



Longline fisheries

(the Norwegian style)

Basics of the gear, history in brief,
resources, important discoveries,
fleet status and examples on
technologies used in Norway
(i.e. the North-East Atlantic area)

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Longlining the Norwegian style

(in the North-East Atlantic)

- Basics of longlining,
- History in brief,
- Fishermen and fleet status,
- Species and resources,
- Important discoveries (IMR),
- Examples of UIT study areas,
- Modern vessels,
- Some current technologies



Hook and lines and longlines are passive - and in most cases - stationary gears equipped with bait to attract fish from an area around. The use of a (baited) hook may be one of the oldest fishing methods. The efficiency of the gear depends on many and complicated factors.

Basics of the longline



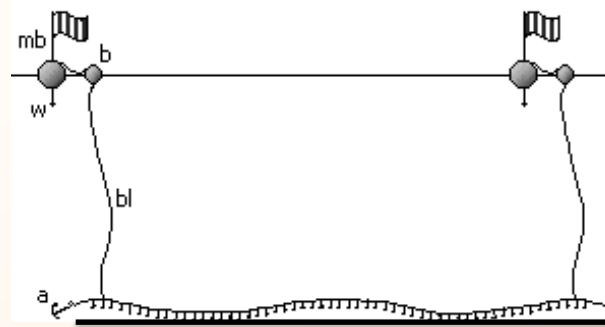
- Main line (groundline), spun PES or PA mono
- Gangion (snood, brancline), spun PES or PA mono
- Hook (many choices)
- Bait (usually herring, mackerels, sauri and squids, ...)
- Hook spacing, i.e. distance between branclines (1.0 m and upwards, but usually 1.2-1.4 m in autoline)



Longlines are usually operated as bottom set lines for typical species like cod, haddock, wolf-fish, tusk, ling, halibut, turbot (Greenland halibut).

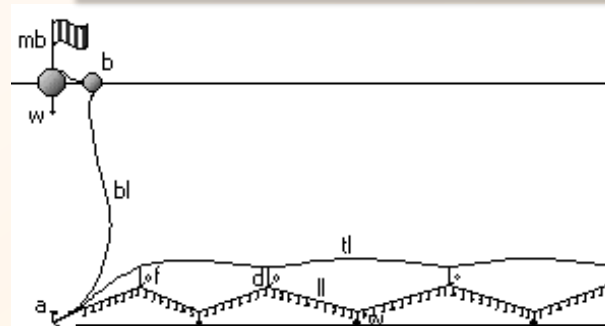
During certain conditions and for certain species other techniques are used.

Bottom set line;
PES main line

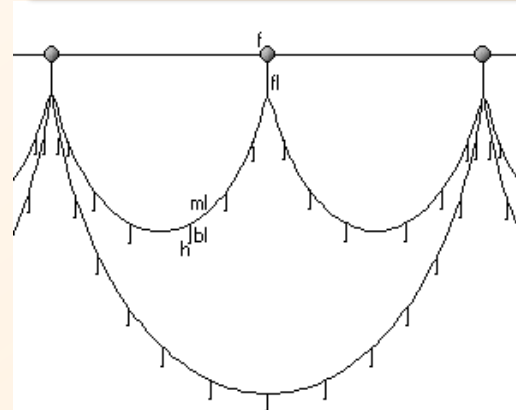


mb: marker buoy,
b: buoy,
w: weight,
bl: buoyline,
a: anchor
fl: floats

Semi-pelagic line
PA (or PES) main line
(avoiding copepods)



Sub-surface set line
PA main line
(mainly for haddock)



When fish appear deeper,
less floats are used

It's all about the money always!

Hook and line caught fish is preferred in many markets. For high-cost cod products like stock-fish and clip-fish, nothing compares to line-caught fish.



HG-cod and fillets of top quality: Non-stressed fish without gear-induced damages makes “hook & line” (longline) caught fish a winner in many European markets

Stock-fish has for hundred of years been the **icon** of exported Norwegian fish products; Only superior quality counts in the exclusive Italian markets.





Brief history and current importance



- Hook and line fisheries has long traditions in Norway/Scandinavia. (The bone hook ca. 4000 years old was found in South Norway; a stone carving found in South Sweden).
- Longlining can be dated back to early 18th century, but the gear was forbidden during several periods as it was known to be too efficient.
- Until the end of the 19th century handlines (i.e. jigging) were commonly used for the large cod fisheries along the coast.
- Longlining gained more importance in the beginning of the 20th century as industrial, large scale production of hooks became possible.
- By the end of the 1970ties the deep sea fleet increased to ca. 80 vessels.
- Currently there are 21 large longline vessels left, which of several combine gillnetting and longlining.
- Currently around 15% the Norwegian cod quotas are landed by longliners. For haddock the figure is close to 40%.



***Longlining** is often termed with wording like: “conservation-oriented”, “low-fuel- consumption”, “eco-friendly”, “sustainable fishery”:*

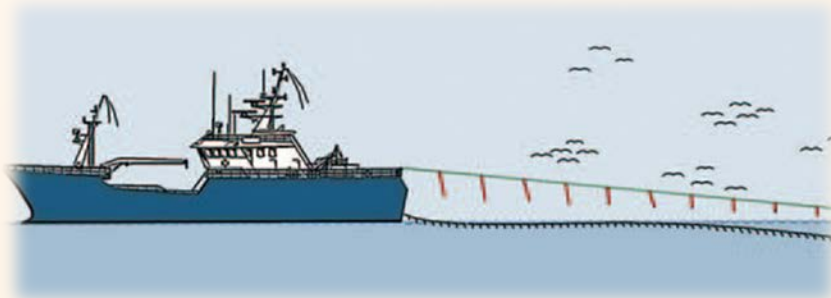
True or false? (and some facts)

Advantages:

- Needs low degree of mechanization (small-scale fisheries)
- Very suitable/efficient method when fish are widespread
- We need little manpower for the operation
- The energy (fuel) consumption is relatively low
- Catches fish of very high quality
- The gear doesn't damage the seabed
- Lost lines wouldn't cause any "ghost fishing"

Disadvantages:

- The consumption of bait is high, usually fish and squids
- Lines are less size and species selective than other gears
- During fishing there's a considerable "high-grading" and removal of non-target species/sizes
- By-catches of seabirds are “grim” (still low in Norway)



Easy mechanical solutions (“scare-crows”) or advanced lasers could save many birds from attacking the bait and/or reduce the loss of bait caused by birds

Available resources and common species for longlining:

*Most of the landings from the longline fleets are from typical groundfish species. The cod (*Gadus morhua*) is the most important both in the inshore and deep sea operations.*



Figure 27.

Species caught:

Cod,

Haddock (bottom/pelagic),

Turbot,

Ling,

Tusk,

Rays,

Wolf-fishes,

Halibut,

Grenadier species



In year 2013 Norwegian quotas on North East arctic cod and haddock were 468.000 tonnes and 96.000 tonnes, respectively. Around 14.5% of the Norwegian cod-quota and close to 38% of the haddock-quota was fished by longliners.

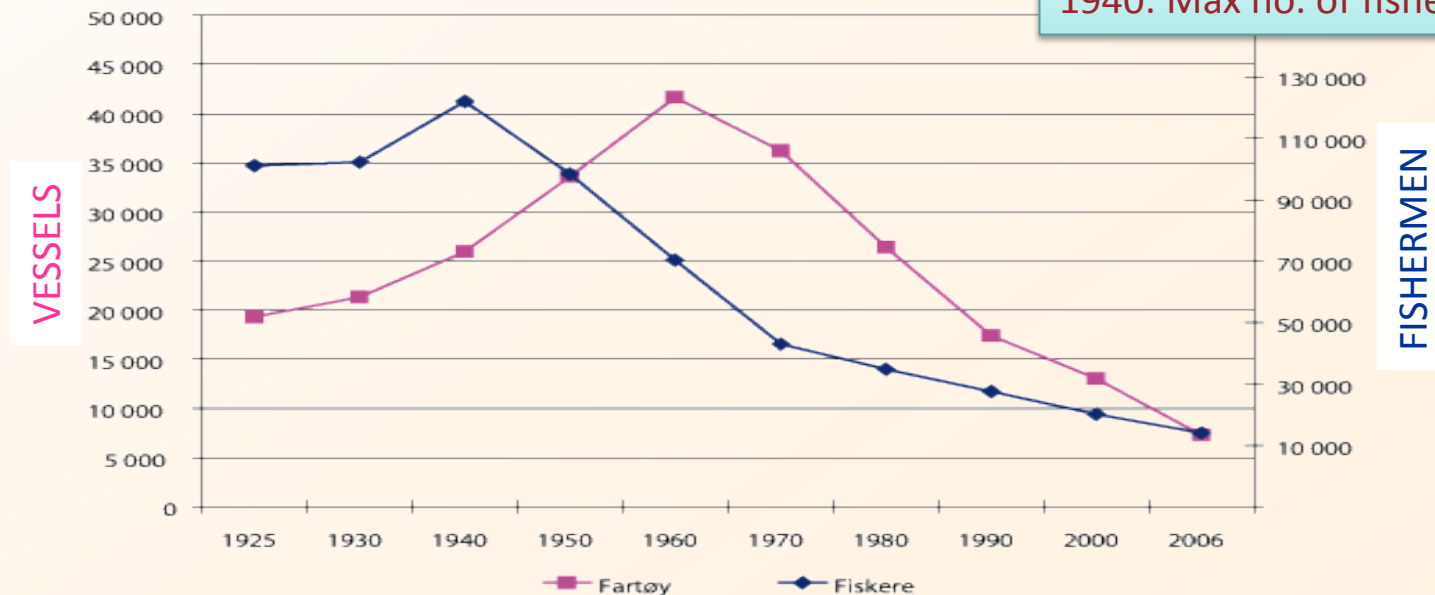
The structure of the Norwegian fishing fleet and number of fishermen

Norway has had a dramatic reduction in the numbers of fishing boats and fishermen over the last 5 decades.

By 2014: No of registered Norwegian fishing vessels = 5934

a) Inshore/coastal fleet: 4.714 vessel < 11 meter, 689 vessel between 11-15 m, 150 vessels between 15-21 m and 130 vessels between 21-28 m.

b) Deep sea fleet: Totally 251 vessels over 28 m (500 m³).



NB! Observe that 91% of all Norwegian fishing vessels are smaller than 15 m.

The use of advanced technology has become more important

Only through increased use of technology during the last 5 decades it was possible to reduce numbers of fishermen to ca. 25% and number of vessels to ca. 35% catching the same quantity of fish.

In 1930 the Norwegian fish landings were 0,99 mill. tonnes, in 1950 the landings were 1,3 mill. tonnes and in 1970 we landed 2,7 mill. tonnes.

Note: 40 years (in 2010) later we landed the same volume, i.e. 2,7 mill. tonnes, but with a huge difference in numbers of vessels and fishermen!

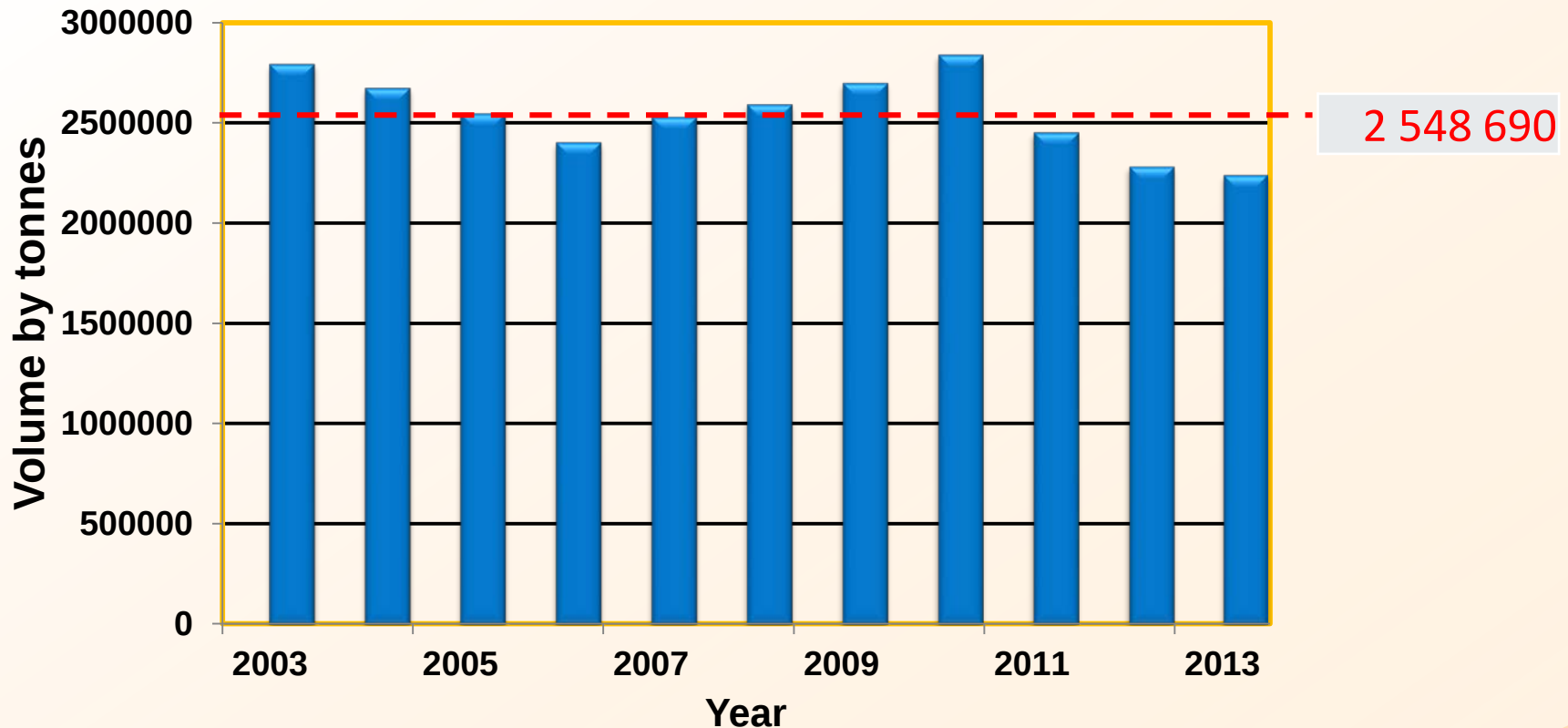
Year	Volume	Fishing vessels (all)	Fishermen (all)
1970	2,7 mill. tonnes	17.000	45.000
2010	2,7 mill. tonnes	6.309	12.993

By the end of 2014 the numbers of registered fishermen were 11.316 (whereof 9.398 as fulltime employed) and 5.934 fishing vessels. The reduction of fishermen from 2010 to 2014 was ca. 13% and fishing vessels ca. 6%.

(A peak-landing was reached in 1977 by totally 3,4 million tonnes).

The Norwegian marine fisheries (without farming) various around 2,5 million (metric) tonnes. Over the last 4-5 years groundfish species has increased, while major pelagic species (i.e. herring) has decreased.

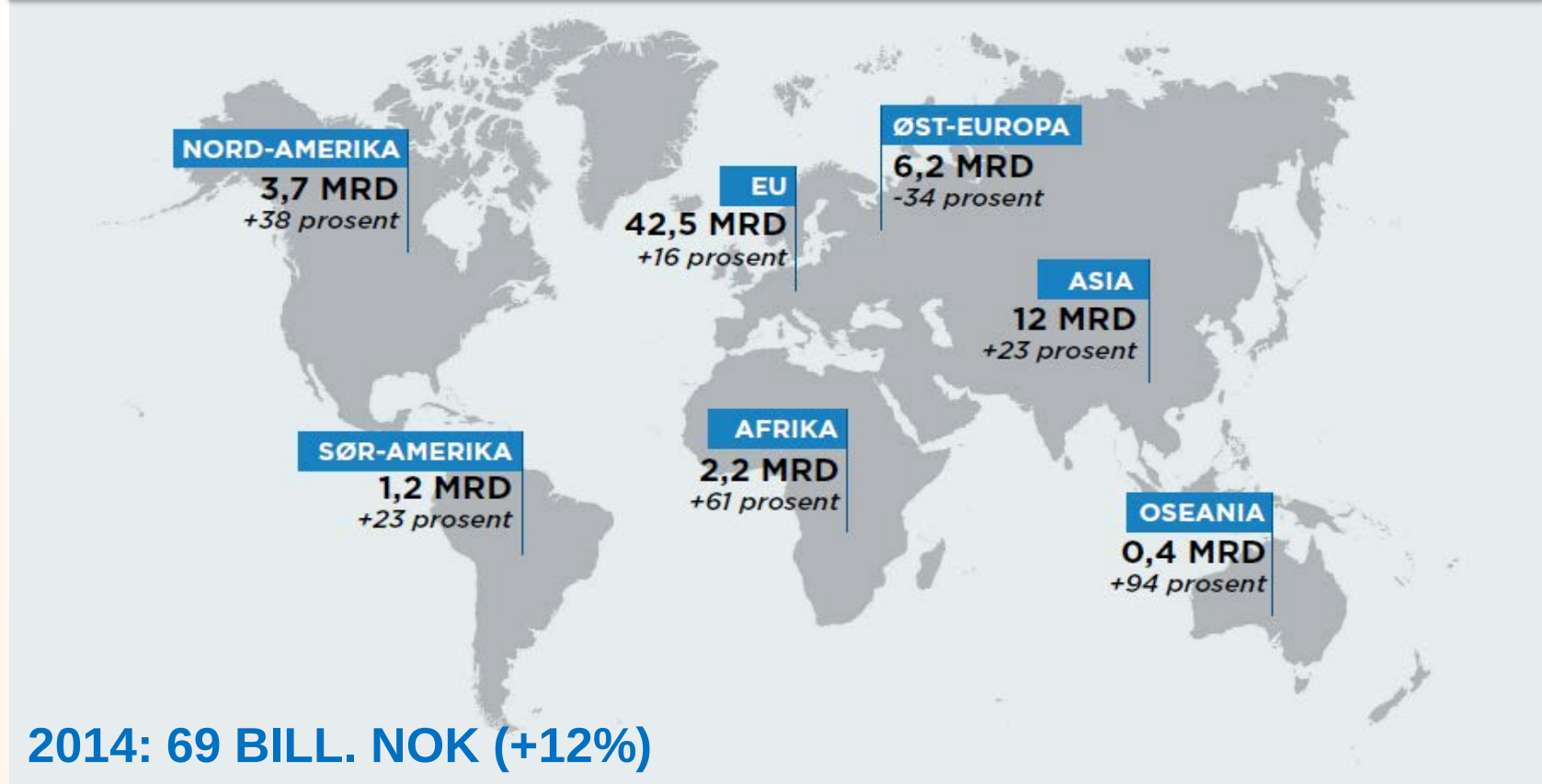
Total marine capture in Norway (2003-2013)



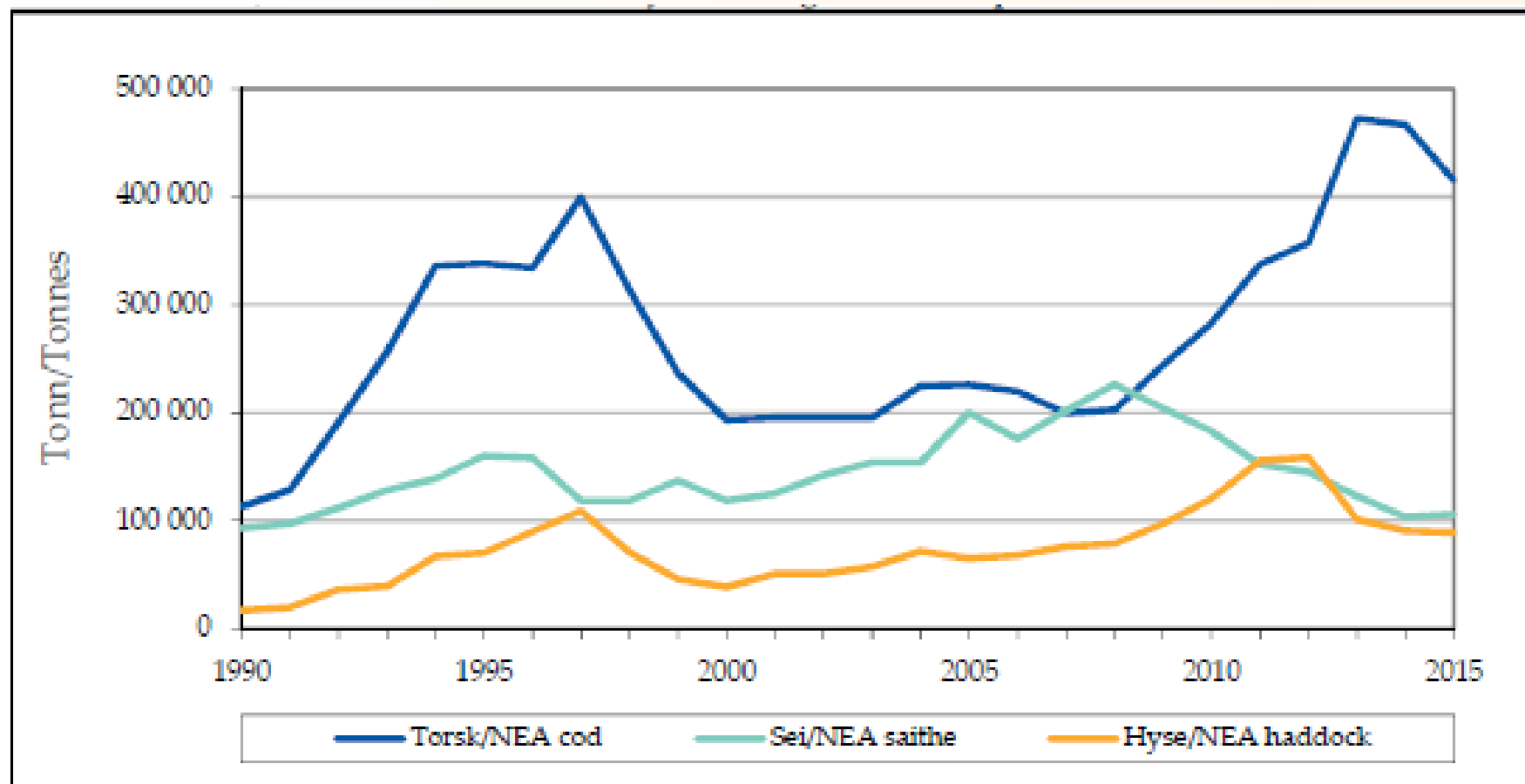
THE NORWEGIAN SEAFOOD EXPORT IN 2014

(INCLUDED SALMON AND TROUT) IN BILLION NORWEGIAN KRONERS*) AND THE CHANGE BY PERCENTAGE FROM 2013. THE EXPORT VALUE INCREASED BY 12% COMPARED TO 2013 AND REACHED 69 BILLION NOK.

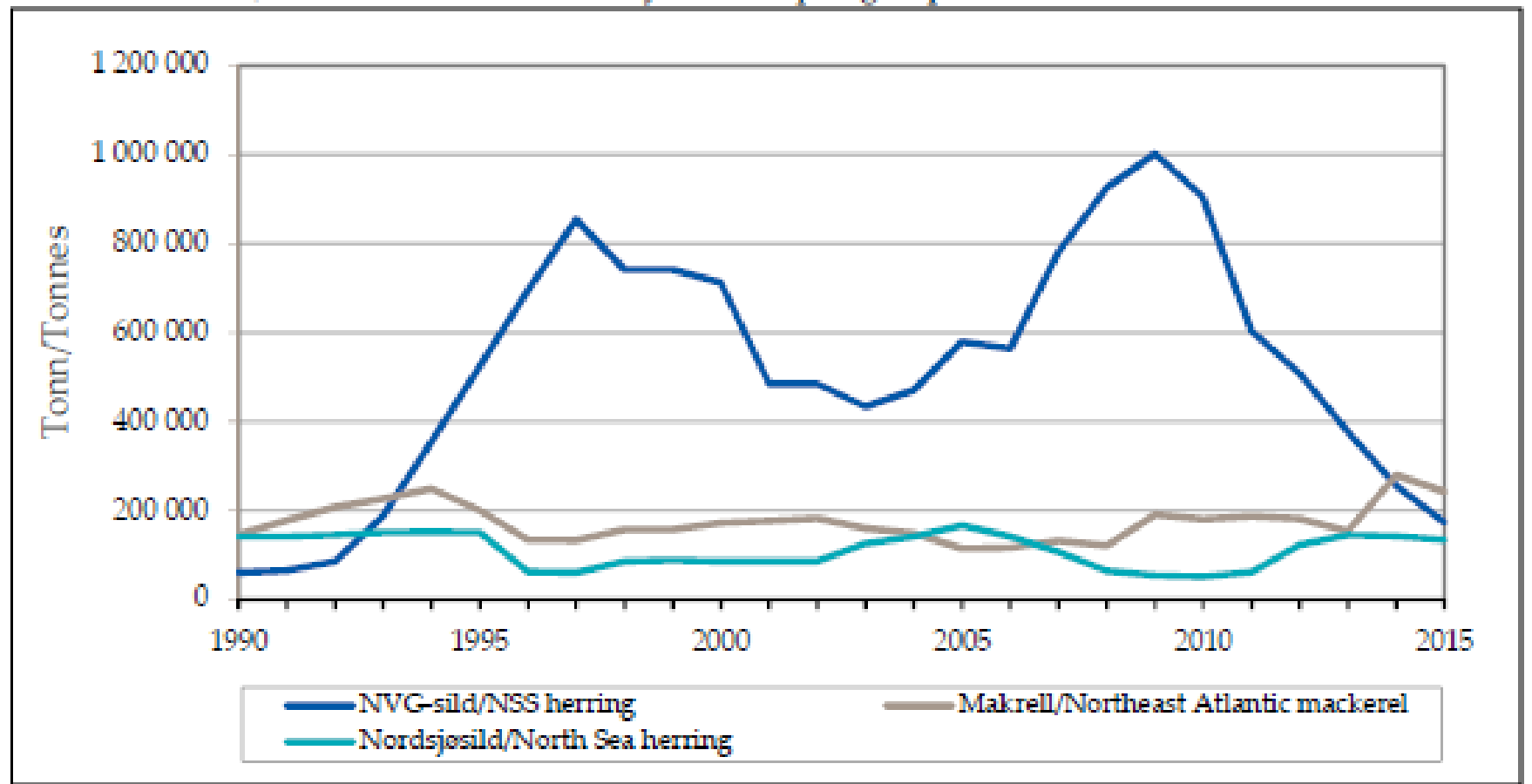
*69% OF THE VALUE IS FROM FISH FARMING (AQUACULTURE)
AND 31% IS FROM MARINE FISHERIES*



Norwegian quotas allocated on the most important/main groundfish species in the North East Atlantic 1990-2015



Norwegian quotas allocated on the most important/main pelagic species in the period 1990-2015



Norwegian quotas on North-East Arctic cod and haddock for 2015 and their distribution between gear-groups

(Major NEA fish quotas for 2016 are shown on slide 51)

Species	Tonnes (%)	Gear type
Cod north of 62°N 	130.675 (31,5)	Bottom trawlers
	33.987 (8,2)	Conventional deep sea vessels ^{*1)}
	212.027 (51,1)	Conventional coastal vessels ^{*2)}
	38.231 (9,2)	Other areas (incl. research and school system)
	414.920	Total

Species	Tonnes (%)	Gear type
Haddock north of 62°N 	33.161 (37,2)	Bottom trawlers
	9.739 (10,9)	Conventional deep sea vessels ^{*1)}
	44.367 (49,8)	Conventional coastal vessels ^{*2)}
	1.778 (2,0)	Other areas (incl. research and school system)
	89.045	Total

*1) Mainly longlines and some Demersal seines & *2) Jigging, Gillnets, Longlines, Demersal seines

Period 2010-2012: The use of different types of fishing methods in the northern inshore/coastal fisheries for codfish species (*Gadidae*) like cod, haddock and saithe (pollack)

Vessel size group > 11 m: 65-70.000 tonnes codfish	
Longlines	22%
Jigging	25%
Gillnets	46%
Purse seine	0
Dermersal seine	0
Others	7%

Vessel size group 11-15 m: 50-65.000 tonnes codfish	
Longlines	23%
Jigging	3%
Gillnets	52%
Purse seine	12%
Dermersal seine	10%
Others	0

Vessel size group 15-21 m: 38-41.000 tonnes codfish	
Longlines	21%
Jigging	0
Gillnets	25%
Purse seine	8%
Dermersal seine	46%
Others	0



Controlled experiments to improve catch rates

Modernization inside longlining was driven by eager fishermen in the 1970ties, however the IMR, Bergen Norway (Å Bjordal and S Løkkeborg) documented several of the important features to improve efficiency in the fishery.

Parameter	Catch increased by
New hook designs	20-50%
Smaller hook	20%
Smaller bait, cod	20-50%
Smaller bait, haddock	30-120%
Swivel	10%
Monofilament mainline	100%
Monofilament branch line	10%
Setting direction	100%
Setting time	Essential
Bird deterrents	30%
Mechanized longlining	Revolution



Examples of figures from a medium coastal/inshore vessel (15 m) and of a medium deep sea vessel (50 m)

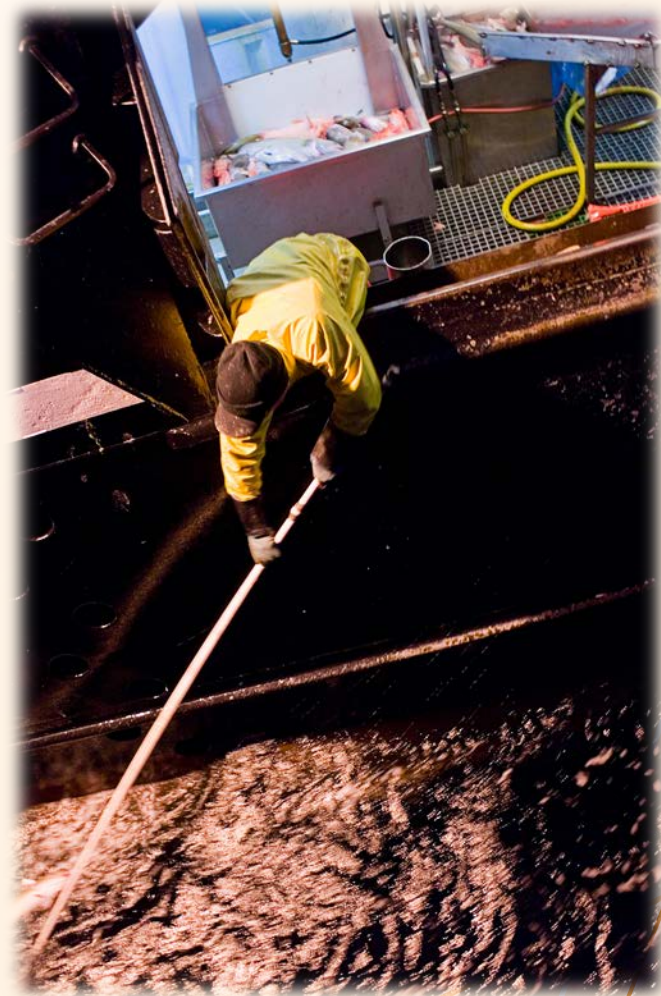
Feature	Coastal	Deep sea
Hook capacity	8.000-30.000*)	40.000-65.000
Hauling speed	20-24 hooks/minute	40-45 hooks/minute
Catch rate	0,5 – 2,0 kg/hook	0,15-0,5 kg/hook
Crew	2-4 men	12-15 men
Product	Fresh on ice & seawater	Frozen HG/Fillets

*) Most coastal vessels use handbaited lines in tubs of ca. 300 hooks (standard 540 m line), a few mechanized 15 m vessels operate 25-30.000 hooks a day.



High effort to improve the standards of Health and Safety (& Ethics)!

Fisheries continues to be the most dangerous occupation, but numbers of fatalities has decreased as a result of more focus on safety. Despite improved HSE there is still room for improvements, especially on board small inshore boats, which is often operated by 1 person only.



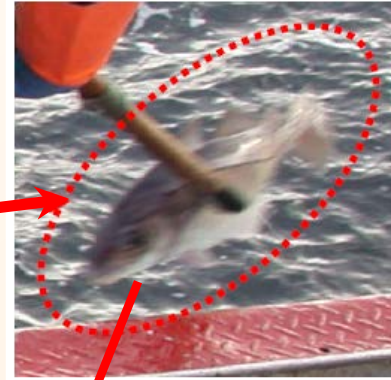
*Examples on physical hard and dangerous working conditions during the **conventional** hauling operation in longlining*



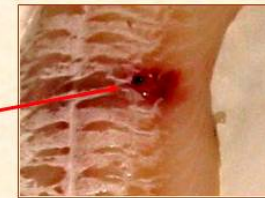
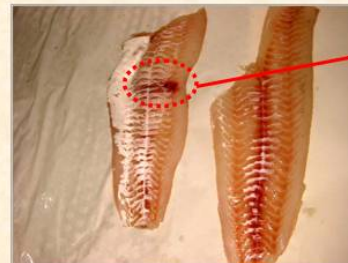
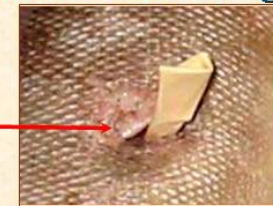
The gaff is important in many longline fisheries to secure and de-hook the fish. Work positions might be hazardous. At the UIT we have participated in various studies to improve fish quality – also by removing the gaff during hauling.



Gaffing and securing catch at the rail-roller



Haddock with marks from the gaff



This part of the fillet is lost in production

The conventional hauling method during longlining:

Crew has to secure and “lift” every fish and they are exposed to “the elements”: Important, but extremely hard/dangerous working position on a longline vessel



The automatic Longline Hauler system (ALH) - experiments during 2002-2006 on coastal vessels

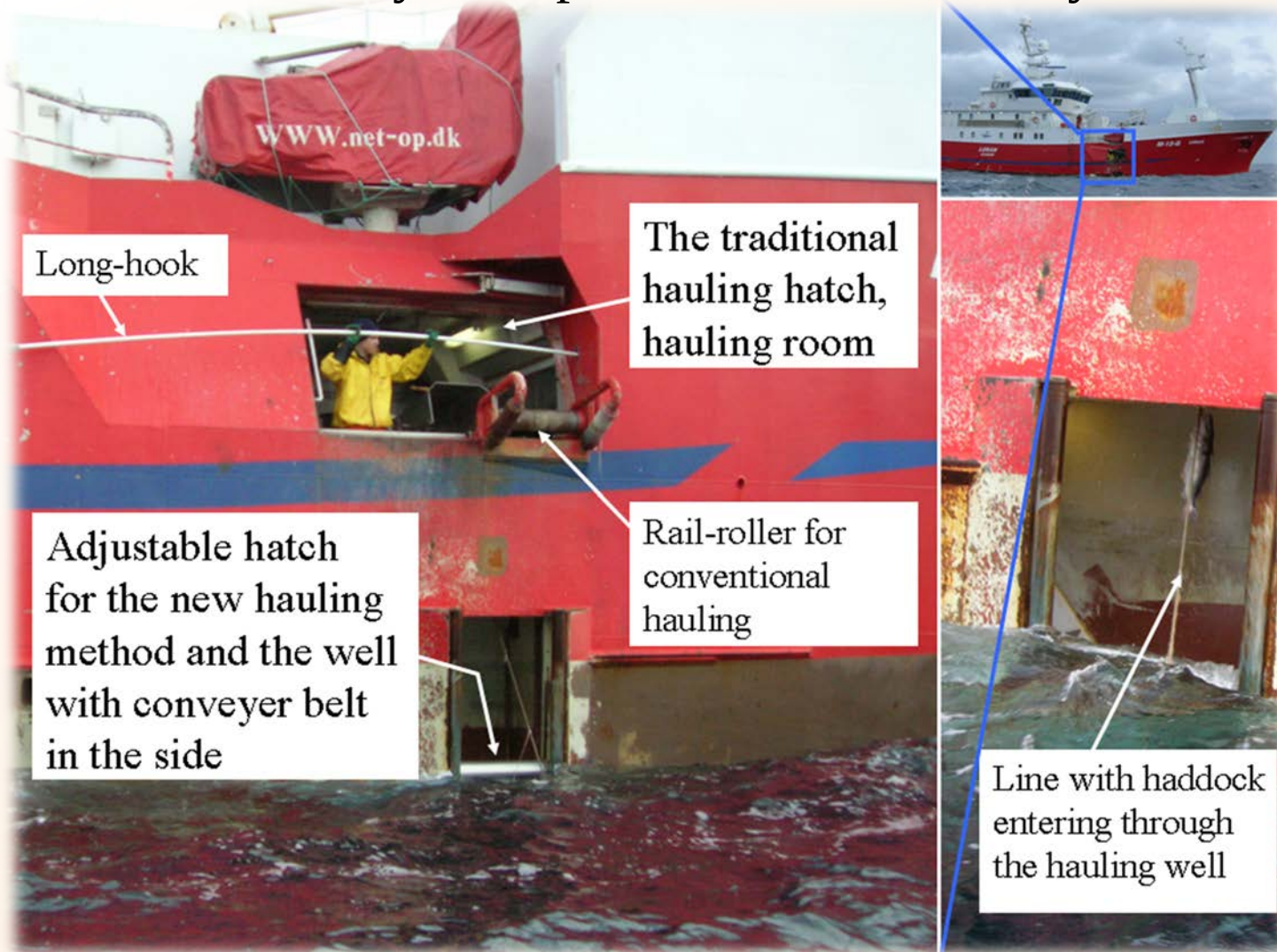
Currently 2 inshore/coastal vessels use the integrated version of the technique



- 1: Hauling a bottom set PA line with cod
- 2: Live fish to be kept in net-pens (2004)
- 3: Turbot caught with PES line (2006)
- 4: L. Rindahl inspecting the collapsible ALH during the 2006 experiments

The ALH system for larger vessels: Experiments during 2006-2007 on gillnet/longline vessel “Loran”

Currently 2 deep sea vessels use this system

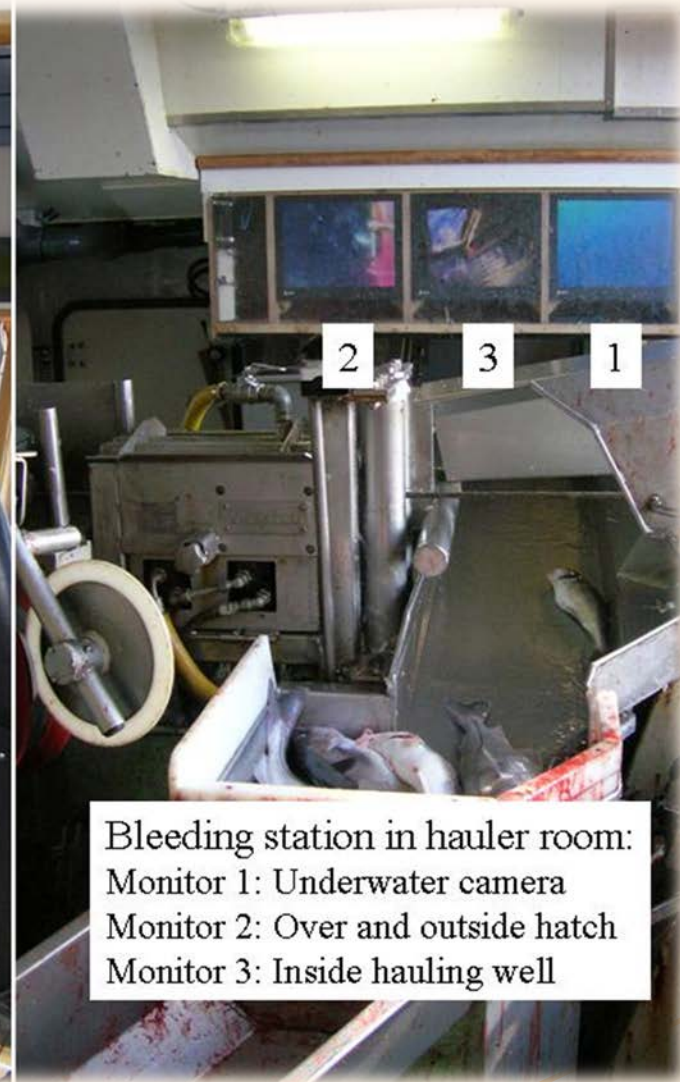


The ALH system for larger vessels - experiments during 2006-2007 on gillnet/longline vessel “Loran”

The use of video-monitoring during the hauling process



Skipper view in the wheel house:
Monitor 1: Underwater camera
Monitor 2: Over and outside hatch
Monitor 3: Inside hauling well
Monitor 4: Hauler room



Bleeding station in hauler room:
Monitor 1: Underwater camera
Monitor 2: Over and outside hatch
Monitor 3: Inside hauling well

The ALH system for larger vessels - experiments during 2006-2007 on species cod, haddock and turbot

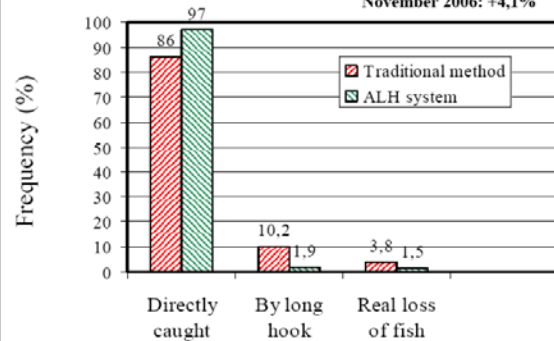
Focus: Reduced unaccounted mortality

May 2007: Results on cod (*Gadus morhua*)



Catch efficiency on cod (+2,3% with ALH)

November 2006: +4,1%

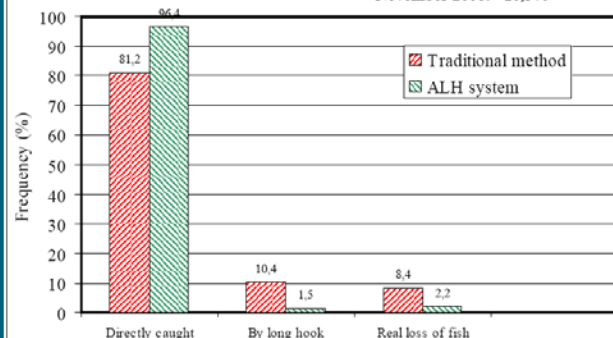


May 2007: Results on haddock (*Melanogrammus aeglefinus*)



Catch efficiency on haddock (+6,2% with ALH)

November 2006: +10,5%

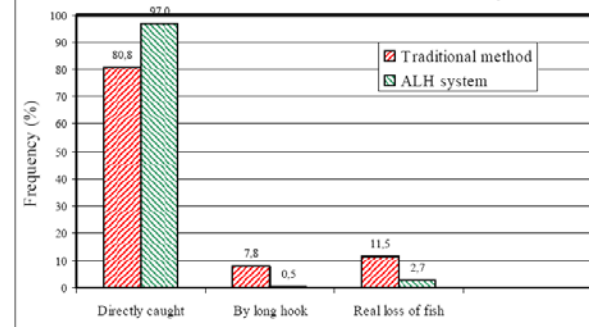


May 2007: Results on Greenland halibut (*Reinhardtius hippoglossoides*)



Catch eff. on Gr. halibut (+8,8% with ALH)

November 2006: +14,4%



- A fraction of fish caught by longlining is lost on the surface during hauling. Anecdotal information reports losses of 3-10% (or higher)
- It is believed that most "floaters" will die, hence resulting in unaccounted mortality
- High-grading during hauling would have the same effect

Comparisons between conventional hauling, ALH- and moonpool-systems in the deep sea fleet 2008

Three larger mechanized longline vessels used in the same area and with equal gears November 2008: Three different hauling methods analysed.

Conventional hauling



ALH hauling

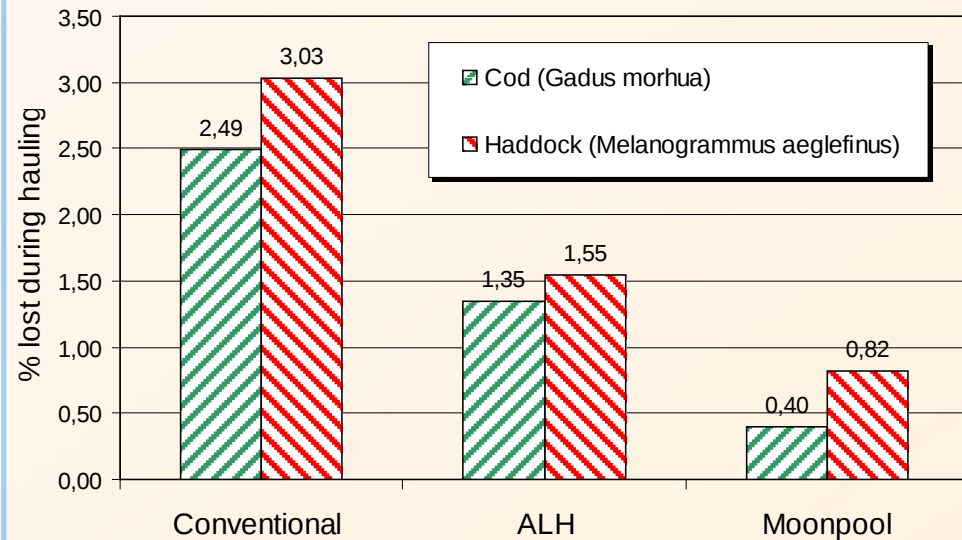


Moonpool hauling



Focus on unaccounted mortality, fish quality and crew safety/working conditions

Comparisons between 3 different hauling methods



Fish lost at the surface during hauling
(% by numbers) during 2008 experiments

Autoline vessels "Geir", "Carisma Viking", "Geir II", "Frøyanes" and "Leinebris" use the moonpool hauling-system for hauling lines (and gillnets).



The coastal longline vessels for tomorrow, fishing patterns and mechanization?

(as discussed with several Norwegian fishers)

- Speed vessel or conventional hull?
- Season based fishery (and single species fishery, i.e. Norwegian model) or all year fishery (extended areas and more target species, i.e. Icelandic model)?
- Mechanized systems (Coastal, FishSelect, Oilwind) or hand baited lines?
- Systems to ensure high fish-quality on board?
- Traditional gaffing or moonpool/ALH system?



Examples of new (2010-2012) coastal longliners (11-15 m)

*Icelandic and Norwegian speed vessel designs are popular, but the majority of coastal vessels are built with conventional hulls. **Extremely efficient: 4 of these vessels are operated the full year round and land up to 1500-2000 tonnes each***



"Åsta B" 2010 with Mustad Autoline (28.000 hooks), 15 m



"Saga K" 2012 with Mustad Autoline (30.000 hooks), 15 m



"Havbryn" 2012 with 30-40 line tubs (ALH), 11 m



"Ingvaldsson" 2011 with 50-60 line tubs (ALH), Gillnets, King crab pots, 15 m



"Bolga" 2012 with Mustad FishSelect (15.000 hooks), 13 m

We asked the industry (i.e. coastal fleets): Would a change of line-parameters improve efficiency?

- Bait: Mackerel, squid, herring, sauri, bagbait – which is better?
- Snood/branch line: Which perform better - PES or PA?
- Mainline diameter: Does size ($\emptyset$ thickness) affect catch rates in the longline fishery?
- Hauling speed: What is a correct hauling speed (i.e. number of hooks/minute)?
- Hook shape & swivel on hook:
Recent practical experience with new constructions are rewarding



Various parameter studies in (coastal) longlining:

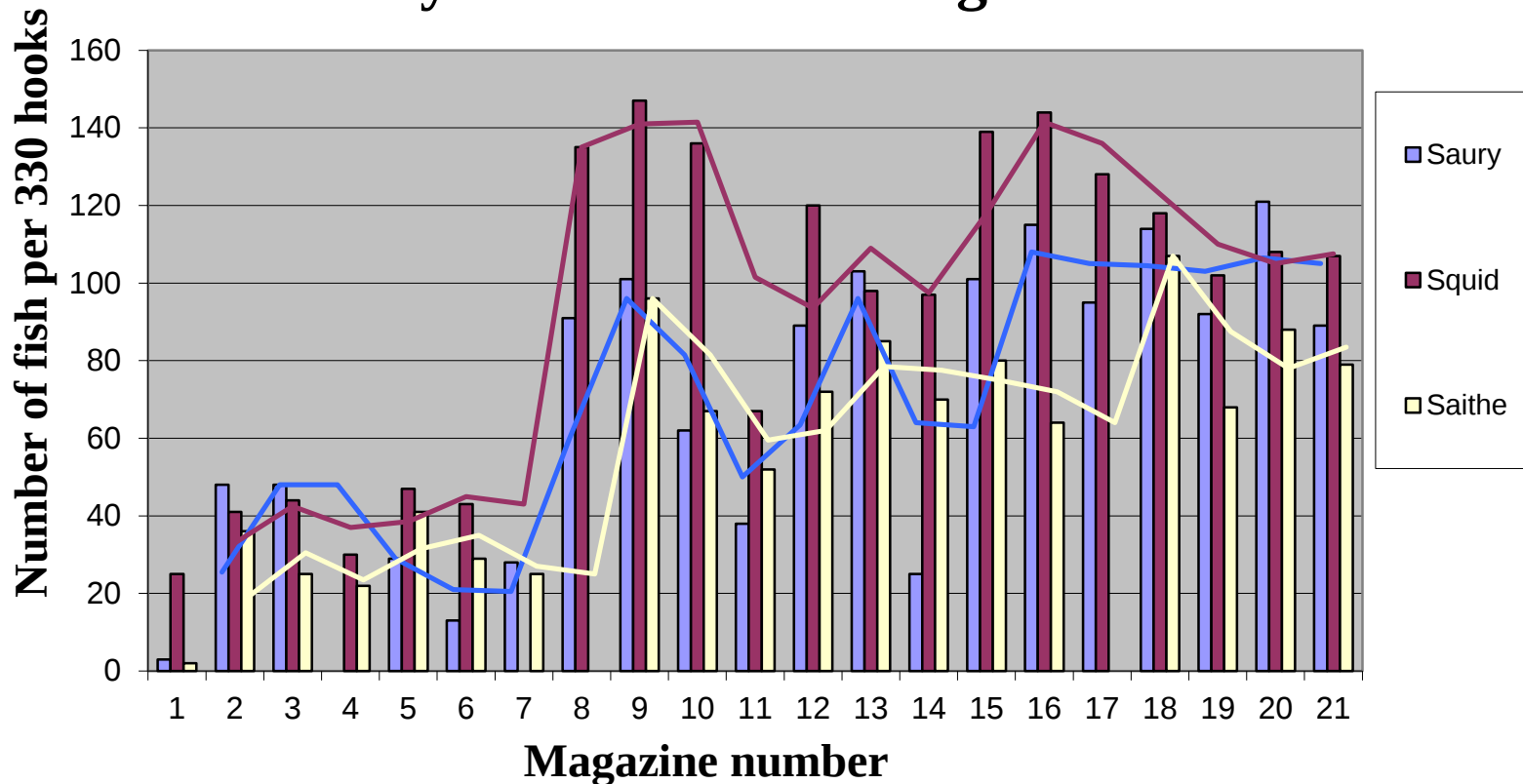
Bait – Size selectivity – Efficiency

Parameter	Vessel-type
Studies on various types of bait (sauri, mackerel, bagbait) during 2009	- 36' autoliner from Troms. The bagbait selects for larger haddock and cod
Effect of baittype on size-selection on haddock (bottom set line) during 2009	- 40' trad. vessel from Båtsfjord. Results indicate that bagbait can reduce numbers of juveniles
Comparing 2 types of snoods (twisted PES and PA mono) and 2 mainline sizes (7.2 and 9.0 mm) during 2010	The trials were performed on board two coastal autoline boats (36' and 50'). Unclear results

(Alternative baits, see slide 45)

Bait trials with mechanized longline – 36' coastal vessel (mechanized longline = autoline)

Turbot - Greenland halibut (*Reinhardtius hippoglossoides*), Tromsøflaket, July 2009 with MV “Saga K”



Icelandic bagbait from Bernskan HF

(used by Icelandic fishers in North-Norway for a selective haddock fishery)



Some of the benefits with the bagbait: They are easier for hand baiting and they are exact in size, ca. 9.3 gram (mackerel is ca. 19 and sauri 11.7 grams)

Trials with 2 snood-types: PES and PA mono w/welded eye; (i.e. PA-trials encouraged by good results in New Zealand longlining)

Note: In most of the coastal fishery branch lines of 0.8-1.0 mm PA are preferred

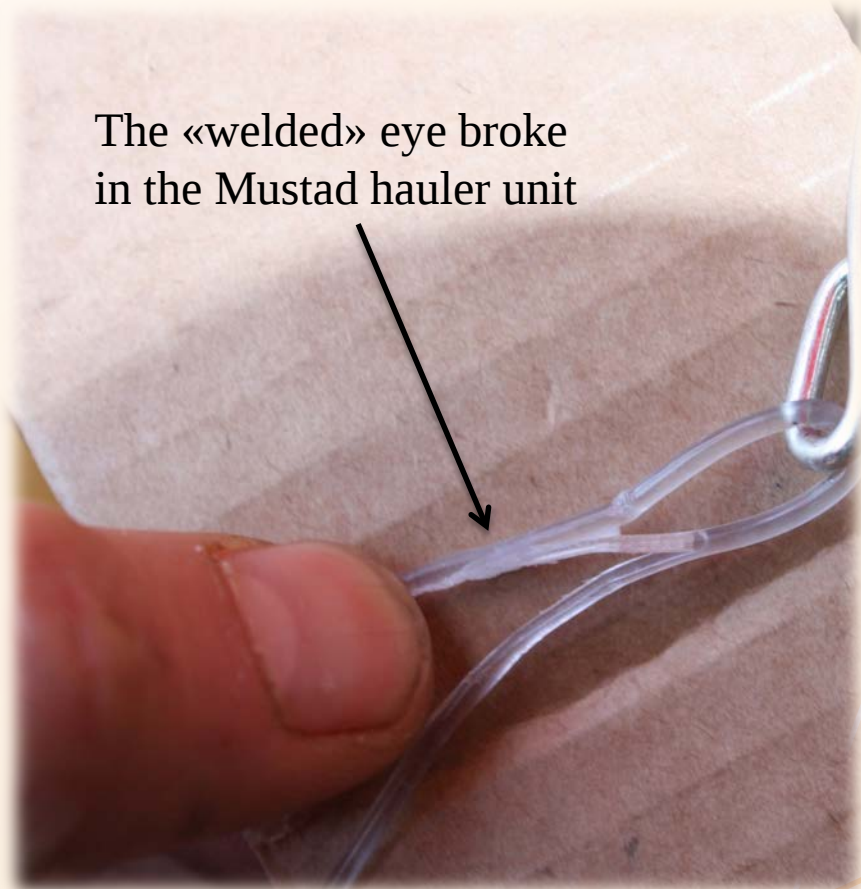


Snoods made from 2-yarn twisted PES (as preferred in the Icelandic longline fishery)



The PA mono snoods didn't work for us:

Complicated to mend (replace) and they broke too easily



Experiments on board moonpool vessel «Carisma Viking»

Does swivel on the hook improve catch rates on cod and haddock?

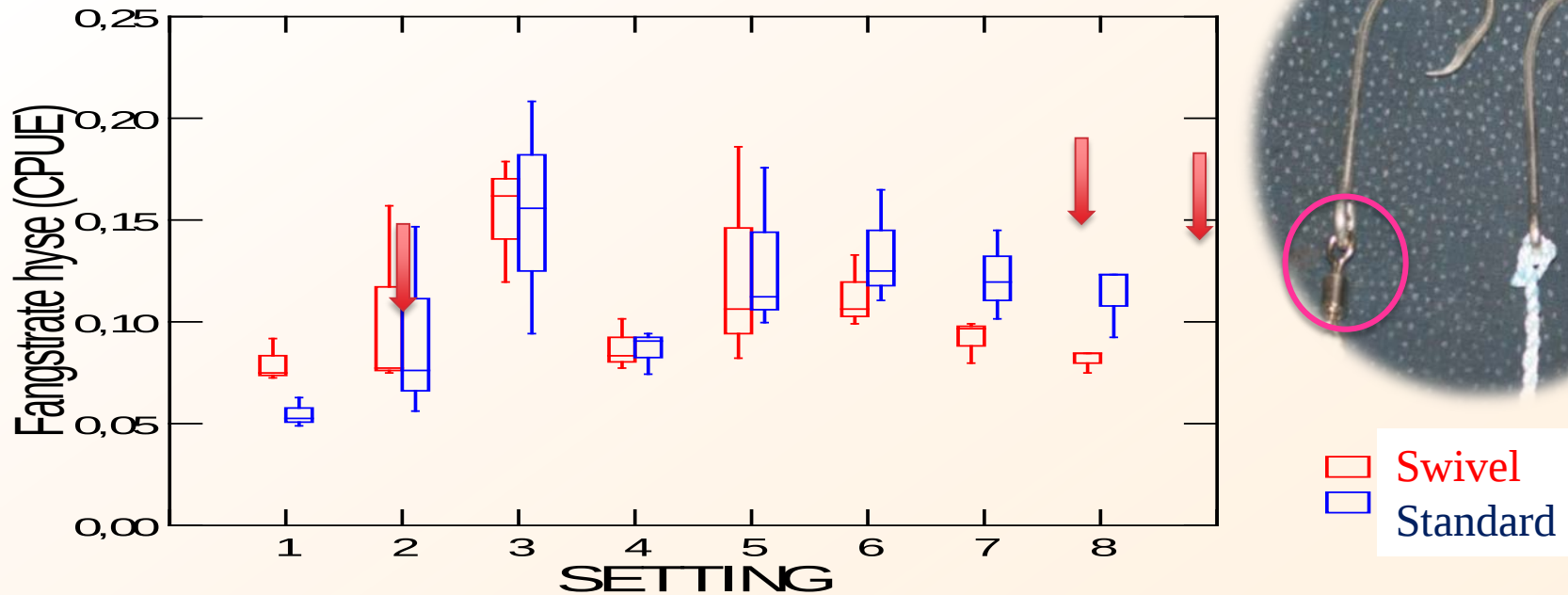
November 2013: Number of hooks and catch of haddock and cod by numbers.
All fish were weighed and length-measured individually.

Hook-type	Haddock	Empty	Cod	No. of hooks
Swivel on hook	3 967	12 658	875	17 500
Standard hook	4 066	12 393	1 041	17 500
Total	8 033	25 051	1 916	35 000

We caught fish on 28,4% of the hooks at a hauling speed of 43 hooks/minute.

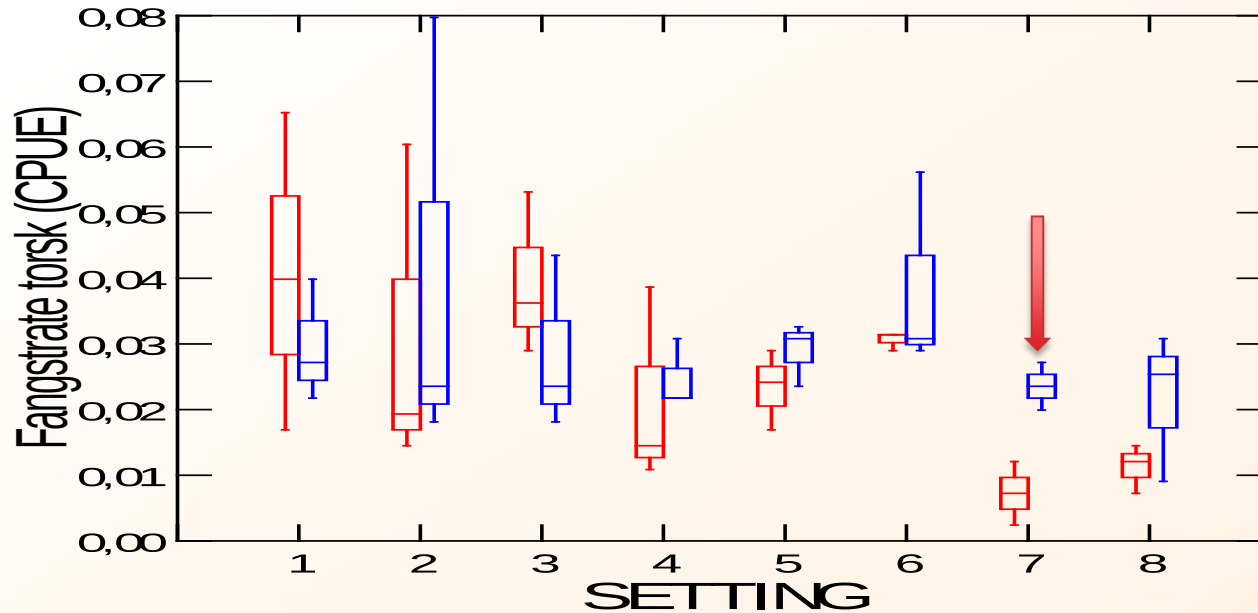
Distribution by percentage for swivel-hooks and standard hooks				
Hook-type	Haddock (%)	Empty (%)	Cod (%)	N hooks
Swivel hook	22,7	72,3	5,0	17 500
Standard hook	23,2	70,8	5,9	17 500
Average	22,9	71,6	5,5	
Numbers	8 033	25 051	1 916	35 000

Catch rate on haddock, Barents Sea, November 2013 during experiments with standard and swivel hooks (12/0 EZ baiter)



Setting	1	2	3	4	5	6	7	8
P-verdi	0.050	0.513	0.827	0.827	0.827	0.275	0.050	0.043

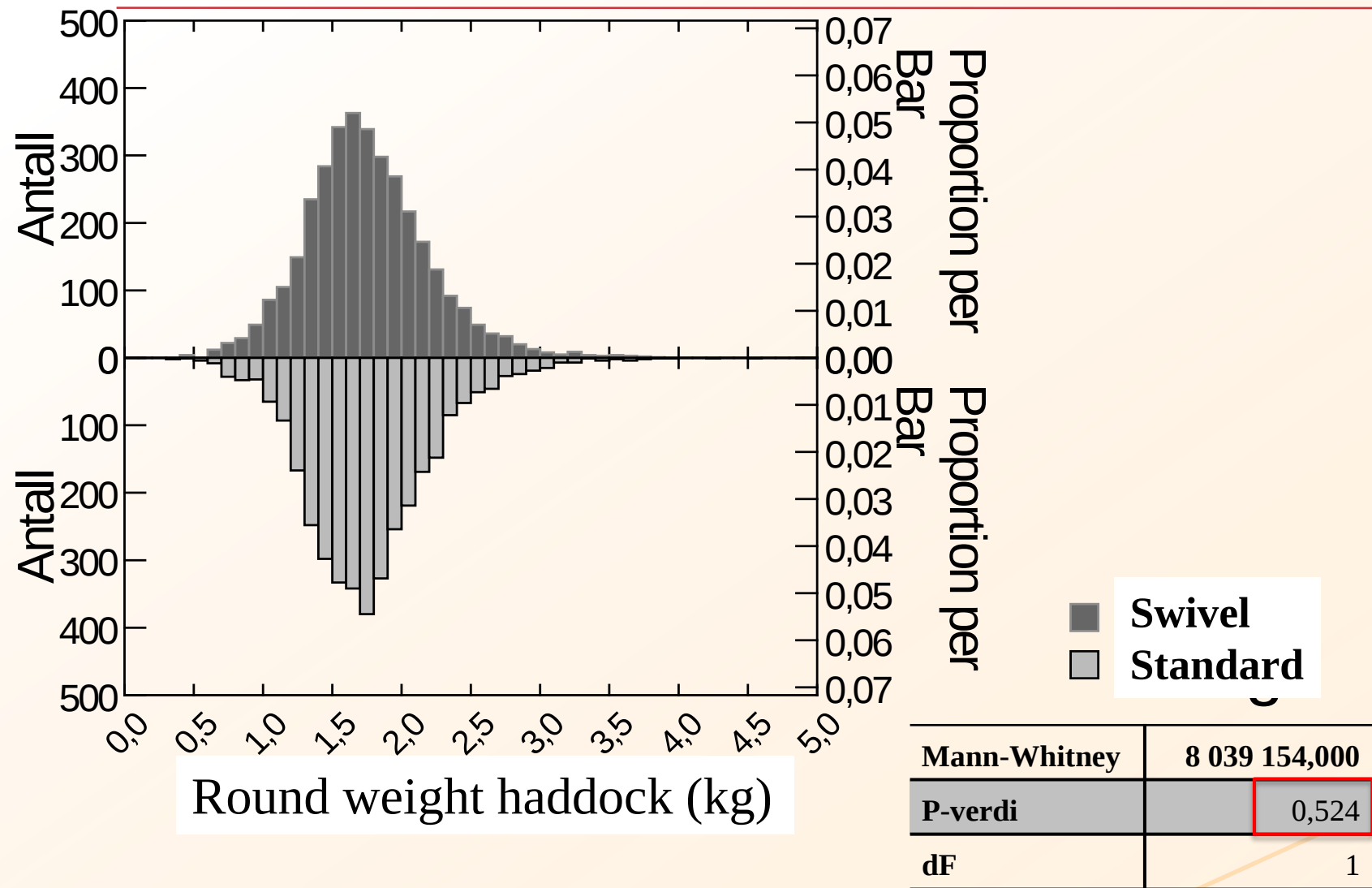
Catch rate on cod, Barents Sea, November 2013 during experiments with standard and swivel hooks (EZ baiter)



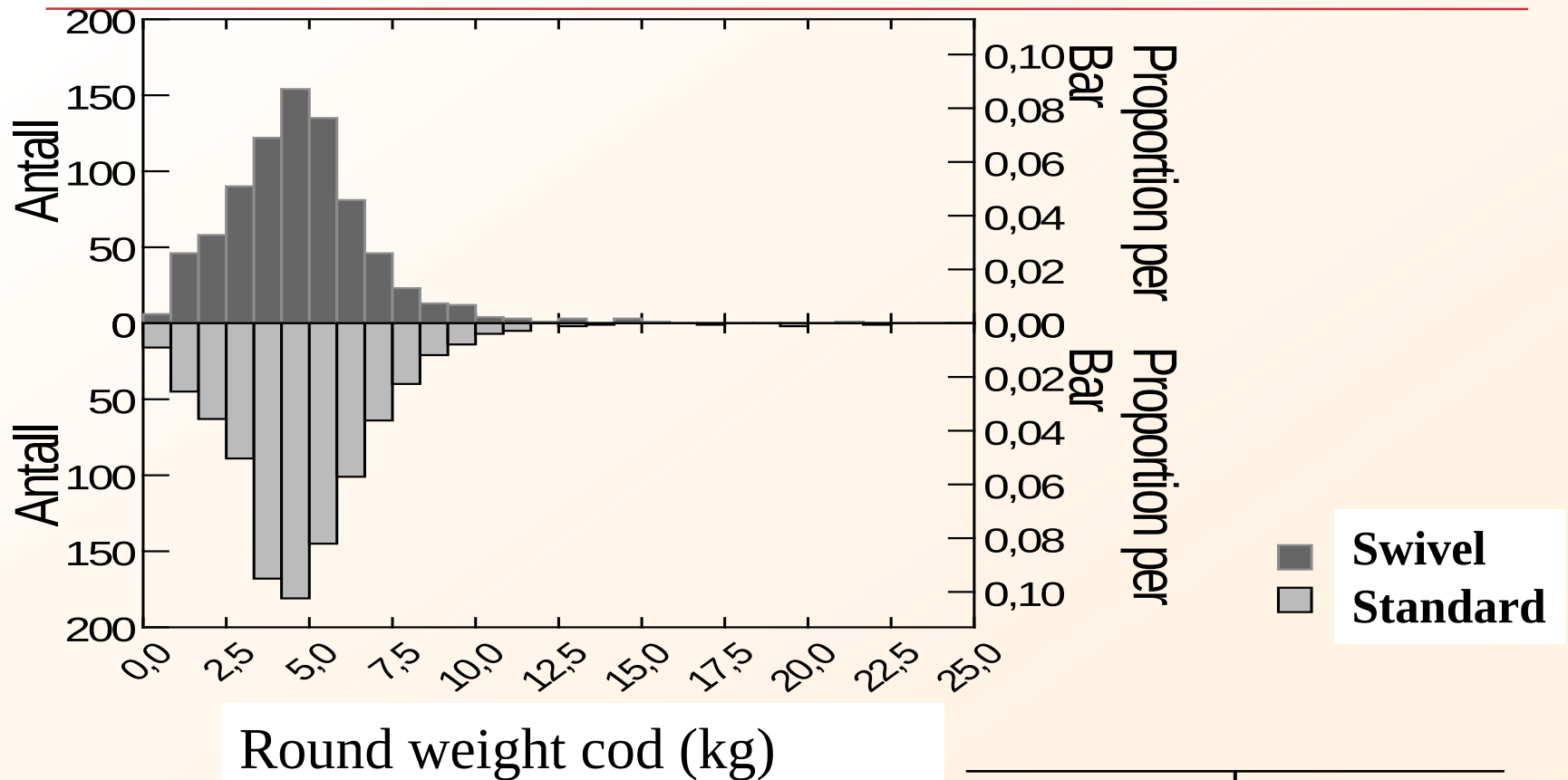
Swivel
Standard

Setting	1	2	3	4	5	6	7	8
P-verdi	0.658	0.513	0.275	0.507	0.275	1.000	0.050	0.275

Weight distribution for haddock, November 2013



Weight distribution for cod, November 2013



Mann-Whitney	444 055,000
P-verdi	0,186
dF	1

Experiments on board ALH vessel «Loran» May 2013

Does swivel on the hook improve catch rates on cod and haddock?

May 2013: Number of hooks and catch of haddock and cod by numbers

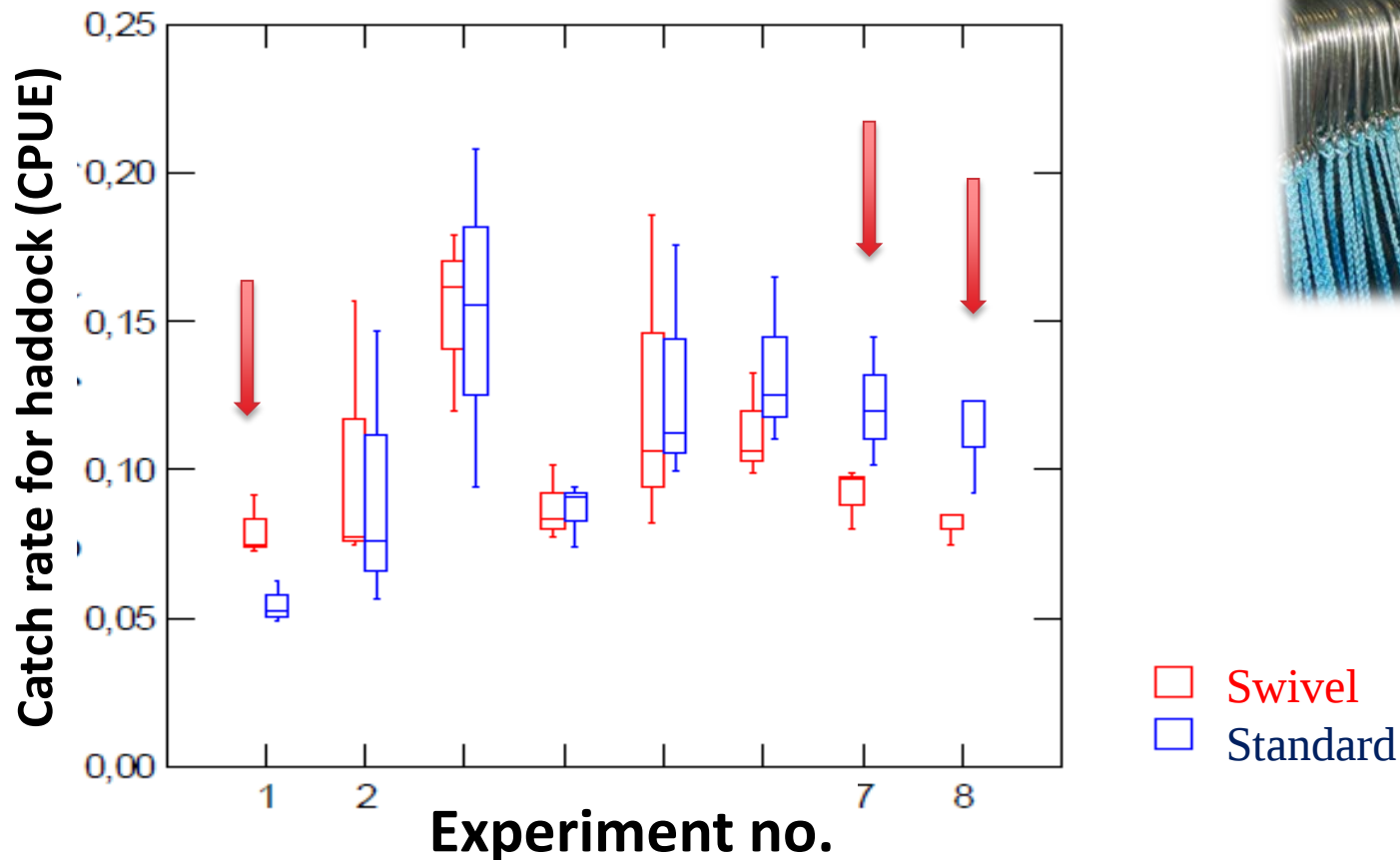
Hook-type	Haddock	Empty	Cod	No. of hooks
Swivel on hook	998	8 281	243	9 522
Standard hook	1 443	11 144	385	12 972
Total	2 441	19 425	628	22 494

We caught fish on only 13.6% of the hooks at a hauling speed of 58 hooks/minute.

Distribution by percentage for swivel-hooks and standard hooks				
Hook-type	Haddock (%)	Empty (%)	Cod (%)	N hooks
Swivel hook	10,4	86,9	2,5	9 522
Standard hook	11,1	85,9	2,9	12 972
Average	10,8	86,3	2,7	
Numbers	2 441	25 051	1 916	22 494

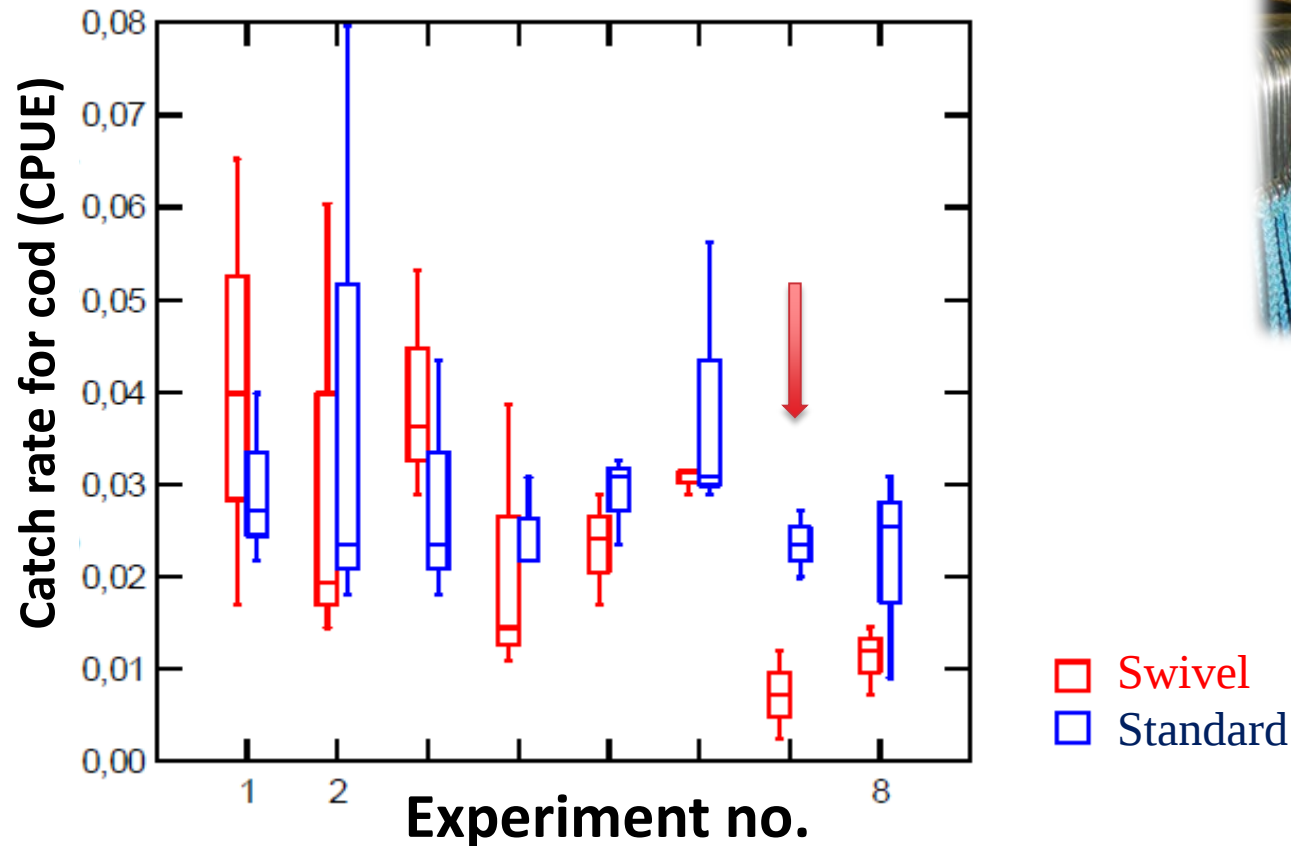
(Note: Lower catch pr hook on cod and haddock in May than in November)

Catch rate on haddock, Barents Sea, May 2013 during experiments with standard and swivel hooks (12/0 EZ baiter)



Setting	1	2	3	4	5	6	7	8
P-verdi	0.050	0.513	0.827	0.827	0.827	0.275	0.050	0.043

Catch rate on cod, Barents Sea, May 2013 during experiments with standard and swivel hooks (12/0 EZ baiter)



Setting	1	2	3	4	5	6	7	8
P-verdi	0.658	0.513	0.275	0.507	0.275	1.000	0.050	0.275

The “never ending run” for replacing natural baits;

We know a lot about attractants (free amino acids, etc.) in natural baits, but we are still far from a real replacement of natural baits.

Norbait: «Sausages» made from restructuring waste fish and fish offal from processing industry. Mixed with gelling agents, binders and other attractants. Results are “variable”.

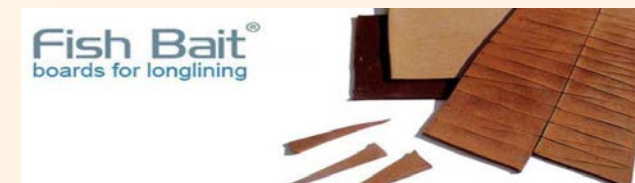


W.E.S. Carr bait (USA): Artificial bait on a «spongy» material used with different flavours. Small pieces with taste of shrimp was comparable efficient to natural baits (N-Norway).

Bagbait (Bernskan, Iceland): Based on fish (mackerel) and packed in equal sized cellulose-fiber bags. Used in Norway for selective haddock fisheries.



Arom Fish Bait (Spain): Based on natural raw materials and produced as dry sheets that is cut into baits. So far no known results from fisheries.



Polybait (Kvalvik Bait): «Cream» made from polymer-composites added natural attractants. Planned tested for (deep sea) longlining.

Will longlining survive as an important fishing method?

How do we convince new generations to stay inside a labour intensive fishery if more simple methods give the same income?



Lately, the tendency in Norway was a shift towards Demersal seining and gillnetting on the expense of longlining.

We've seen more imported labour on board the deep sea vessels - also inside longlining. There's a fear over the loss of local skills inside a traditional fishery associated with high quality and top fish products.

Mechanized longlining (autoline) in the coastal fisheries:

Small efficient vessels landing fresh fish on day-basis (*the Icelandic concept*) may be one model to maintain the coastal fleet



The fishing industry had over the last 30 years to compete with the oil- and gas industry on salaries, working periods/conditions, safety standards, accommodations at sea, etc.

The response from the fishing industry: Mimic their standards



The living standard on board a modern deep sea vessel anno 2010 in Norway



The use of modern technology increases efficiency and quality on landed fish in both deep sea and inshore/coastal fleets

(Remember: It's all about the money



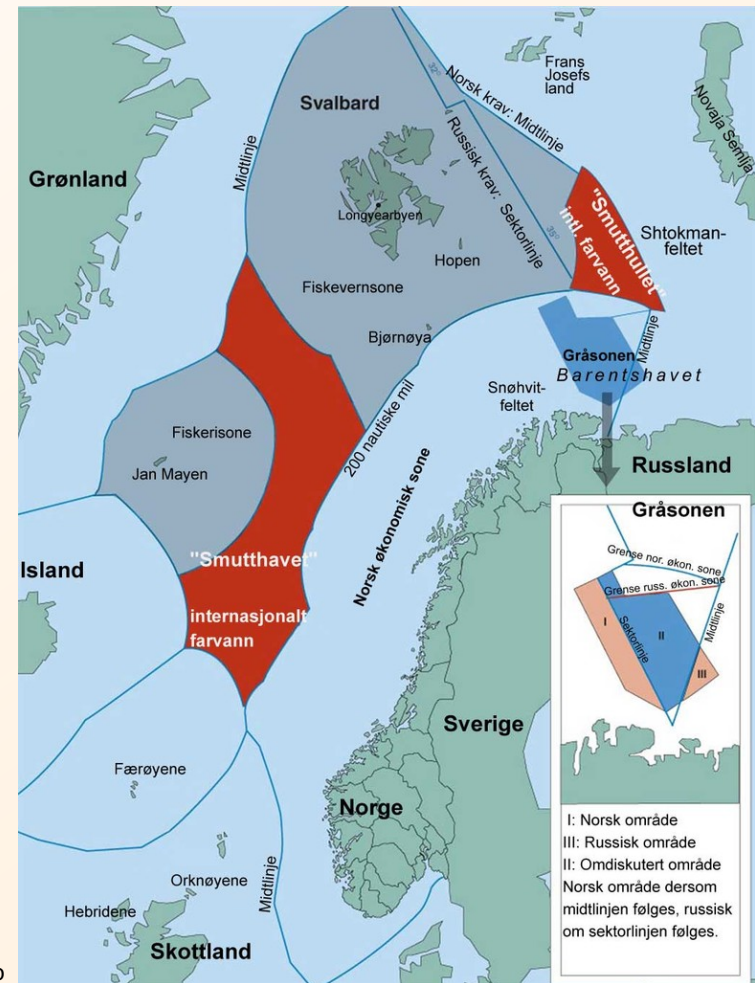
The use of modern technology increases efficiency in both deep sea and coastal fleets - and it improves safety and working conditions for crew



(Still; It's all about the money)

Fishing zones in the North–East Atlantic and major Norwegian fish quotas north of N62° for 2016 (in 1000 metric tonnes):

Cod: 401.24, Haddock: 118 , Capelin: 0, Turbot: 22, Ocean perch: 30



Shaded area (more or less) are typical fishing grounds north of N62°.

Thanks for your attention



*Please, continue to solve the flukes
and preserve a sustainable fishing
method.*