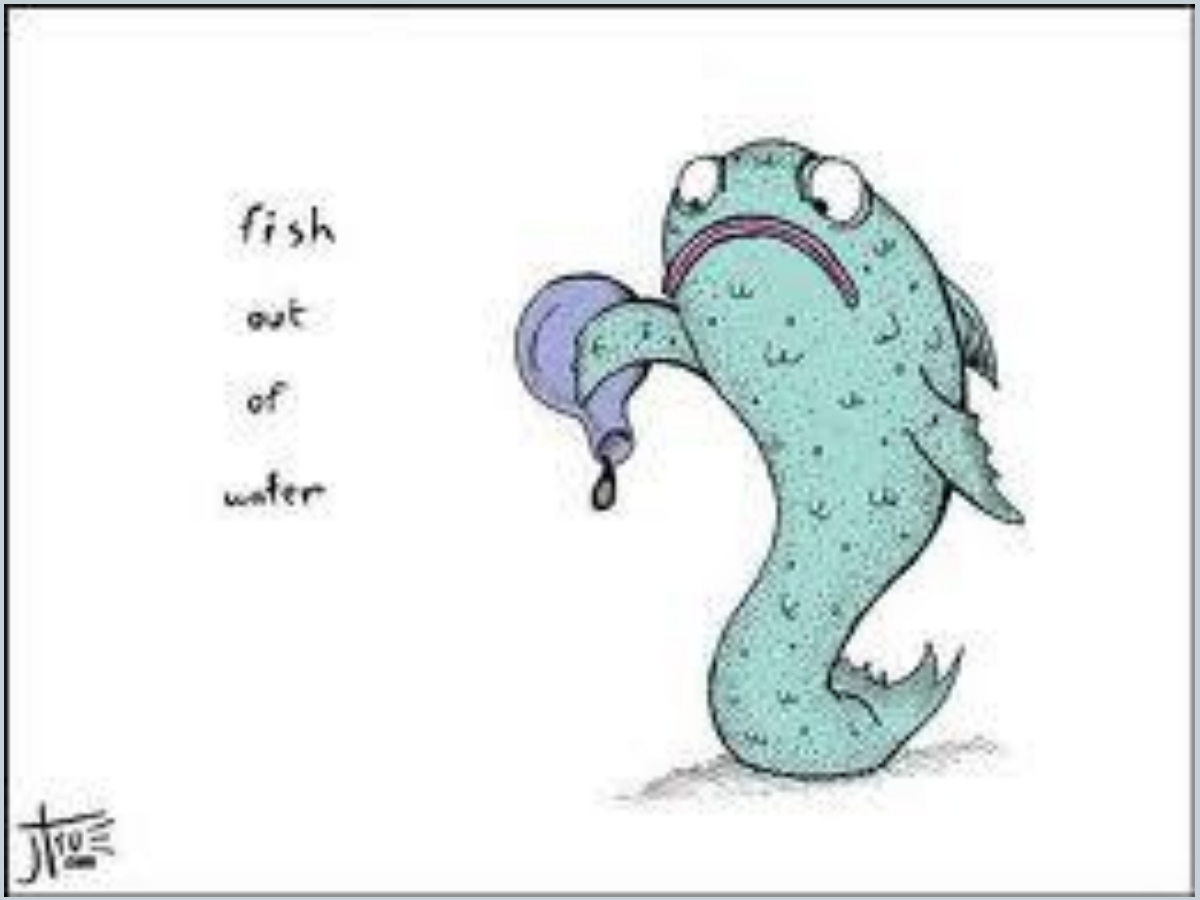
In general…

No differences in mortality rates

- Barbed hooks cause increased handling times
- **However, they do not result in greater mortality rates**
  - Barbed hook restrictions appear not to be based on evidence

Species	Method	Reference
rock bass	barbed *vs.* barbless jigs	Cooke *et al.* (2001)
rock bass	barbed *vs.* barbless worms	Cooke *et al.* (2001)
salmonid spp.	barbed *vs.* barbless singles & trebles	DuBois & Dubielzig (2004)
bluegills	barbed singles hooked in oesophagus	Robert *et al.* (2012)
walleye	barbed *vs.* barbless livebait	Reeves & Staples (2011)

Air exposure

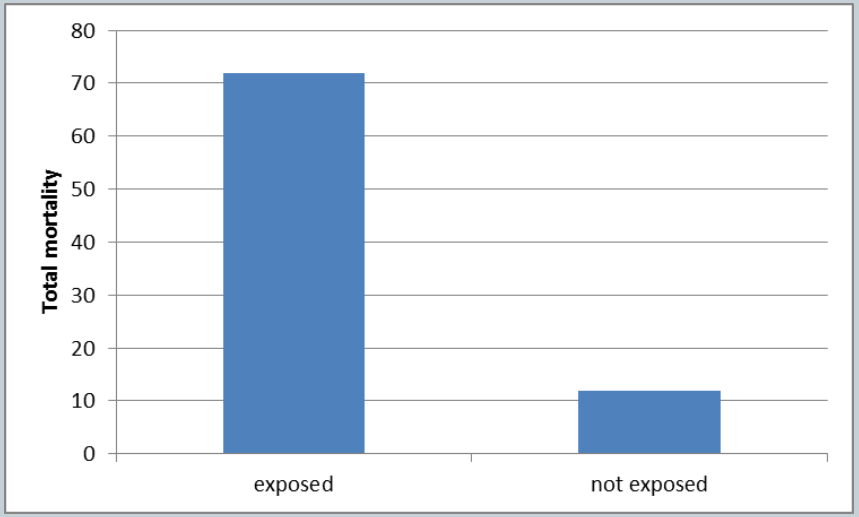


Air exposure

In general…

- Deprives fish of oxygen when they must recover
- Strong positive correlation between exposure duration and cardiovascular variables
- Strong negative correlation between exposure duration and swimming performance
- **Air exposure following exercise greatly increases the likelihood of mortality**

rainbow trout following 60s of exercise



adapted from Ferguson & Tufts (1992), *CJFAS*

The impact of barotrauma

The impact of barotrauma

The effects of barotrauma

- Forms gas bubbles that result in:
  - Blood clots
  - Embolisms
  - Haemorrhaging
- Gut expulsion
- Ruptured gas bladder
- Exophthalmia

Exophthalmia ("pop-eye")

rosy rockfish; Rogers *et al.* (2011), *Fisheries Research*

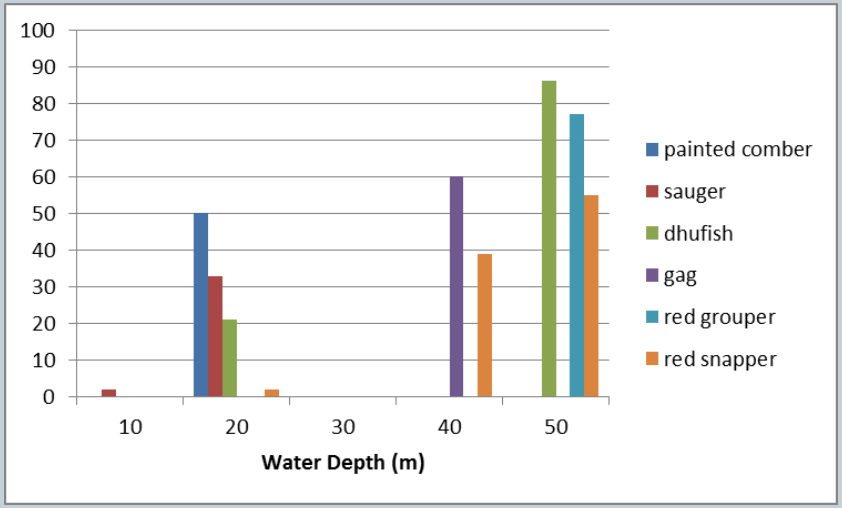
Eye displacement can be as great as 61% of total body length

The impact of barotrauma

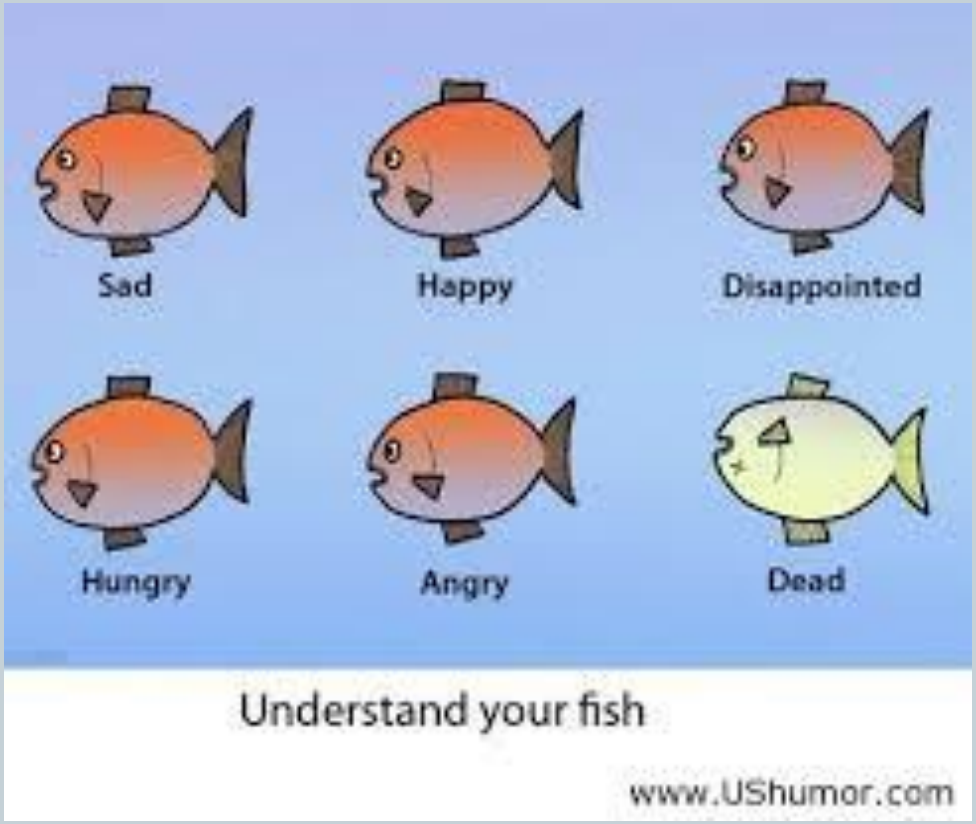
In general…

- **Strong positive correlation between capture depth and mortality**
  - Associated with barotrauma

Capture depth and mortality



Sub-lethal consequences of C&R

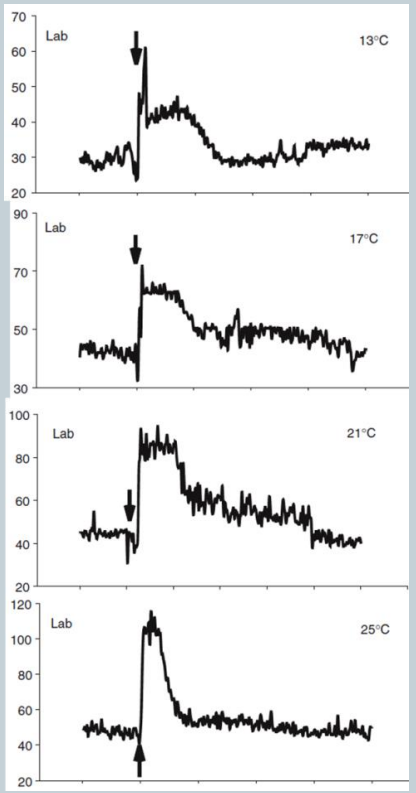


Physiological disturbance

In general…

- C&R significantly elevates stress hormone levels & cardiac output
- It also disrupts osmoregulatory capacity
- **All of which negatively impact mortality rates**

Heart rate telemetry of angled largemouth bass



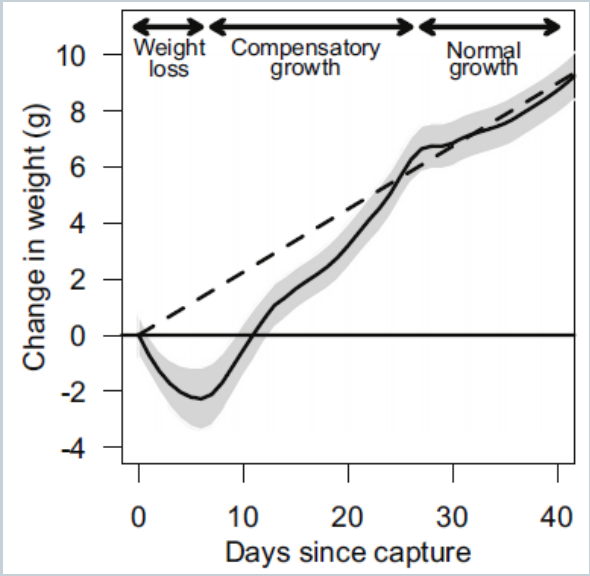
adapted from Cooke *et al.* (2004), *J. of App. Ichth.*

Impact of multiple C&R events

In general…

- C&R interrupts normal foraging behaviour
  - Injury
  - Stress
  - Retention
- **However, growth rate does not appear affected**
  - Largemouth bass (40 days)
  - White-spotted charr (50 days)
  - White seabass (90 days)
  - Largemouth bass (330 days)

Compensatory growth in angled largemouth bass



(--) un-angled, population-wide stable growth rate
(-) angled fish growth rate

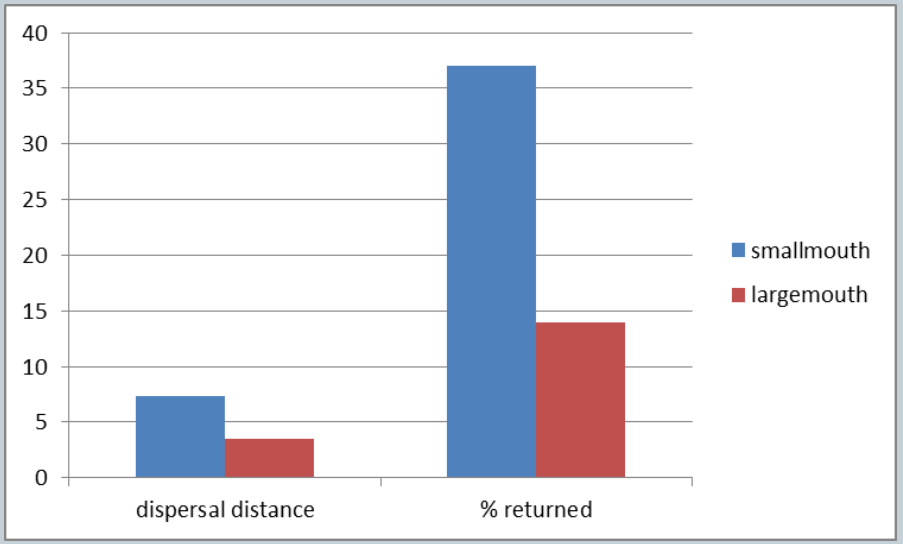
from Cline *et al.* (2012), *CJFAS*

Behavioural disturbance

In general…

- Behaviour strongly influences post-release mortality and sub-lethal impacts
- Released fish can disperse many kms from capture site
- May take weeks or months to return

Tournament angling for black bass



adapted from Wilde (2003), *Fisheries*

Black bass angling tournaments

- Increased nest abandonment rates.
- Depressed reproductive output.
- Smaller offspring.

However, population level effects appear minimal to neutral.

- Suggests behavioural effects may be short-lived.

Main findings

- Mortality rates following a C&R event vary widely; with an average of 18% across freshwater and marine species.
- Increased mortality rates following a C&R event when hooks are set in anatomical locations other than the mouth.
- Single and treble hooks result in different outcomes following a C&R event; with a reduced likelihood of mortality when using treble hooks as a result of shorter handling times.

Main findings

- There is little empirical evidence supporting the widely held belief that barbless hooks result in a reduced likelihood of mortality following a C&R event.
- Natural baits have the potential to result in a greater likelihood of mortality following a C&R event compared with artificial lures.
- Line-cutting for individuals deeply-hooked is a viable management practice that reduces the likelihood of mortality following a C&R event.

Main findings

- A period of air exposure, exacerbated by periods of exercise prior to landing a fish, increases the likelihood of mortality during a C&R event.
- A C&R event significantly elevates stress hormone levels, cardiac output and disrupts osmoregulatory capacity; all of which may negatively impact mortality rates.
- Multiple C&R events do not necessarily result in compromised long-term growth.
- Although short-term behaviour may be altered by a C&R event many species do not exhibit long-term effects. This could suggest fish populations are not severely impacted by the disturbance of small numbers of individuals even during sensitive periods of the life cycle, such as spawning.

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