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Report of the Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT)

19–20 April 2008

Tórshavn, Faroe Islands

ICES
International Council for the Exploration of the Sea
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Executive summary

SGPOT was proposed by the topic group on alternative fishing gears, which met at the FTFB meeting in 2005 and 2006. SGPOT had its first meeting 21–22 April 2007 in Dublin, Ireland and this second meeting was held in Tórshavn, Faroe Islands, 19–20 April 2008 prior to the FTFB meeting.

The group was attended by 24 participants representing 14 countries. The agenda followed the Terms of Reference closely.

A review of worldwide use of fish pots that was initiated at last year's meeting was continued. It seems difficult to get worldwide catch data for fish pots as these are mixed with other gears. The group decided to make an extensive list of fish pots in commercial use, as research tools and any emerging use of fish pots, as this can be a valuable platform for exchange of information.

In a discussion of new fish pot research several examples were presented. In Norway the two-chamber pot has been redesigned with one entrance and floated off bottom resulting in a 45% higher catch rate of cod. In Sweden the deformation of the Norwegian pot when floated off bottom in high current has been tested in flume tank. New attachment and extra buoyancy will now be used to counteract deformation.

A discussion on fundamental research needs on fish behaviour to improve catching efficiency and assessment use of pots had a slow start as this seems to be a complex subject and includes a wide variety of variables. Although lessons can be learned from other baited gear, the behavioural component is more important for fish pots. The discussion was mainly on attraction variables and what predisposes a fish to be caught and actual capture process examples were discussed. Group members will work further on this item and prepare text to be discussed.

In a discussion on design and ecosystem effects the main issue was ghost fishing and responsible codes of practice were suggested both with regard to design and operation of fish pots.

The terminology to be used for fish pot was discussed and a generic figure with names will be developed. The group also discussed the definition of a fish pot as the group was not happy with the draft definition as presented by SGCOMP.

The group also discussed gear conflicts, which seems to be one of the main contributors to ghost fishing. Spatial and temporal separation of gears seems to be the best method to avoid conflicts but also designs with rounded corners and few surface lines may reduce conflicts.

The outline of a Cooperative Research Report was discussed and group members were assigned to prepare text for the report before Christmas 2008. SGPOT will work by correspondence and meet at the FTFB meeting 2009.

1 Terms of Reference

The Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes [SGPOT] (Chair: B. Thomsen, Faroe Islands) will meet in Tórshavn, Faroe Islands, in April 2008 (concurrent with the FTFB meeting) to:

a) complete a review of the current use of fish pots and provide a global overview of commercial fisheries and assessment surveys using these gears;

b) more specifically identify fundamental research needs on fish behaviour in order to improve catching efficiency and assessment use of pots, in particular:

  i) development of methodology for describing fish behaviour relevant for the capture and escape process.

  ii) reactions to different stimuli, including bait attraction, in the far and near field.

  iii) efficiency of pot and trap entrances, and

  iv) behavioural variation due to biological status and environmental conditions.

c) suggest specific behavioural experiments to be conducted jointly between institutes

d) make recommendations for improving the mechanical design and construction of pots, with considerations given to ecosystem effects such as ghost fishing and other unaccounted fishing mortality, with the specific aim of improving catch efficiency and their utility as survey gear, including drafting recommended consensus terminology for parts of a fish pot;

e) consider conflicts between pots and other fixed and mobile gears

f) develop an outline for writing a Cooperative Research Report.

SGPOT will report by 31 May 2008 to the attention of Fisheries Technology Committee.

2 Introduction

The Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT) was established according to the recommendation from the topic group on "Alternative fishing gears" that met at the ICES-FAO Working Group on Fishing Technology and Fish Behaviour meeting in 2005 and 2006. SGPOT had its first meeting in Dublin, Ireland from 21–22 April 2007. This second meeting was held at the Faroese Fisheries Laboratory in Tórshavn, Faroe Islands 19–20 April 2008. Bjarti Thomsen (Faroe Islands) was Chair and Michael Pol (USA) was Rapporteur. The meeting was attended by 24 participants representing 14 countries; see Annex 1 for full list of participants. Bjarti Thomsen opened the meeting with introduction of the Study Group and the ToR and then reviewed the agenda, which was then accepted by the group, see Annex 2. The agenda followed the Terms of Reference closely with one additional item on updates of current pot research and developments.

The group has an offer from ICES to use a Sharepoint site for the group work. This site will be used for preparation of a final Cooperative Research Report. The group has also available a password protected ftp site where a huge number of relevant references for fish pots are available as well as documents from the group meetings.

3 Review of worldwide use of fish pots

At last year's meeting a table was developed and meant to be the frame for an overview of current fish pot use including catch figures on fisheries to indicate the importance of pots. However it appeared that it is difficult to obtain catch statistics for pots as these figures are hidden/mixed with other gears, especially traps and other static gears.

The group decided to make an extensive and flexible list of use of fish pots grouped into three categories: commercial use, research tool and emerging use of fish pots. It is believed that this can be a valuable information resource for researchers and for exchange of information. It was suggested to add pictures to the information and give examples of catch per effort.

Although pots have low efficiency they have appealing characteristics and are introduced in new fisheries. One example is the fishery for toothfish where fishers have special quota for pots as long-lines have problems with interaction with whales and birds.

Fish pots are superior as research tools e.g. when catching fish for tagging. However, when used as survey gear for abundance estimation similar difficulties exist as with other survey gears, such as survey design, standardizing and the unit of observation. These questions were further discussed under future research needs, see paragraph 5 below.

4 New research on fish pots

In the session on new research on fish pots several participants reported national ongoing and planned research on development and use of fish pots. Not all study group members were able to attend the meeting but have submitted text before and after the meeting. This text has also been included below.

4.1 Faroe Islands

Bjarti Thomsen

The Faroese research on developments of pots for cod and haddock has continued. In the autumn 2007 cod and haddock behaviour around the Norwegian two chamber pots was compared and contrasted to look for the prospects to have a selective pot fishery for haddock. Although haddock was observed to be higher in the water column downstream from the pot cod was seen to readily enter the entrance that was made in the upper half of the pot. This indicates that it might be difficult to separate haddock from cod in pot fisheries.

Future research on pot development will concentrate on the use of other stimuli than bait to increase the efficiency of pots. Preparations have been made to test low frequency vibrations to attract fish and lure them inside the pot.

4.2 Norway

Svein Løkkeborg

The Norwegian two-chamber pot has been redesigned and floated off bottom. The original two chamber pots had two entrances, one in each end in the lower compartment whereas the floated pot has only one entrance. Floating the pot off bottom allows the pot to turn with the current with the entrance always facing downstream. Mean number of cod per pot was 2.4 fish in bottom-set pots and 3.5 fish in floated pots. When comparing fish above mean landing size (MLS) of 47 cm the numbers were 2 and 2.4 respectively. In floated pots almost all fish (95%) approach the pot from downstream, see figure below. When comparing pots with one and two entrances the number of fish caught was 403 and 271 fish respectively. When comparing the catch of fish above 50 cm the numbers caught were 101 and 50 respectively. Floating the pot off bottom has also been proved to be an effective way to avoid non-target catch of crabs. Experiments with floated pots have been reported in Fisheries Research 92 (2008) 23–27.

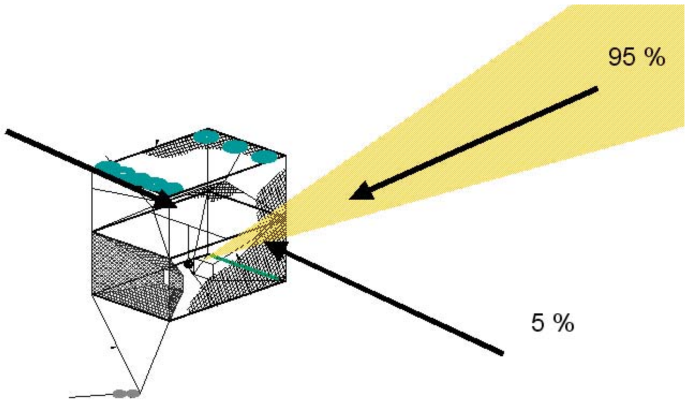

Figure 4.1. Norwegian two-chamber fish pot floated off bottom. The pot turns with the current to allow the entrance to face downstream. Almost all fish (95%) approach the pot from downstream.

4.3 Sweden

Haakan Westerberg and Sven Gunnnar Lunneryd

Swedish experiment with floating Norwegian cod trap

In 2007 field trials with floating cod traps were made in the southern Baltic and in Öresund between Denmark and Sweden. Öresund was chosen because this is an area with relatively high cod abundance. Against expectations, the catch in the Sound was very low (0.04 ±0.1 cods/pot and haul) compared to the Baltic area where catch rates varied between 1 and 2 cods/pot.

A hypothesis why the catch in the Sound was so low was the high current speed there. A test was made in the SINTEF flow tank in Hirsthals. This showed that with the rigging used in 2007 (the same as had been used in Norway earlier) the trap was severely deformed at a current of 1 knot. The trap is sheared horizontally in the current direction and tilted downwards at the free-floating end. The funnel of the trap was effectively closed at this speed.

Several modifications were tested to improve the geometry of the trap. Instead of a single bridle attached to the bottom frame a pair of bridles was attached to the middle and bottom frames at each side. Together with more floats at the attached end this decreased the shearing deformation considerably. To decrease the dipping of the free end more floats can be attached in this end, but an alternative is that the counterweight at the bottom frame can be hung a distance below the trap. In this way the buoyancy of the upper free end can act in full to right the trap when the weight reaches the bottom.

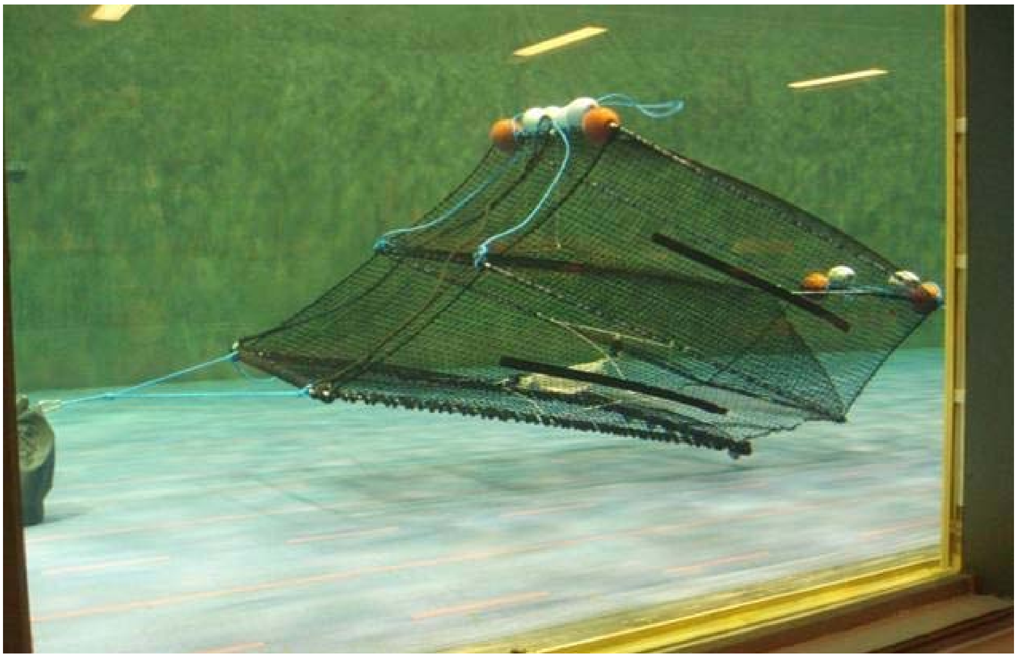

Figure 4.2. The Norwegian two-chamber pot tested in flume tank current.

4.4 France

Jacques Sacchi and Pascal Larnaud

There is a long tradition of pot fishing in French waters which was progressively reduced since the 1960s with the introduction of nylon for gillnets. Pot fishing is nowadays limited mainly to the cuttlefish, snail, and crustacean fisheries of Brittany and Normandy coasts, and to seasonal fishing activities targeting conger, sea breams, wrasses, etc.

More or less successful trials to reintroduce the use of these gears were carried out since the end of the 1970s, targeting deep-water crustaceans as well as sea bass or gadoids in coastal waters.

Considering their advantage in terms of catch quality and environment preservation a stronger research effort was developed beginning in 2005, focusing particularly on fish pots.

ITIS project

Labelled by the Brittany sea pole of competitiveness, the project was started on 1 May 2007 (with an intended duration of 3 years). It is mainly focused on the development of fish pot and Nephrops trap fishing techniques. In June 2007, on the occasion of a workshop organized at Ifremer (Lorient) flume tank, fifteen fisheries professional attended the tests conducted on various current traps and pots and the presentation on the state-of-the-art about these fishing devices. The objective was to define the first specifications of traps and pots adapted for use in the Bay of Biscay on species such as sea bass, sea bream or hake. There is a particular interest in sea breams which exert high predatory action on mussels over the whole Atlantic and the littoral Mediterranean. Following flume tank tests on available pots, novel concepts of fish pots are currently being developed in partnership with Le Drezen company and will be tested at sea in 2008 and 2009, from the shore to the open sea.

On demand of toothfish longliners, several prototypes of dedicated toothfish pots were also developed and are currently being tested near the Kerguelen archipelago, compared to Australian pots and longlines.

Experimentation on fish pots in the Mediterranean Sea

So as to offer the Mediterranean small-scale fisheries a lower impact technique than static or towed nets, the implementation of fish pot technique has been studied by Ifremer since the 1990s. The actions completed up to now have mainly consisted in simple technology transfer to the fishermen as it was done for Norwegian lobster and deep shrimp traps. Since 2005, Norwegian collapsible pots have been tested for fish living on the continental slope between 100 and 600 m. Several technical modifications have been tested so that they can be adapted to the fleet characteristics (vessels less than 15 m LOA) and fishing conditions (depth, hard bottom, current). Problems were experienced with target fish behaviour, pot stability, choice of material type and netting colour, scavengers, and competition. Beginning last year an experimentation is being conducted in cooperation with fishermen's organizations on 3 types of fish pots for the catch of *Sparus aurata* in lagunas and coastal waters.

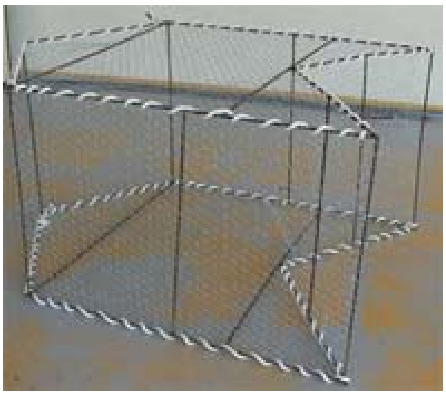

Figure 4.3. Arrow shape fish pot tested for sea bream.

4.5 Greece

Angeliki Adamidou

Information on pot fisheries in Greece have been submitted to SGPOT via French colleagues (*Jacques Sacchi*). This includes an overview of both fish and crustacean pots used in Greece. This text is attached in Annex 4.

4.6 Germany – Baltic Sea

Jens Floeter (jens@floeter.info)

In the Baltic Sea coastal areas of Germany bycatch of birds and mammals in a gillnet fishery for cod is seen as a problem. Therefore, a series of small-scale feasibility studies was conducted with the intention to, if possible, fully or partly replacing the gillnet fishery with cod pots:

2003–2004: "Investigating the catchability of fish traps in the area of the artificial reef 'Großriff Nienhagen'….". Joint project by Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern, Germany, and Fisch und Umwelt M-V e.V.

Description of work: In the Baltic Sea coastal area 6 Stucki-traps and one prototype cod pot (double chamber, 30mm, 10mm mesh opening) were deployed. The Stucki trap was deployed without bait while the trap was baited with either sandeel or herring.

Conclusions: The cod pot caught almost exclusively cod while the Stucki traps, caught also six other fish species including eel, as intended. There seemed to be a negative correlation between cod and eel catches within a Stucki trap.

Setting the pots close to the bottom caused problems with algae and jelly bycatch; investigating the catchability in the pelagic realm remains a future task.

Contact: Bodo Dolk, Fisch und Umwelt Mecklenburg-Vorpommern e.V., Fischerweg 408, 18069 Rostock, Germany.

2005–2006: "Increasing the fisheries value of coastal areas…". Joint project by Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern and Fisch und Umwelt M-V e.V.

Description of work: The Stucki traps and 8 cod pots of 7 different designs, including pots from the Norwegian REFA Froystad Group, were deployed for 8 months. Some mark-recapture experiments were conducted. Cod catches of pots in the period May-August were higher than later in the year. Eel was the main species caught by the Stucki traps. In total around 20 cod pots were deployed in single and later also in long line mode.

Conclusions: This small-scale experiment (total cod catch < 500kg) with a limited number of cod pots could confirm the results of the previous project. Additionally, good mesh selection properties were demonstrated and a semi-pelagic pot was constructed and tested.

However, key tasks of defining the optimal deployment depth, optimal baiting strategy – especially during the summer with high water temperatures –, and pot design remain.

2006: In August, the Federal Research Centre for Fisheries conducted a research cruise with RV "Clupea" to compare the cod catches of gillnets and cod pots. 50 gillnets (2000 knots) and 12 pots (Norwegian type) were compared. In total the pots caught 15 kg cod; the nets caught 712kg cod, i.e. a factor of ~ 50.

2007–2008: Joint project by Bundesamt für Naturschutz and Fisch und Umwelt M-V e.V. Description of work: Five commercial fishermen were equipped with a limited number of cod pots, which they deploy with long lines. First results confirm higher catches in summer than in winter, but at generally too low levels to be economically feasible.

Future plans: There is a joint initiative between vTI, BfN and Fisch & Umwelt e.V. for a new larger scale project, which aims at a more active involvement of commercial fishermen, increasing the number of pots and enhancing their catch efficiency in cooperative trials.

4.7 Russia

Oleg Lapshin

At last years meeting a presentation was given on Russian literature on fish pots. This literature has now been translated into English and is available as a pdf-file on the group's ftp site and is also attached as Annex 6.

Russian pot researchers have invited SGPOT participants to suggest and participate in relevant laboratory behavioural experiments at facilities in Russia. Laboratory experiments to study inlets, soaking time and form of pots are planned in August 2008.

4.8 Ireland

Dave Stokes

In Ireland the area of survey use of pots has particular interest. Following the video footage at last year's meeting showing fish attracted to hooked and struggling fish the intention was to deploy fish traps during a juvenile cod survey in the Spring and to look at having a number of pots with bait on hooks to compare if having a fish struggling in the pot affected catch rate - compared to a standard passive bait bag. This work has now been postponed to the autumn. Others suggestions for improvements or alternatives will be welcomed.

References on standardization of bait/effort have been gathered, and other input from a Norwegian PhD in this area is expected. A review on synthetic baits and also quality/freshness tests to standardize natural baits will be considered. Information has been received from colleagues in Spain from recent longline surveys that even in the area of a small island that a bait fish can be excellent at one end of the island while the same baitfish for the same target species can be of no use at the other end of the island, where the bait species does not naturally occur. Therefore the effectiveness of baits over a large survey area that may encompass more than one ecosystem might affect the calculation of fishing effort.

Standardization or estimating effort is a big issue for surveys as is the survey design, which will be looked into.

4.9 Canada

Philip Walsh

Commercial trials are continuing throughout the province Newfoundland using the "Circle 6" design. This is a collapsible rigid framed pot with dimensions 1.98m x 1.98m x 0.91m (6.5′ x 6.5′ x 3.0′) containing circular funnels and a floating roof section.

Thirty pots were given to 6 harvesters to use during their commercial operations in 2007. These harvesters fished from September to November with as much as 4050 lbs harvested from nine pots. On November 23, the Marine Institute provided a public demonstration where individuals could come and observe pots during fishing operations. Government groups, fishing company representatives, and harvesters attended.

A professionally produced promotional video is currently in development. Approximately 5000 copies will be produced on discs and distributed free of charge during upcoming industry tradeshows, workshops, and meetings.

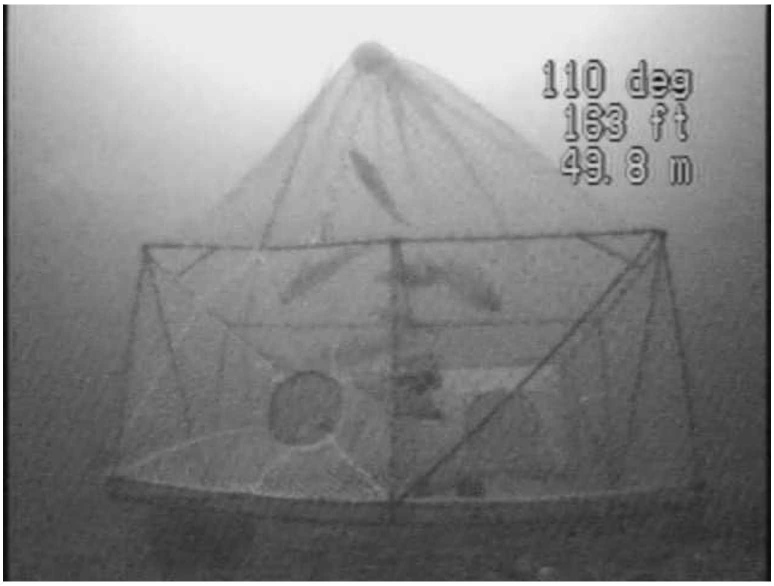

Figure 4.4. "Circle 6" design fish pot used in Newfoundland.

5 Fundamental research needs

A discussion on fundamental research needs on fish behaviour to improve catching efficiency and assessment use of pots had a slow start as this seems to be a complex subject and includes a wide variety of variables. Although lessons can be learned from other baited gear, the behavioural component is more important for fish pots. The discussion in this issue

For the purposes of defining fundamental research needs, participants divided the capture process into near and far-field regions, and considered the catching of fish in pots as consisting of attraction, capture, and escape. Within each of these areas, several areas of investigation were identified. Far field attraction was considered to be driven by detection of attractants by fish. Therefore, investigation into the nature of attractant composition and propagation, in addition to sensory capabilities of the target organisms, was identified. Literature searches or investigations might include defining the number of attractant molecules that trigger a response, fine scale oceanographic modelling to understand dispersal of attractants, the chemical composition and persistence of attractants, and sensory awareness, including eddy chemotaxis. Additionally, it was suggested that hydroacoustics or the nearby use of trawls might help to define the effective radius of a pot. It was also recognized that the probability of response to stimuli was highly dependent on the hunger status of the target, which may be dependent on the presence of other food sources, spawning status, and other factors.

Near-field attraction was largely thought to be dependent on visual stimuli, and direct or remote observation of fish was felt to be the primary research direction. Additional paired or other controlled field experimentation with changes to pot configuration, including bait type, entrance configuration, bait motion, and other aspects of bait presentation and pot architecture were necessary. Similarly, the capture process could be investigated using observation. Finally, the prevention of escape was felt to be a function of pot shape, entrance configuration, and pot architecture. The use of triggers and trigger timers was identified as strategies to reduce escapes.

In the discussion on attraction variables and what predisposes a fish to be caught actual capture process examples were discussed. It was questioned whether we should assume a linear relationship between catch and true abundance as the catch process might have min and max thresholds and catchability may be sigmoid. Group members will work further on these issues and prepare text to be discussed.

6 Design and ecosystem effects

In the discussion on design and ecosystem effects the main issue was ghost fishing and responsible codes of practice were suggested both with regard to design and operation of fish pots.

Fish Pots – "the dark side" *(Mike Breen, Scotland, UK)*

Fish pots have been identified as a potentially "responsible" fishing gear by the WGFTFB Topic Group on Alternative Fishing Gears (ICES 2006); in particular with respect to their environmental sustainability in terms of reduced environmental impact, low energy cost and the welfare of the catch/bycatch. However, this gear does have the potential to induce a number of detrimental effects upon the marine ecosystem and the users of that ecosystem.

These detrimental effects are now widely recognized for various static gears (for reviews see: Brown *et al.*, 2005; Brown and Macfadyen, 2007; Matsouka *et al.*, 2005) and can be summarized in the following broad categories:

- "Ghost-fishing": continue catching of target species when lost;
- "Bycatch": capture/entanglement of non-target species and charismatic mega-fauna;
- physical impact of gears on the benthic environment;
- contribution to marine debris and its associated effects; and
- conflict with other users.

Each of these issues was briefly reviewed and, where available, relevant examples given. But because of the developing nature of fish pots as a commercial gear, it was recognized that limited data are available. It was noted that there has been a particular focus upon the ghost fishing properties of static gears, but there are few examples for fish pots. Discussions in both SGPOT and the Working Group for the Quantification of All Fishing Mortality (WGQAF) recognized the relatively benign nature of fish pots which means there is a minimal impact upon the welfare of captive fish (ICES 2007). Irrespective of whether lost pots kill fish or not, if captive in a pot the fish is removed for the fishable stock. From this perspective, Al-Masoori (2000) estimated that 3–15% of the total value of the fish pot fishery in the Sultanate of Oman was lost annually to ghost fishing. In Japan, an underwater survey identified 639 lost pots from a small inshore pot fishery which shared fishing grounds with aquaculture activities (Matsouka *et al.*, 1997). This was ten times the number of pots actively fish in the area each day by the fishery and of these ghost pots, 274 were still actively fishing (Matsouka *et al.*, 1997).

Some of the common causes of lost static gears, in decreasing order of relative importance, are (based on Brown *et al.*, 2005):

- conflict with other sectors, principally towed gear operators;
- working in deep water;
- working in poor weather conditions and/or on very hard ground;

- working very long fleets of pots;
- working more gear than can be hauled regularly.
- [irresponsible disposal ("dumping") of gear].

But, because of the passive nature of the gear, it was suggested that ghost fishing and these other detrimental issues associated with pots are intrinsically linked and as such may have common solutions. These solutions can be both preventive and curative (Brown *et al*., 2005):

Preventive measures

- Reducing risks of conflict; e.g. zoning of different users
- Reducing risks of snagging; e.g. gear modification
- Reducing efficiency of ghost nets; e.g. biodegradable components
- Reducing fishing effort; e.g. net numbers, soak time
- Improving gear recovery; e.g. attachment of transponders

Curative measures

- Reporting of gear loss for subsequent gear recovery campaigns
- Gear recovery campaigns
- Opportunistic gear recovery through demersal trawl surveys

However, the use of recovery schemes has been criticized by a number of authors because of: the inefficiency of current recovery techniques; potential impact upon the seabed; the destruction of emerging habitats/communities on the establishing artificial reef associated with the gear; the issue of suitable disposal once the gear is recovered; as well as the relative cost of the recovery operations compared with the environmental benefits (Brown *et al*., 2005; Brown and Macfadyen, 2007; Matsouka *et al*., 2005; Wiig, H.C., 2004). In general, it is recognized that preventing gear loss or abandonment is better the any curative measures.

Discussions in SGPOT focused on two particular aspects of preventive mitigation: designing fish pot to promote conservation; and minimizing loss of gear by avoiding conflict with other users. It was recognized by the group that conservation should be considered as a design priority, alongside catch efficiency, in the development of fish pots. Among the conservation design features considered were: floating pots, to minimize benthic impact; biodegradable construction materials, to reduce ghost fishing and marine debris; delayed surface marker buoys and location aids, to promote recovery of lost gear; and non-snagging pots and surface marker lines and floats, to reduce loss of gear. To avoid conflicts with other users, the group noted that spatial and temporal separation of users appears to be the most commonly used and successful method, but careful design of the gear and mooring/marking methods could specifically reduce conflict with other fishing gears. It was proposed that the SGPOT Final Report and CRR should include a guideline code of practice for the responsible design and operation of fish pots.

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7 Terminology

The discussion on pot terminology was facilitated by a list of pot inventory, which are summarized and visualized in the flow chart below.

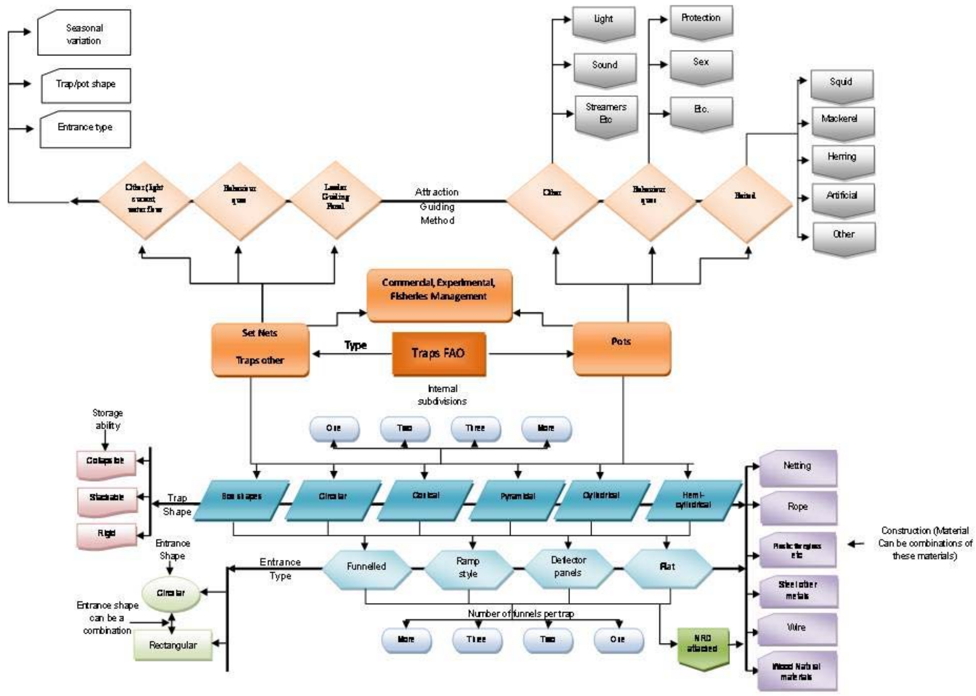

Figure 7.1. Fish pot terminology (Philip Walsh and Alain Fréchet).

To avoid confusion of the terminology it was decided to develop a generic figure of a pot with names on all of its components.

The discussion on terminology led to questions on how to define a pot. The group was not happy with the draft definition as presented by SGCOMP and after considerable discussions the group reached the following definition:

A pot is a type of trap that is a portable enclosure, where the capture process is dependent on attraction to gear-oriented stimuli.

8 Gear conflicts

In the discussion on gear conflicts it was recognized that gear conflict is one of the main contributors to ghost fishing (see paragraph 6 above). This might largely be a management issue, as spatial and temporal separation of gears seems to be the best method to avoid conflicts. However, construction and use such as designs with rounded corners and few surface lines may also reduce conflicts. Group members came up with many examples on how to gear conflicts are managed in existing fisheries, see list in Annex 5.

9 Outline of CRR

The intention is to have the group work reported in a Cooperative Research Report (CRR). The outline of a CRR was discussed and will apparently follow the ToR closely. Group members were assigned to prepare text for the report before Christmas 2008. The question how to credit contributors was also discussed and clarification will be sought from ICES on the format of a CRR.

SGPOT will work by correspondence and meet at the FTFB meeting 2009 to finalize its work and the CRR.

Annex 1: List of participants

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Annex 2: Agenda

Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT)

Meeting Place: Faroese Fisheries Laboratory, Tórshavn, Faroe Islands

Saturday, 19 April 2008

09:00: Greetings, housekeeping

09:20: Introductions and review of TOR

09:45: Adoption of agenda

10:00: Morning break

10:30: Global pot use review

11:13: Updates on current research/state of knowledge

12:30: Lunch break

13:30: Research needs on fish behaviour improve catching efficiency

15:00 Afternoon break

15:30 Suggested behavioral experiments

17:30: Outline for CRR (thoughts for tomorrow)

18:00: End of day summary, review of next day’s work

19:00–23:00: Excurison and food in Nólsoy

Sunday, 20 April 2008

09:00: Opening

09:15: Comment on previous day

09:30: Design and ecosystem effects

10:30: Morning break

11:00: Terminology discussion

12:30: *Lunch break*

13:30: Gear conflicts

14:30: Outline for CRR

15:00: *Afternoon break*

15:30: ICES report

16:30: Assignment of writing tasks and closing

17:00: Closing

Annex 3: SGPOT Terms of Reference for 2009 meeting

The Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes [SGPOT] (Chair: B. Thomsen, Faroe Islands) will meet in Ancona, Italy from 16–17 May 2009 (concurrent with the WGFTFB meeting) to:

a) finalize structure and text material for proposed ICES Cooperative Research Report;

b) provide timetable for ICES Cooperative Research Report publication.

SGPOT will report by 30 June 2009 to the attention of the Fisheries Technology Committee.

Supporting Information

Priority:	The current activities of this Group will monitor and encourage current ongoing work in several countries, faciliate communication of results and lead ICES into improved techniques for surveying marine living resources. The work of this group is the development of a fishing gear that has many environmental benefits and will contribute to sustainable fishing. Consequently, these activities are considered to have a high priority.
Scientific justification and relation to action plan:	The group's work is of relevance to the ICES Action Plan 1.13, 3.16, 3.17 and 3.18. Several research milieus are conducting significant studies in the development of fish pots development both for commercial use and for survey purposes. The study group is working towards an ICES CRR providing comprehensive review of state-of-the-art and further research needs.
Resource requirements:	The research programmes which provide the main input to this group are ongoing, and resources are already committed.
Participants:	The Group is normally attended by some 20–25 members.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups:	There is a close working relationship with WGFTFB

Annex 4: Description of the main Greek pot fisheries

Angeliki Adamidou, NAGREF Fisheries Research Institute, 64007 Nea Peramos, Kavala, Greece, E-mail: adamidou@inale.gr

Fish pot

A fish pot has an ellipsoid shape with flat bottom to be adjacent to seabed (Figure 2). The diameter in the wider extent of the pot is 0.5–0.8m, the height is 0.5–0.8 m and the weight about 2 kg. It is made of galvanised steel wire of 2.5–3 mm thickness that is weaved to form mesh of 0.6–0.7 cm (bar length). The fish pot has a funnel shape entrance at its upper side. The opening of the entrance is reduced gradually as it comes down inside the pot, to allow fish to enter, but not to escape, unless they are smaller than the wire mesh size. Fish pots are baited and hauled, usually independent one from the other, at depths from 15m to 70 m on muddy or sandy bottom or close to rocks. The bait is usually salted fish, cheese or yeast. A single line with plastic buoy is attached to each fish pot to mark its position. Depending on vessel size, 30 to 100 pots are used. The soaking time is 12–24 hours. The pots are retrieved individually, by holding up the buoy line with a hooked pole. The pot is emptied, re-baited and reset. The fish pots are used mainly in the South-eastern Aegean Sea (Dodecanese area) and the main target species are: white sea bream (*Diplodus sargus*), black sea bream (*Spondyliosoma cantharus*), sharp snout sea bream (*Diplodus spuntazo)* and groupers (*Epinephelus spp*.)

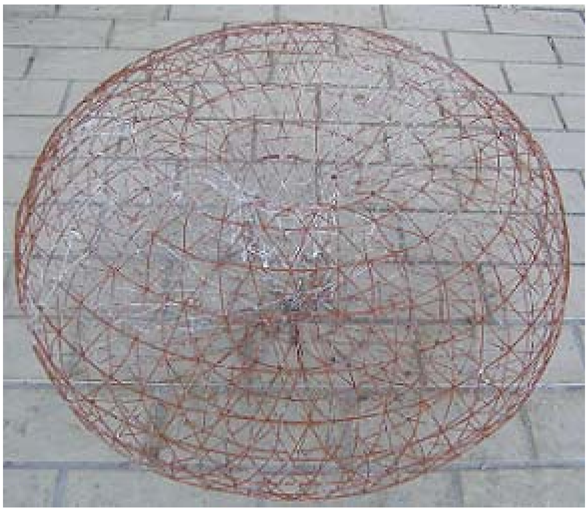


Figure 2. A typical fish pot.

According to national legislation (Presidential Decree 157/2004) the wider extent of the pot shall not exceed 1 m, the height 0.5 m and the diameter of the entrance shall be at least 13 cm. Every vessel is allowed to have on board or use up to 300 fish pots. The fishing period for fish pots is from 1 August to 30 April.

Crustacean pots

The Crustacean pots may be rectangular with rounded or flat upper part or barrel shaped. The rectangular pots are made up of steel rods frame that is covered by twine netting of stretched mesh size 16–24 mm when it targets shrimps, 40 mm for crayfish and 60–80 mm for lobster (Figure 3). The barrel shaped pots are made of, horizontal slats fixed on 3-4 PVC hoops. The opposite sides are covered by twine netting of 48–80 mm (stretched mesh). A plastic funnel of 20–40 cm opening at the upper part leads crustaceans inside the pots where the bait is placed. Small-sized fish or pieces of fish are the most common bait. The fishing for shrimps and lobsters is carried out at depths ranged from 70–130 m, on muddy (shrimp) or rocky (lobster) bottoms while for crayfish from 200–520 m. Crustacean pots are set in fleets. The soaking time ranges from 4 hours (crayfish) to 1 day (lobster). The number of pots used varies from 50 to 200 depending on the length of the vessel and the number of crew. The Crustacean pots are used mainly in the South-eastern Aegean Sea (Dodecanese area) and in the Central Aegean Sea.

a) **b)**

Figure 3. Crustacean pots for (a) lobsters and (b) shrimps.

According to national legislation (Presidential Decree 157/2004) the length of the crustacean pots shall not exceed 0.8 m, the height 0.45 m and the stretched mesh size of the netting shall be at least 28 mm. Every vessel is allowed to have on board or use up to 300 crustacean pots. The fishing period for fish pots is from 1 August to 30 April.

Octopus pots

They are of the oldest type of pots, traditionally made of clay. Nowadays, lighter and more long-lasting materials are used such as plastic buckets or pipes (Figure 4). Their length is about 30 cm and their diameter 12 cm. Inside the plastic pots, a small amount of cement is placed at the side that is adjacent the seabed to keep the pot on the bottom. Octopus pots are not baited and set always in fleets of 50–100. They are set at depths of 10–70 m and the soaking time is 5–10 days. They are used in the Northern and Eastern Aegean Sea targeting the common octopus (*Octopus vulgaris*).

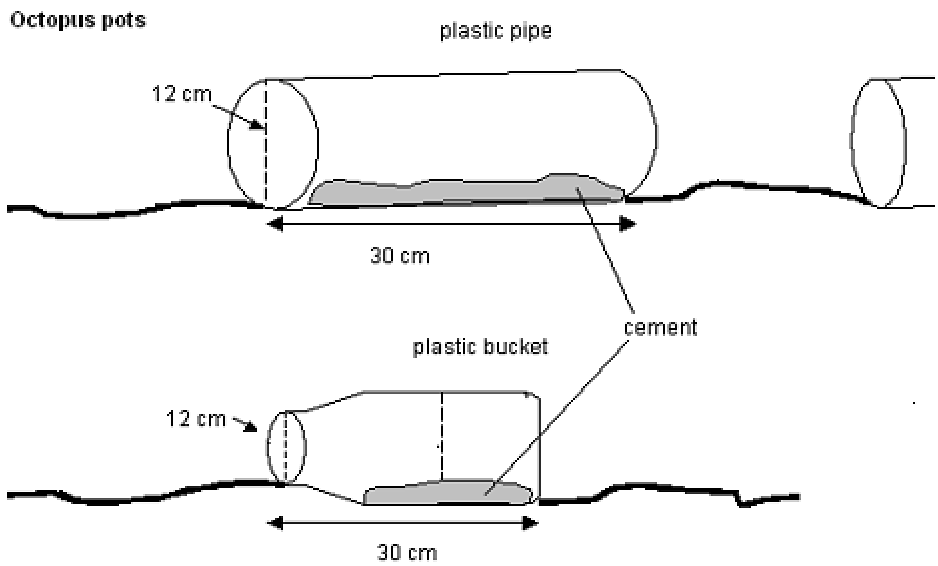


Figure 4. A rough drawing of octopus pots.

According to national legislation (Presidential Decree 157/2004) the length of octopus pots shall not exceed 30 cm, and the mouth opening shall be at least 12 cm. Every vessel is allowed to have on board or use up to 1500 octopus pots. The fishing period for octopus pots is from 1 October to 30 June.

The above text is cited as follows:

Adamidou, A. 2007. Commercial fishing gears and methods used in Greece. In: Papaconstantinou, C., Zenetos, A., Vassilopoulou, V., & G. Tserpes. State of Hellenic Fisheries HCMR Publ., 118-131 pp.

The technical characteristics that are mentioned in the text, are according to official recordings of the gears throughout the Greece, that was took place in the frame of the project "Recordings and description of the Greek small-scale fishing gears and study of their viability" that was realized by: 1) Fisheries Laboratory of Ministry of Rural Development & Food and 2) Fisheries Research Institute (FRI) – NAGREF.

Annex 5: Conflict management

Sweden	zoning perm by gear type (by banning trawling)
Alaska	trawl excl zone around marine mammal breeding and haulout areas
English Channel	French trawler & English gillnets - volunteering rotating zonation
Scotland	western sealochs closed to trawling; closed areas to towed gears e.g. Firth of Lorn & Windsock
Faroes	12 nmiles - exclude trawl (some flat fish)
Faroes	Exclusion zones outside 12 nmile - will provide map
Norway	6 nmiles
Gulf of Lyon	temporal voluntary access scheme e.g. gillnet set in the evening and lifted at dawn, trawls only work during the day
Bay of Biscay	Excl zones - pelagic to 6nmiles; bottom trawling to 3nmiles
Iceland	Closed areas for different gears - complex array of zones - get link for map
Ireland	Communication! pelagic sector notified of the position of static gear; linked with a compensation scheme
Alaska, Baring Sea	King Crab sanctuary - trawling banned
Labrador	No trawl zone to allow for crab potting (shrimp trawlers)
Fortune	Gillnet exclusion
Bermuda	Tourist diving - drove out pots
French Guyana	Fish pots banned
Shipping Channels	Navigation hazards
Anchoring	Navigation hazards e.g. Placentia Bay
Oil platforms	500m exclusion zones

Other solutions:
Use non-snagging measures
"Over-trawlable" designs
NB - single pots can reduce conflict with other static gears
Drivers to change gear - may mitigate conflict • Economic pressure to change gears? • Bycatch reduction pressure to change gear

Annex 6: Fish Pots in Russia

Seslavinsky V.I. 2005. Small traps for rational and effective fishing in the Russian Far East region shelf zone. Izvestia (Proceedings) of TINRO. Vol. 142. P. 349–390.

Translation of Russian text on fish pots provided by Oleg Lapshin.

Small traps are widely used in the world practice for fishing, and catching invertebrates and molluscs. Basic parameters of the traps are explained: the form, volume, type and number of entrance devices, type of frame and material of covering. Besides, fishing results on cod, sablefish, halibut, perches and other species are estimated. Depending on type of the trap (rectangular, oval, cylindrical, or conic), fishing object and fishing ground, the catch reaches 170 kg per one trap/day and 7–50 kg per unit effort. Influence of the trap parameters on the catch value was determined experimentally in conditions of good fishing grounds at the testing area in the Ussuri Bay and in field conditions. For flounders, greenlings, cods and halibuts, the catch dependence on trap volume, entrance devices type and size, fishing nets assortment and duration of the trap's exposition is determined. World experience of cod, sablefish, halibuts, and perch fishing allows us to wait a great expediency of the small traps in the Far East region.

Commercial fishing gear are classified by the principle of their operation, then according to the means by which the principle of operation is realized and constructional peculiarities and are divided into classes, groups and type (Baranov, 1933; Treschev, 1958; Lukashev, 1963; Mel'nikov, 1979; Voinikanis-Mirskii, 1983). Traps, listed in a separate class are subdivided into (Treschev, 1958):

- stationary set traps (pots are open from above, with lifting net devices, entering labyrinths, funnel and combined entering devices),
- fykenets (pots are closed from above, with different types of entrances),
- movable pots (frame and flexible),
- drifting pots.

Set traps and fykenets are considered as stationary fishing gear and are usually set on traditional sites on the path of motion of migrating fish. Small pots widely used worldwide to catch fish, crustaceans and molluscs are considered among transportable. These pots are set into strings placed on board of the ship and transported to the site of fisheries. Drifting pots are not used widely in commercial fisheries due to the complexity of maintaining the working parameters of both the pot and leading elements (wings, internal and external lean-to's) during the drift.

According to the principle of their action fishing gear used in commercial fisheries differ in the motion of gear and object relative to each other. If the object is caught by fixed fishing gear such as the mesh in the net, hook in the longline or bait in the pot such gear is referred to as passive. If the object is caught by moving, fishing gear regardless of the fact if the object is stationary or moving relative to the fishing gear – then the fishing gear is referred to as active. Such are trawls, purse and haul seines. Active and passive fishing gears differ significantly in the energetic costs of fisheries.

The fishing gears described in this article are considered among the class of pots and within the group of movable pots. For a more precise definition, we introduce the concept of "compact" or "small" pots that possess frame which maybe either rigid or flexible. Small pots differ from fykenets and set traps by the lack of wings and lean-to's placed outside the trap and needed to direct the object into the trap.

Pots maybe used on sites with hard, rocky bottoms which are not used for fisheries at present, for fisheries on low-density aggregations where the use of active fishing gear is not profitable due to high energetic costs on the unit of caught fish. Objects of fisheries enter the pots attracted by the bait (Malyukina *et al.*, 1974) and/or in search of cover if the bait is not present. Rather small volume of pots allows hauling in the whole gang on the ship thus quickly changing the region of fisheries.

Due to the introduction of 200-mile zones and the appearance of license fisheries many countries lost significant volumes of catch, while countries with well-developed coastal fisheries retained their positions. Thus, the switch of fleet to fisheries in the coastal zone let Australia, Argentine, Brazil, Mexico and Uruguay keep the volumes of catch in crisis situation (Molunov, Sataev, 1982). Countries with well-developed coastal fisheries have increased the catch due to the intensification of fisheries in their zones and utilization of long-lines, nets and pots. Thus, in Japan the period of transition was characterized by the increase of catch by 1.4 million tons. Countries directed toward oceanic fisheries needed to change the structure of fisheries and fleet fast, as the large-capacity vessel became non-profitable in the new conditions unlike small-capacity vessels working in the coastal fisheries.

Coastal fisheries, based on the principles of rational fisheries must be based on the complex of passive fishing gear including long-lines, set-nets and pots. Relative to the object and the region of fisheries, each fishing gear has certain catchability as well as species- and size-specific selectivity. That is why the substantiation of fishing gear selection should be carried out taking into consideration these peculiarities and the necessity of effective and rational fisheries.

Under coastal we understand fisheries of seafood from small-capacity vessels mechanically equipped for work with one or several fishing gear types and modern devices used to find the object and control the process a fisheries. The power of the main engine and fishery mechanisms should be enough to work on depths comparable with shelf depths, with crew of two to four people (Barkova, 1979).

The effectiveness of fisheries depends on the fuel consumption divided by the unit of caught fish and is characterized by the fuel coefficient K_t, value of which is equal to 0.6–1.0 for vessels of medium- and short-range equipped with bottom trawl. The coefficient $K_t = 0.1$ for coastal fisheries' vessels equipped with nets and pots and equal to 0.075 using long-lines (Shentyakov *et al.*, 1980; Endal, 1980).

The test of possibility to use pots to catch deep-water fish species was performed by Polar Research Institute of Fisheries and Oceanography (PINRO) researchers in the Barents and Norwegian seas. Test trials of several pot designs used to catch cod and halibut from different fishing vessel types. Commercially–technical characteristics of the following pot designs were compared (Proceedings ..., 1983):

- rectangular (2.5–3.0)x1.0x1.0 m (V 2.5–3.0 m^3) and 2x1x1 m (V 2 m^3), that have two counter entering devices situated off the traps symmetry axis;
- cylindrical 2.5 long, ∅ 1.2 m (V 2.83 m^3) with two entering devices installed one against another;
- rectangular with sizes 2x1x1 m, 2.0x0.9x0.9 m, 1.75x0.80x0.80 m with two entering devices installed on the sides of the trap.

Frames of the experimental traps were made of pipes with ∅ 20–35 mm or angle bar 40x40x4 mm. The frame was covered with metallic net and mesh with mesh size 10–100 mm. Entering devices were made of mesh with mesh size – 18 mm, inlet of round form ∅ 0.25–0.30 m or square with side 0.25–0.30 m. Capelin was used as bait. The mean catch of cod and halibut was 10 kg on one trap. As the result of the experimental trials, trap soak time of 12 to 24 h was proposed.

Comparative trials of cylindrical and rectangular traps were carried out on depths up to 980 m by Pacific research institute of fisheries and oceanography (TINRO). Rectangular traps were made 2–4 m long with the height of sides equal to 0.8–1 m, two cone-shaped inlets with the opening size being 0.2x0.2 m (Figure 7) were installed serially. The frame of the trap is folding and covered by net. The catch of rectangular trap with sizes 2.5x1.0x1.0 m (V 2.5 m^3) constituted 32–94% of the cylindrical trap's (sizes 2.5x1.0 m (V 4.9 m^3) catch (Markin, 1982).

Trials of the experimental cylindrical trap were carried out during catching the sable fish and halibut (Markin, Makeev, 1983). The frame of the trap is demountable made of pipes ∅ 20–40 mm, and consists of two rings ∅ 2–4 m reinforced by spacers and 8 vertical stands 0.8–1 m high (Figure 8). Stands fastened to the rings of the lower and upper bases with yokes. The trap covered with net (mesh size 18–50 mm) and four entering mesh devices with square or rectangle openings. The entering devices were expanded by four braces fastened to the mesh of the traps bases. Two bridles were hitched to the traps basis and then a rope ∅ 8–10 mm that was used to fasten the trap to the mainline. Short arrangements of traps were used consisting of 3–11 traps with the distance in between them 40–50 m in order to find higher concentrations of fish. Working on big depths and muddy bottoms arrangements with two signal sacks were used. Medium fishing vessel carried up to 200 traps. Authors of the experiment note that three men of the crew were involved in setting and raising the trap arrangements.

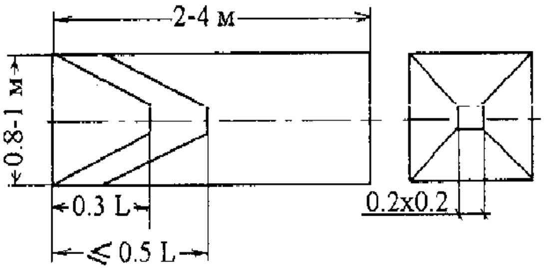
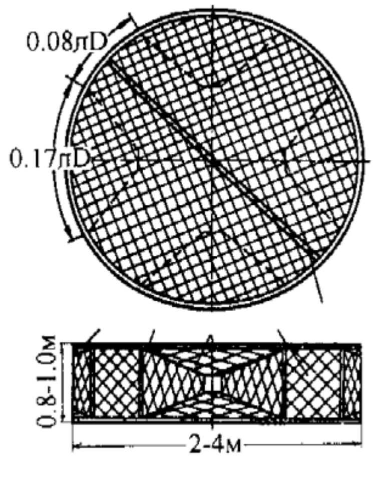


Рис. 7. Ловушка прямоуголь
складывающаяся
Fig. 7. Folding rectangle trap

Рис. 8. Ловушка круглая цилиндрическая
Fig. 8. Round cylindrical trap



Experimental fishing was carried out in the Bering and Okhotsk seas on depths 35–1650 m. Objects of fisheries were: sable fish and halibuts. By-catch consisted from rasps, cod, flounders, rays, grenadiers, crustaceans and molluscs. Fish species of low value (for example, Pacific saury) were used as bait.

The mean catch of round cylindrical trap with four openings constituted 42–46 kg for 40 h exposition (Markin, 1981). It was determined that decreasing the number of openings from four to one the catch decreases on 17, 56 and 72% respectively; higher catches of halibut may be obtained using trap with square-shaped inlets of 0.2x0.2 m size; it is more expedient to use round cylindrical traps with bases ∅ 3.0 m, height 0.8 m and 5.6 $м^3$ volume when working on big depths as they are more convenient in exploitation.

Performed analysis of traps used in Russia and other countries is presented in tabular form (Table 1), basic parameters of fisheries (form and size of the trap, type and number of the inlets, bait, catch) are considered.

Table 1 Fishing parameters of comparing constructions of traps

Object	Trap type	Trap volume, m^3	Catch per exposition, kg (%)	Mean catch, kg/m^3
Sable fish	Cylindrical	1.90	51.0	26.80*
	Rectangular	3.60	25.0	6.90
Sable fish	Truncated cone	0.69	7.0	10.10*
	Rectangular	2.22	20.0	9.00
Sable fish	Cylindrical	1.92	76.0	39.60*
	Rectangular	3.57	35.0	9.80
Bass	Z-shaped	3.20	7.0	2.20
	Rectangular	0.68	4.9	7.20*
Bass	S- shaped	1.37	(125)	0.91*
	Z- shaped	3.20	(100)	0.31
Cod, halibut	Round cylindrical	4.90	(100)	0.20
	Rectangular	2.50	(63)	0.25*

***Trap constructions were higher catches are obtained**

The data of Table 1 allows to represent the character of fisheries of different fish species using traps, compare the catches depending on the form and volume of the traps, material of the frame and cover, type and number of inlets and their position, depth on which traps are placed and their exposition, baits used. Fish traps are used in different regions with different fish species, their concentrations, type of used vessels and mechanization and – the most important by the type and size of the traps themselves. Effectiveness of fisheries using traps of different construction can be compare if the trials are carried out from one vessel and in one region. These conditions comply with some of result of comparative commercially technical trials of traps given in Table 1. As the value of the catch depends from the sizes of the trap (with all other conditions being equal) we will estimate the compared constructions according to the ratio of the catch Q to the volume of the trap k=Q/V. The relative catch characterizes the construction of the trap and fish concentration in the region of fisheries. Obtained results allow recommending the following for commercial fisheries of:

1) Sable fish
   - cylindrical traps 2.2–2.4 m long, ∅ 0,9 m with two serial inlets, size of the opening – 0,2x0,2 m;

- traps in the form of truncated cone with 1.1–1.9 m^3 volume with three inlets.

2) Bass

- S-shaped traps with sizes 2.44x1.22x0.46 m (V 1.37 m^3) with one inlet in the form of vertical slot;
- rectangular traps with following dimensions 1.37x0.86x0.71 m (V 0.69 m^3), 0.91x0.81x0.36 m (V 0.27 m^3), with one cone-shaped inlet directed towards the lower base of the trap.

3) Cod

- rectangular traps with following dimensions 2.00x0.75x0.75 m (V 1.12 m^3), with two serial cone-shaped inlets.

4) Cod and halibuts

- round cylindrical traps ∅ 3.0 m, 0.8 m high with three cone-shaped inlets ∅ 0.06x0.15 m.

The influence of fisheries' parameters on the pot catch value

Fisheries parameters are divided into technical characteristics and tactical fisheries techniques. Technical characteristics of fisheries are the parameters of pots and strings, vessel, fisheries schemes and mechanization. Means of fisheries effectiveness increase that may be used in fisheries without changing the construction of pots and strings are considered as tactical fisheries techniques. These are: the choice of regions, terms and depths of fisheries, soak time of pot strings, the choice of relative bearings of string setting, utilization of different baits.

According to the international system, the fisheries effectiveness is characterized by the catch relative to the time of fishing. The unit of this parameter measurement is kg/soaktime/pot or kg/h/fishing. The time of fishing is determined by the production cycle i.e. the overall time of fishing (time needed to set, soak time and time needed to haul the pots). The catch depends on the concentration of the shoal in the region of fisheries, pots fishing efficiency coefficient for a given object of fisheries and the zone of fishing gear attraction. Fish enter the pots attracted by food, light or sound. Some objects enter pots without bait utilizing them as cover from predators, predators enter pots attracted by the view of prey and some fish enter pots due to exploratory instinct.

Fishing gear construction is determined by the form and volume of the pot, the construction of the frame (rigid, folding, flexible) and the material of cover, type, quantity and disposition of entrances. The construction of string is characterized by the distance between pots, the material of the groundline and buoy lines, devices used to determine the strings' position (reflectors, flashing beacons, etc), by the means of attaching the pots to groundline.

Methods of calculating and determining the catchability coefficient proposed by F.I. Baranov (1933), V.N. Lukashev (1963), V.A. Ionas (1968) are used for active fishing gear (trawls, beach and purse-seines, Danish seine) predominantly. Methods of calculation are usually linked with the evaluation of fish behavior and their quantity in the fishing gear's zone of action, and these are almost impossible to determine (Treschev, 1974).

The experimental trials which were carried out have shown that catchability coefficient has constant value only in conditions when fishing is performed in one region with a given concentration of fisheries' objects, and fishing gear of one type are used (Denisov, 1978). Fishing gear's catchability coefficient fluctuates depending on the region of fisheries that have different concentrations of the studied object and hydrological peculiarities, fishing gear's construction, the duration of fishing and biological peculiarities of the object (size, behavior, physiological condition). The comparative catchability is determined for fishing gear having similar species- and size-selectivity.

The differences of fish species ratio in the catch of pot designs or other fishing gear being compared characterize their species-selectivity. The change of mesh-size and hanging coefficient of mesh in the pot is accompanied by the correction of size-, and in the case of multi-species catches, species-selectivity.

Difficulties in calculation of pots' catchability coefficient have led researchers in the way of determining the retention of pots as dependent of the construction and number of inlets (Sergeev, 1960).

$$\alpha = \frac{\ln N - \ln n}{t}$$

where α – pot's retention, N – the number of fish in the pot at the beginning of observations, n – the number of fish in the pot after the time t. The author concluded that the increase of the number of inlets leads to increased retention but hampers the entrance into the pot for fish. That is why it is advised that commercial fishermen should haul in the pots with one inlet more frequently while soak-time of pots with complex construction and several inlets should prolonged. The determination of retention coefficient makes us closer to the qualitative evaluation of catchability coefficient but does not solve the problem put by.

In practice, catchability coefficients are used for stock assessment, mainly. Zone of action for active fishing gear such as trawl, Danish seines, beach-seines is thought of as equal to the area of trawling or volume of water sieved by the trawl or area encircled by the seine. Zone of action of gillnets is thought of as equal to the length or area of the net and equal to the length of wings for traps (Treschev, 1974). When compact pots lacking wings are utilized the objects are caught owing to attraction that is why the zone of action may be evaluated as the area of food-baits' smell diffusion and when the bait is absent by the distance of visual detection or detection of the pot's hydrodynamic field.

There are few variants of catchability coefficient determination for several fishing gear different in the means of fish capture and retention. According to Denisov (1978) the coefficient of absolute catchability ϕ_a may be found using the following expression:

$$\varphi_a = f(\eta\omega),$$

where η – is the coefficient equal to the ratio of the number of fish caught N_1 to the number of fish N_2 present on the area fished, it takes into account the relation of the catchability coefficient to the design of the fishing gear and fisheries' tactics; ω – coefficient taking into consideration the relation between the catchability coefficient and object's behavior.

If we will consider the catchability coefficient as catch in a unit of time, and N_2= Sq, where S – the area fished in time t, q – the concentration of fish in the region, then the catchability coefficient may be calculated according to the expression:

$$\varphi = \frac{N_1\omega}{qSt}.$$

L.I. Denisov (1978) considers that is possible to compare the catchability coefficient of active and passive fishing gear, beach-seine, set-nets and trawl, for example. Taking the coefficient of behavior for bream ω_s (seine) = 1.0, ω_t (trawl) = 0.8 and ω_n (net) = 0.6, author calculates the value of the given catchability coefficient. Then, multiplying these values by the longevity of fishing with fishing gear compared he gets the value of absolute catchability coefficient.

If concentration of the object is not determined, then it is possible to use the index of excess of catchability of one fishing gear over another. The value of fish behavior coefficient ω is either set or determined experimentally for compared fishing gear and fishing regions. The behavior coefficients are actually coefficients of fish caution or their reaction on the fishing gear. While determining the comparative catchability coefficient of different modifications of fishing gear of the same type and one object, coefficient ω should be taken as equal to 1.

Comparative tests of 8 types of pots' designs were carried out by TINRO researchers in the Peter the Great Bay. The pots differed in volume, form and size of the frame, form and size of the inlets and openings for fish entrance (Seslavinskii, Scherbakov, 1980; Seslavinskii, Timofeev, 1983; Seslavinskii, 1985; Seslavinskii, Averkov, 1985). Experimental works were carried out from the board of small research vessel on a polygon located in the bay of Ussury. Pots were set in strings of 10. The total catch of the string in one haul during the period of the research lets plan the terms of fisheries for some objects of commercial fisheries. The main objects were flounders, greenlings, gobies. Walleye pollack, navaga, basses, gar and some other fish species entered the pots episodically.

Work on the polygon was performed on depths from 6 to 25 m and also in a cage (dimensions 40x10x10 m) where specific concentration of the object was created. The comparison of catch sizes on the polygon and in the cage allows determination of fisheries objects concentrations' concordance in conditions being compared. If the catch in the cage and on the polygon obtained with pots of similar type differs then it is possible to change the concentration in the cage or set correction factors. The catch is directly proportional to catchability coefficient of a given pot ϕ_i, object's concentration q_1 in the zone being fished S and soak-time t_1. The conditions of work on the polygon and in the cage for examined pot designs and object may be represented by expressions:

on the polygon $N_1 = \phi\ q_1\ S_1\ t_1$, in the cage $N_2 = \phi\ q_2\ S_2\ t_2$,

where N_1 – the catch of pot on the polygon, N_2 – the catch of pot in the cage.

When both the distance between pots and the soak-time are equal on the polygon and in the cage $N_1 = N_2$, and $\phi_1\ q_1 = \phi_2\ q_2$. In the case of inequality of concentrations the ratios are $q_1/\ q_2 = \phi_1/\ \phi_2 = k$ and $N_1 = k\ N_2$, where k – the coefficient of discrepancy of concentration of fish in cage relative to that of the polygon.

Pots were set in strings for work on the polygon, while in the cage they were set on buoy lines keeping the distance between pots equal to 10 m. In order to attract the fish into the pots stationed on the polygon, baits made of minced fish put into mesh sacks were used. Pots which were used for work on the polygon had the following parameters:

- rectangular (Figure 9, a) one entrance with square section (round, cylindrical with circular section) with dimensions 2.0x0.8x0.8 m, V_{tot} 1.28 m^3,
- round, cylindrical three entrances (Figure 9, б), ∅ 1.2 m, height 0.6 m (V_{tot} 0.68 m^3), the length of entrance 0.35, the diameter of entrance from 0.1 to 0.18 m,
- three entrances, truncated cone (Figure 9, в), lower diameter 1.1–0.7 m, higher diameter 0.6–0.5, height 0.54–0.42 m (V_{tot} 0.61–0.31 m^3),
- oval cylindrical, two entrances (Figure 9, г), length 2.0 m, height 0.8 m (V_{tot} 0.88 m^3), round entrance diameter 0.1–0.18 m.

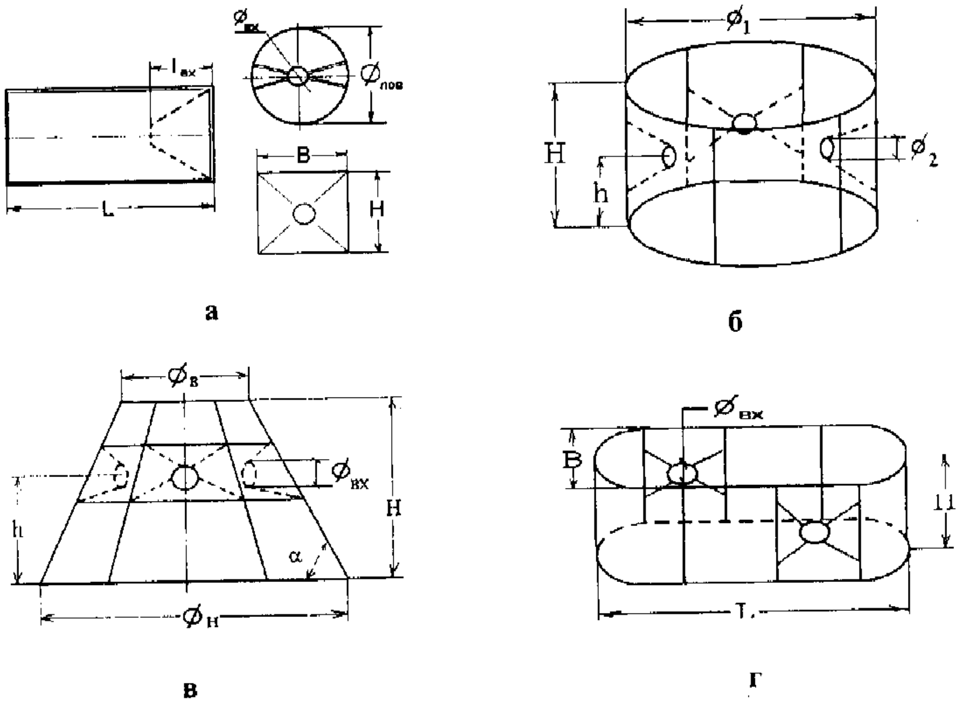


Figure 9. Experimental traps for polygon and cage work: a — rectangular one entrance with square section (round, cylindrical with circular section), б — round, cylindrical three entrances, в — three entrances, truncated cone, г — oval cylindrical, two entrances.

The form of pots which was used to adjust the parameters on the polygon and in the cage covers the range of designs used abroad to capture different fish species. When pot was reduced down to the size at which fish are able to see the whole pot the general recommendations on the sizes of inlets and taper angles for pots (Mel'nikov, 1979) should be defined more precisely. It is recommended that inlets in set traps of big sizes should be made up to several meters wide so that fish will not be scared of the mesh. The fact that fish enter pots through the inlet of size comparable with fish's cross section may be explained due to the attraction by food bait, search of refuge from predators or driven by exploratory instinct.

Inlets in compact pots are made in the form of vertical or horizontal slit or funnel. The main objects of fisheries are bottom fish that perform vertical relocations comparable with the height of the pot. Inlet made as a vertical slit allows catching walleye pollack, greenlings and basses with pot of limited height; horizontal slit is preferable to catch flounders and halibuts as it suits their behavioral preferences at most. Funnel-shaped inlet having the shape of truncated cone is a derivative of the antecedent designs and has bigger holding capacity compared to all other inlet types and is recommended to catch different fish species at long soak-time of the fishing gear. The form and size of the inlet ensuring the entrance of fish into the pot are determined by fish size in maximal section. The behavioral peculiarities of given species while moving through the inlet are also important. The height of the slit in pots with vertical slit inlet is sometimes made equal to the height of the pot. Fish enter compact pots singly so the main parameter of the inlet may be the width of fish's section.

The following fish types may be chosen from the variety of classification systems describing fish body form by conformational and hydrodynamic indices (Soldatov, 1934; Nikol'skii, 1974; Aleev, 1976; Protasov, Starosel'skaya, 1978):

- torpedo-like, with ellipsoid maximum section (mackerel, herring, mullet, sharks), b/h = 0.4–0.7 (b – width, h – height of body in the maximum section);
- deep-bodied – body flattened in the lateral direction (bream, blue bream, sunfish, headfish), b/h = 0.1–0.4;
- flat – body flattened dorsiventrally (rayfish, frogfish, flounders)), h/b = 0.1–0.4;
- eel-like – body elongated, section is close to circle (eels, lampreys, moray-eels), b/h = 0.8-1.0;
- grenadier-like – body section is cone-shaped (grenadiers, scorpionfish), b/h = 0.8–0.9.

The variety of fish species shapes may be expressed through relations taking into account the biometric sizes during the substantiation of form and size of inlets for pots. These relations are defined by a group of researchers (Efanov *et al.*, 1988) for some bottom fish species. The size of the inlet depends on the size of fish in the maximum section.

Depending on the relation $b/L_o = k$, where k – length coefficient, fish are divided into three groups: narrow, medium and wide (Voinikanis-Mirskii, 1966; Umantsev, 1980). It is experimentally established that k 0,10–0,14 for narrow fish. Such include mackerel (k 0.10), herring (k 0.11–0.12), horse mackerel (k 0.14). Medium fish have k 0.15–0.19 (Caspian shad k 0.15; sea-roach k 0.17). For wide fish k 0.20 and more. Such are different flounders (flounders, halibuts).

Size of the opening in inlets of vertical or horizontal slit types is calculated using the height and width in fish's maximal section:

$$P=k1(h\times b),$$

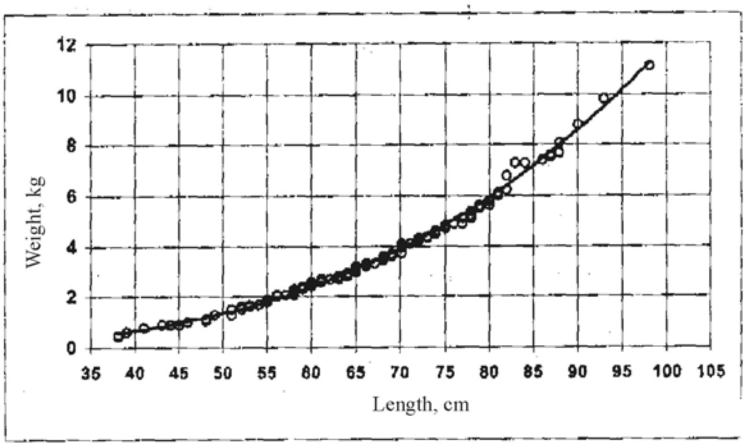
where k_1 – correction factor discounting for fish behavior peculiarities when it enters the pot, b – thickness of body in maximum section. Its value is calculated experimentally. If fish are to enter the pot freely then $k_1> 1$. The results of experiments that would be described later have shown that $k_1> 1.2$ for littoral fish such as walleye pollock, herring, greenling, flounder.

Square- or circle-shaped opening may be used for fish that have commensurable b and h. In this case the size of the opening P or the diameter Ø are chosen according to the biggest size of fish body section and is found from the expression:

$$P, Ø = k_1 h\times h \text{ or } P, Ø = k_1 b\times b.$$

There are certain patterns between fish length, width and mass that we will view using Pacific cod as an example (Figure 10–13). Size of the opening may be chosen taking into account the dominating range of object's length or its maximum size expected. In the latter case an increase of the pot size should be expected. Let's determine the parameters of the opening for 45–70 cm (length range typical for trawl catches) (Novikov, 1974) cod. The calculations will be based on a 70 cm cod that has the following body parameters: weight 4.0 kg, height 15.3 cm, width 8.7 cm and circumference 42.0 cm. To make a vertical slit opening size of the opening should be $P=k_1(15.3x8.7)$ cm. As k_1 is 1.2, the minimum size of a rectangular opening P=19x11 cm. For a funnel-shaped inlet the diameter of the opening would be equal to fish's height, therefore P=0.19. When some parameter of cod's section is missing it can be calculated using another one. Thus, height may calculated using circumference $h= C_M/0.315b$, where C_M – perimeter in maximum circumstances.

Рис. 10. Зависимость массы трески тихоокеанской от длины
Fig. 10. Dependence of mass from length of Pacific cod



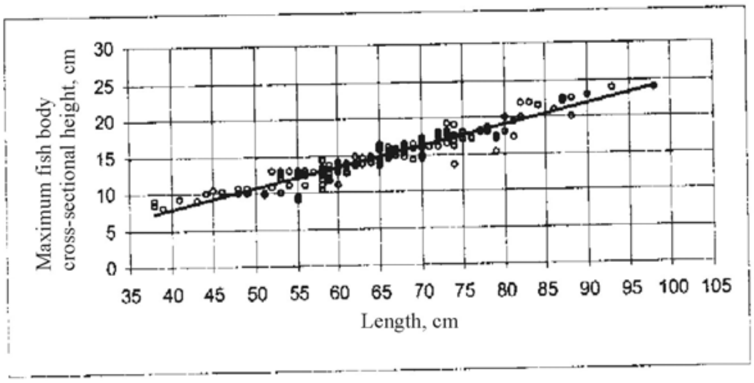


Рис. 11. Зависимость высоты сечения тела трески тихоокеанской от длины
Fig. 11. Dependence of body cross-sectional height from length of Pacific cod

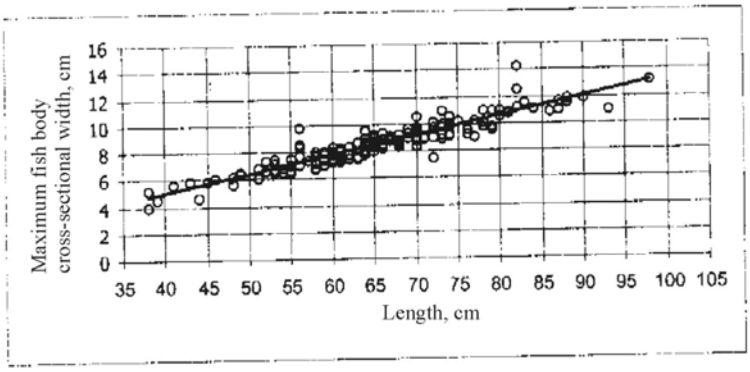


Рис. 12. Зависимость ширины сечения трески тихоокеанской от длины
Fig. 12. Dependence of body cross-sectional width from length of Pacific cod

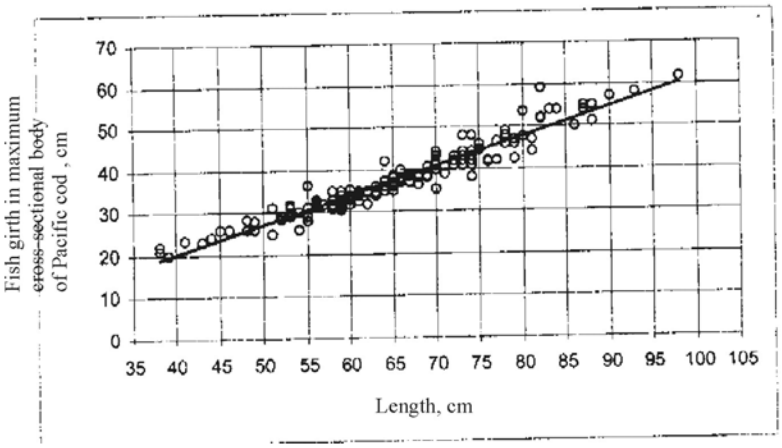


Рис. 13. Зависимость обхвата в максимальном сечении тела трески тихоокеанской от длины
Fig. 13. Dependence of girth in max cross-sectional body of Pacific cod

We will provide conformation relations for some fish species that may be perspective objects of fisheries. Walleye pollock 54 cm long (being an object of trawl fisheries) (Fadeev, 1984), body height in the maximum section is equal to 10 cm, width 5 cm. Therefore rectangular opening for vertical slit inlet would be $P=k_1(h \times b)=12 \times 6$ cm, while circular opening for funnel-type inlet would be P= Ø=12 cm.

Navaga 44 cm long has 9 cm of height and 5 cm width in the maximum section, sizes of the opening are P=11×6= Ø 11 cm.

Average sizes of north bass caught by trawl are 40–60 cm (Novikov, 1974; Polutov *et al.*, 1980). Bass 60 cm long weighs 3.5 kg. This fish is considered as medium in terms of section width, so *k* is 0.19. Therefore $b=L_o k=0.19 \times 60.0$ = 11.4 cm and $h=0.326L_o–0.351$ = 19.2 cm, where L_o – total length of fish. Size of the vertical slit inlet opening will be $P=k_1(h \times b)$ = 14x23 cm, funnel inlet opening 23 cm.

Halibuts are considered as wide fish, the value of k for which is 0.2–0.25. Horizontal slit with sizes $P=kk_1(h \times b)$, where $b= L_0k$ is the most practical form of the inlet for them. Average length of alabato in commercial catches is within the range 40-9 cm (Fadeev, 1984). Alabato 90 cm long has h equal to 8 cm. Body width will be defined using the relation h/b = 0.2, therefore b=40.0. Size of the inlet considering k_1 will be $P=k_1(h \times b)$ or P = 10x48 cm.

Black halibut average length is 45–80 cm in catches. Black halibut of 80 cm length has $b=L_0k=80.0 \times 0.2=16.0$ cm. Body height in the maximum section will be determined from the relation characteristic for broad fish species, $h = b(0.1–0.4) = 16.0 \times 0.4 = 6.4$ cm. As the biological coefficient k_1 is 1.1 the size of the horizontal slit inlet will be $P=k_1(h \times b)$ or P = 8x19 cm.

Horizontal slit inlet parameters for 45–80 cm long arrow-toothed halibut would be calculated similar to the ones of black halibut. Size of the opening would be the same P = 8x19 cm.

Of all fish present in the pot's zone of action, ones approaching it in the AOB taper angle sector will enter the pot with higher probability (Figure 20).

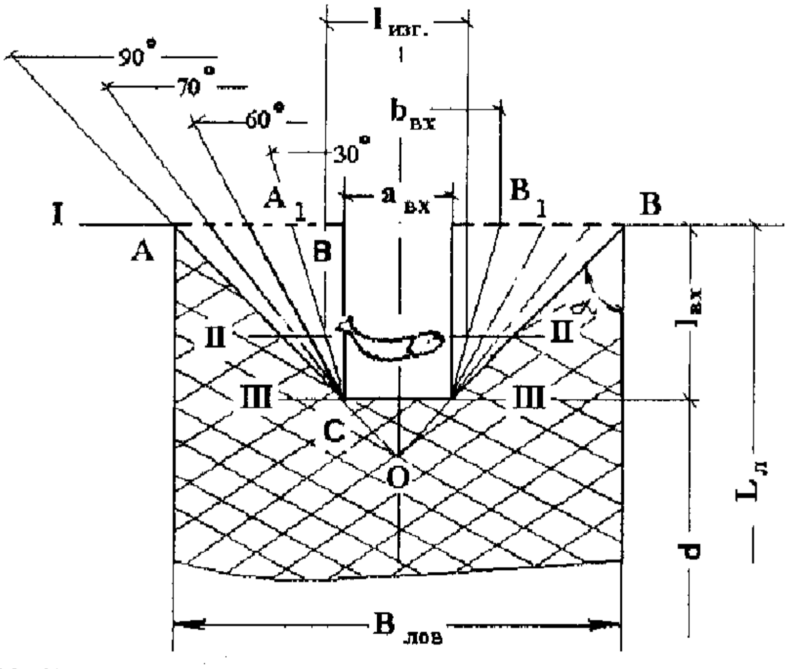


Рис. 20. Параметры входного устройства ловушки
Fig. 20. Inlet's parameters of the trap

Horizontal slit type inlets that possess the angle of approach AOB have a higher probability of fish entering them than for such equipped with a vertical limited by the rectangular section. Not all fish that pass through the I-I section will enter the pot as there is critical section II-II in which it may turn back. The size of the critical section l_{cr} $(l_{изг})=k_2L_M$ where k_2 is the coefficient of turning ability (Protasov, Starosel'skaya, 1978), characteristic for given fish species. Fish that passes the critical section will enter the pot. The enlargement of inlet's taper angle from A_1OB_1 to AOB brings section II-II closer to section III-III in which fish is caught by the pot, but at the same the probability of fish's turn and escape from the pot also increases. Apparently, higher probability of capture will be observed in the vertical slit type inlet when $l_{cr}=a_{inlet}(a_{вх})$ but in this case fish approach front decreases. Inlet form selection is always a logical solution that is tested in practice afterwards. It should be noted also that value of k_1

equal to 0.12 was taken based on the experimental works on the polygon i.e. for littoral objects; therefore it is needed to define this parameter more precisely in experimental conditions for deep-water fish that have larger sizes.

Thoughts on inlet type selection will be continued by pot form substantiation. After fish enters the pot its movement in the limited space, for example in the volume of a rectangular pot will represent trajectory shown in Figure 21 by continuous line. The smaller the pot, the higher the probability that fish will move not along a circular trajectory but along a jogged one that will create possibility to escape from the pot. Pot size increase favors smooth movement of fish along a trajectory shown by a dotted line (Figure 21). Minimum size providing smooth fish movement may be achieved using pot of straight circular cylinder form. These thoughts were confirmed during observation of walleye pollock, herring and greenling movement in cage conditions.

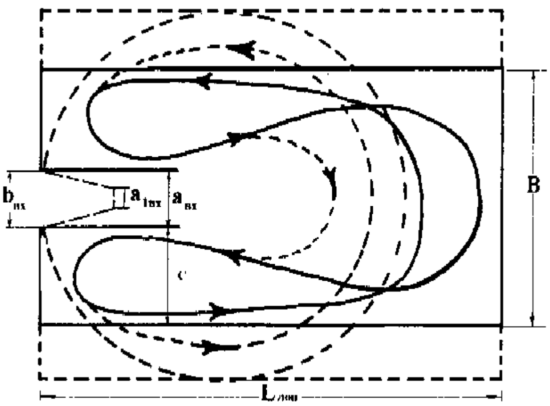


Рис. 21. Характер движения рыбы в ловушке
Fig. 21. Method of moving the fish in the trap

The form of the pot, type, number and sizes of inlets are interrelated and determined using formulae (Figures 20, 21):

$$B_{pot}\,(B_{л}) = a_{inlet}\,(a_{вх}) + 2l_{inlet}tg\alpha,\ H_{pot} \text{ is set } L_{pot}=l_{inlet}(l_{вх})+d,\ V_{pot}=BHL,$$

where B_{pot} – width, m; L_{pot} – length, m; H_{pot} – height; V_{pot} – volume of the pot, m^3; $a_{inlet}(a_{вх})$ – width of the inlet, $a_{inlet}(a_{вх})=k_1b_p$, m; $l_{inlet}(l_{вх})$ – length of the inlet, m; α – inlet's taper angle, degrees; d – the distance between inlets, m.

The values of width and height of fish section b_p, h_p are taken from relations presented in figures 10–13. On the basis of underwater observations of fish behavior in cage conditions $d=1.5\ L_p$, $l_{вх} = L_p$. Considering these conceptions on fish behavior in pot's zone of action

$$B_{л} = k1bp + 2Lptg\alpha \qquad (2)$$

where k_1 – fish behavior coefficient, equal to 1,2; b_p – fish section width, m; L_p – fish length, m.

Length of the pot depends on the number of inlets, in case of one inlet

$$L_{л}=l_{вх}+d \qquad (3)$$

if there are two inlets in a rectangular pot or several pots in a circular cylindrical pot

$$L_{л}=2l_{вх}+d \qquad (4)$$

Value of the taper angle is set within 30–45°. Based on the experimental data obtained on the polygon and considering the world experience the height of the pot is taken as equal to 0.8 m.

Let's compare the sizes of pots and inlet openings calculated using fish biometric sizes with those used in world fisheries practice on the example of cod (Table 5).

Table 5. Traps parameters for researching target of fishing.

Target species	Type of pot	Commercial parameters				Calculated parameters				
		N	LxBxH	V	bxh	α	N	LxBxH	V	bxh
Cod	Rectangular	1, 2S	1.15x0.54x0.37	0.23	0.15x0.20	30	1	2.00x1.06x0.8	1.70	0.11x0.19
			2.00x0.75x0.75	1.12	0.06x0.15		2	2.80x1.74x0.8	2.37	
			2.45x0.84x0.84	1.73		45	1	2.00x1.74x0.8	2.78	
							2	2.80x1.74x0.8	3.90	
	Round cylindrical	4	∅2–4, H 0.8–1.0 ∅3, H 0.8	5.6	0.06x0.15			∅2.8, H 0.8	4.92	

N – number of inlets, S – in series situated inlets

The influence of pot parameters' fluctuations on the value of littoral fish species (flounders, greenlings, walleye pollock, basses, ruffes, navaga and others) catch founded in the result of works carried out on the polygon.

1) For rectangular pots catches depend on the volumes Q = = f(V) or $Q_1/Q_2/Q_3$= f($V_1/V_2/V_3$) are in the following relation 1.00/0.67/0.19 = 1.00/0.45/0.17, i.e. catch grows slower than the volume of pot with increasing pot volume (Figure 22).

2) Catches of fish with fusiform bodies (greenling, lenok and ruff for example) relative of the diameter of the opening are Q = f(Ø) or $Q_1/Q_2/Q_,/Q_4$ = f($Ø_1/Ø_2/Ø_3/Ø_4$) and are in the following relation, 1.00/0.84/ 0.79/0.66 = 1.0/1.2/1.5/1.8 correspondingly, i.e. catches decrease with increasing size of the opening (Figure 23).

3) Present relations between the size of the opening and fish cross section were found changing the size of the opening from 0.10 to 0.18 m. When one of fish sizes is equal to the size of the opening, the latter is thought of as equal to one. Experiments have shown that diameter of the opening is related to fish cross section in the following way 0.10 to 0.89%, 0.12 to 0.81, 0.15 to 0.58, 0.18 to 0.55% (Figure 24).

4) When length of the inlets is changed from 0.1 to 0.7 m the number of fish caught in the pot also increases. Elongation of the inlet provides a 45% increase of the catch. Influence of different types of inlets on catch size was studied using rectangular pots. Higher catches were obtained with pots that have funnel-like inlet with a round opening, then funnel with square opening and vertical slits 120 mm wide and 310–610 mm high (Figure 26).

5) Relative catch depending on the soak-time for all tested pot designs was: 24 h soak-time – 100%, 12 h – 64%, i.e. if the pots will be hauled every 12 hours, the expected catch in 48 h may be increased by 1.56 times (Figure 27).

6) Increase of the inlet's taper angle from 30 to 90° needed in order to catch bottom fish species forming low-density aggregations is accompanied by a 60% drop of catches which may be explained by solitary fish behavior peculiarities (Figure 28).

The catch in 24 h soak-time for studied pot designs constituted (in decreasing order):

- straight round cylinder – 4.8 kg/day (Ø 1.2 m, H 0.6 m, V 0.6 m^3, three funnel-like inlets, P= Ø 0.12 m);
- oval straight round cylinder – 3.6 kg/day (L 1.6 m, H 0.6 м, V 0.6 м^3, three funnel-like inlets, P= Ø 0.15 m);
- truncated straight round cone – 2.9 kg/day ($Ø_Н$ – 1.1 m, $Ø_В$ – 0.7 m, H 0,6 m, V 0,61 m^3, three funnel-like inlets, P= Ø 0.12–0.15 m);
- parallelepiped – 2.1 kg/day (L 1.6 м, H 0.6 м, V 0.6 м^3, one funnel-like inlet, P= Ø 0.15 m);
- truncated pyramid – 1.5 kg/day (L 1.6 м, H 0.7 м, V 0.47 м^3, λ 2.15, one inlet P= Ø 0.15 m).

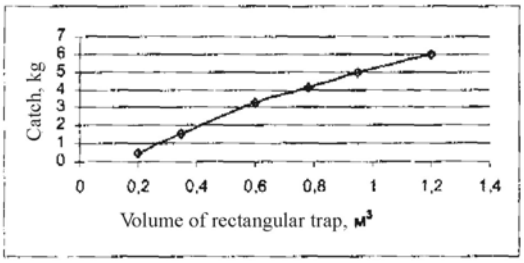


Рис. 22. Зависимость уловов прямоугольной ловушки от объема

Fig. 22. Dependence of catch from the volume of rectangular trap

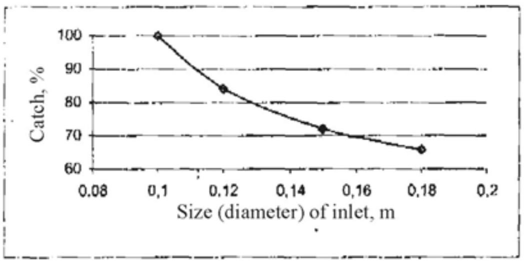


Рис. 23. Зависимость улова от размера входного отверстия ловушки

Fig. 23. Dependence of catch from the size of inlet

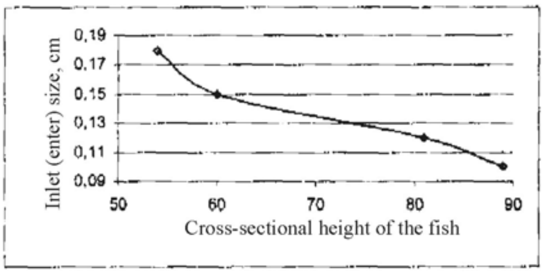


Рис. 24. Зависимость размера входа ловушки от сечения рыбы

Fig. 24. Dependence of enter size from cross-sectional height of the fish

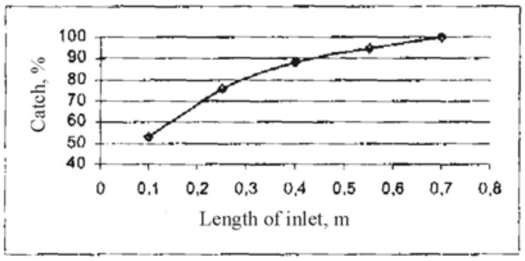


Рис. 25. Зависимость улова от длины входного устройства ловушки

Fig. 25. Dependence of catch from the length of inlet

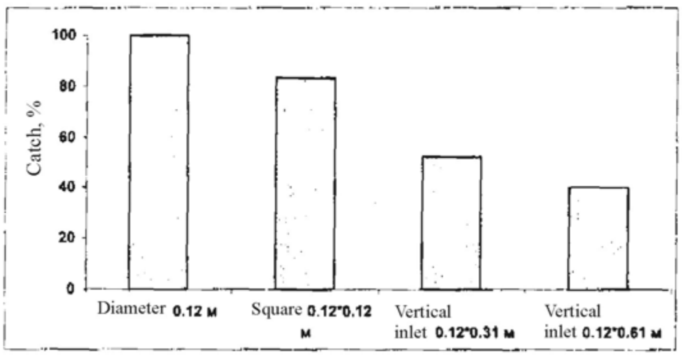


Рис. 26. Влияние формы и размера входного отверстия ловушки на величину улова

Fig. 26. Impact of the form and size of inlet for catch quantity

Рис. 27. Зависимость улова от длительности застоя ловушек
Fig. 27. Catch dependence of traps standstill durations

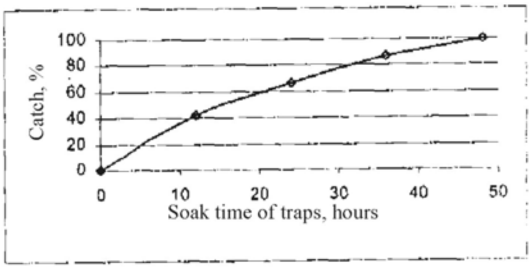
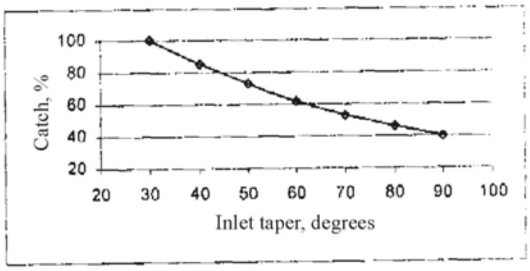


Рис. 28. Зависимость улова от угла конусности входного устройства ловушки
Fig. 28. Inlet's taper angle impact to catch quantity



We need to know the fishing gear's soak-time in order to determine the catchability coefficient. Unknown parameters such the object's concentration and fishing gear's zone of action area may be determined in a cage of specified sizes. During the haul of the pots the catch was taken, while the number of fish in the cage remained constant in order to maintain fish concentration equal to 0.03 ind/m^2 (Seslavinski, Timofeev, 1982). Results of the experiments are given in table 6. The impact of object's concentration on the catch size and the value of catchability coefficient may be determined only in a cage, as the pot's zone of action may be set by the size of the cage. Described method of catchability coefficient determination needs to be tested further especially in the part of determination of concentration impact on catch size and definition of pots' zone of action.

Table 6. Fishing pots parameters

Traps' shape	V_{common}, m^3	V_w, m^3	λ	φ	Ranking on catching	
					proving ground	cage
Round cylindrical	0.61	0.49	0.50	0.06	1	2
Oval cylindrical	0.61	0.53	0.32	0.05	2	1
Truncated cone	0.47	0.42	0.31	0.04	3	4
Rectangle	0.58	0.52	2.15	0.02	4	4
Truncated pyramid	0.61	0.55	2.15	0.04	3	5
Stright circular cone	0.60	0.25	2.28	0.03	6	5

Note. V_{common} — the traps' common volume; V_w — the traps' common volume without volume of inlets; λ — the ratio of trap base to height; φ — catchability coefficient of the trap.

If fish that have not reached the commercial size are to escape from rigid frame pot it is needed to utilize mesh with selective size for object's commercial size while the coefficient of mesh fitting is to be determined taking into consideration the studied fish species' conformation. Mesh size 21–38 mm should be used for selective fisheries of most fish species. In order to test the impact of different mesh fitting on species and size composition of the catch in the coastal area of Peter the Great Bay, round and oval cylindrical pots were used. Pots' volume was 0.6 m^3, there were three funnel-type inlets diameter of the inlet's entrance was 0.18 m, mesh size of 20, 24, 30 and 40 mm were used. Pots were hauled in May-July from the board of small fishing vessel. Catch's species- and size composition was analyzed. The main objects in this period were flounders, greenlings, walleye pollock and gobies (Figure 29), cod, yellow and brown bass, eelpout, ruff, navaga, hairy crab and giant octopus were in the bycatch. Flounders, greenlings and gobies are migrating objects that is why the changes in catches in the studied period characterize the dynamics of objects' migration. Gobies are not considered as valuable commercial fisheries objects. Flounders being the food objects for gobies attract the latter and provoke them to enter the pot. May was the most favorable period of fisheries considering the migrations of studied fish species when gobies are scarce in the catch. Maximum numbers of gobies are observed in the middle of July when flounder fisheries are complicated.

Рис. 29. Зависимость величины улова от сроков промысла
Fig. 29. Dependence of catch quantity from craft terms

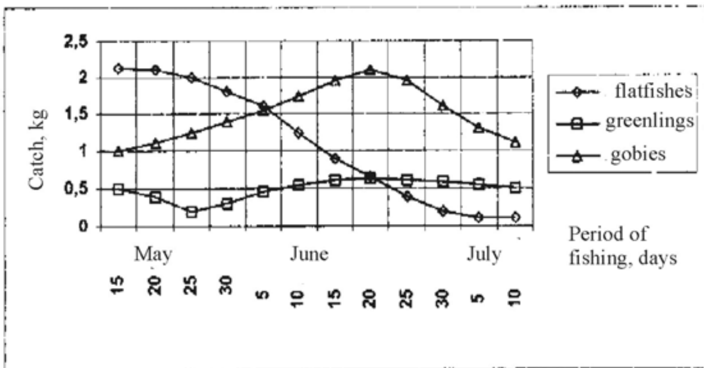
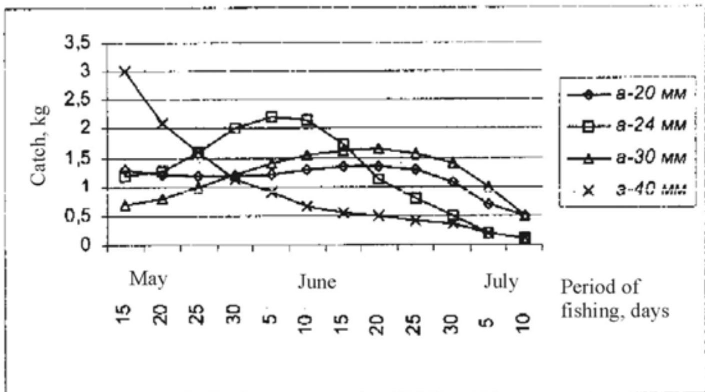


Рис. 30. Зависимость величины улова от сроков лова и шага ячеи дели рыболовных ловушек
Fig. 30. Dependence of catch quantity from catching terms and deli range of fishing traps



The impact of mesh pitch on catches of main commercial fisheries' objects over the studied period is represented on Figure 30. In the initial period of fisheries maximum catches were obtained using pots with 40 mm mesh size and then pots with 24 mm mesh size and the end of the trial with 30 mm mesh size. Such changes in catches are explained by the changes in catch composition caused by withdrawal of flounders.

Let's consider the size selectivity of fisheries for flounders, greenling and walleye pollock. Sizes of studied fish species are 16–70 cm (Figure 30), that is why it is necessary to choose the dominating object of fisheries or studies to achieve selective fisheries. The main objects of fisheries in spring are several species of flounders, coming to spawn. Accompanying species – greenlings and walleye pollock that have fusiform body and fit to the classic variant of mesh fitting with U_x=0.56-0.59. Due to the fact that flounders have flat body, mesh fitting should have U_x=0.96–0.99 in order to determine the pot's size selectivity.

Size spectrum of flounders falls within the range 10–34 cm, while the main mass (up to 80%) – in the range 28–34 cm (Figure 32). By-catch of individuals of non-commercial sizes makes 10% which is slightly higher than allowed according to the Regulations of fisheries. During multi-species fisheries the most suitable solution of size selectivity of flounders for pots with rigid frame is to add an opening through which fish may escape with size corresponding the fish's commercial size. In order to achieve needed size selectivity for fish with fusiform body the filtering mesh pitch for commercial size of the studied object should be set with U_x=0.56–0.59.

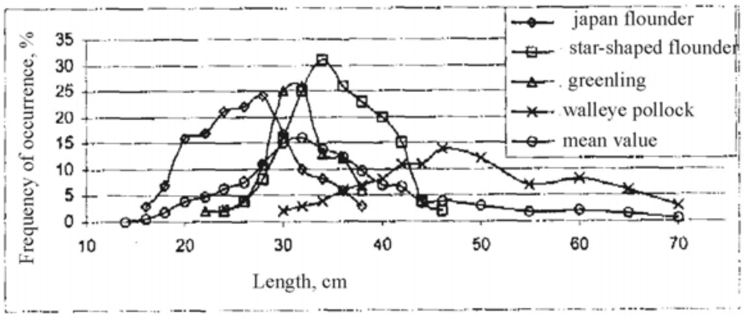


Рис. 31. Размерный состав уловов рыб в ловушках с шагом ячеи 20 мм
Fig. 31. Size structures of traps catching with 20 mm cell step

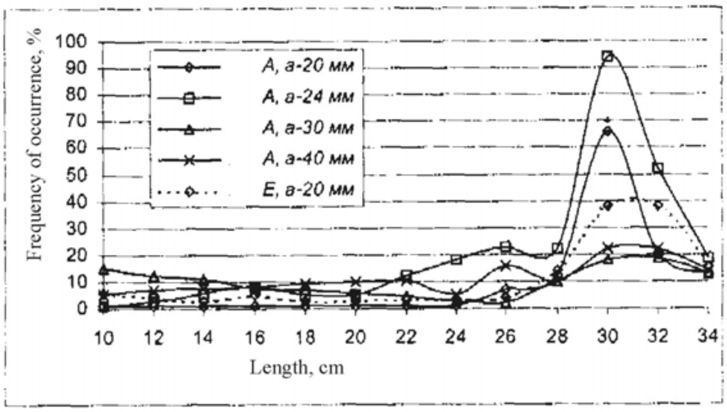
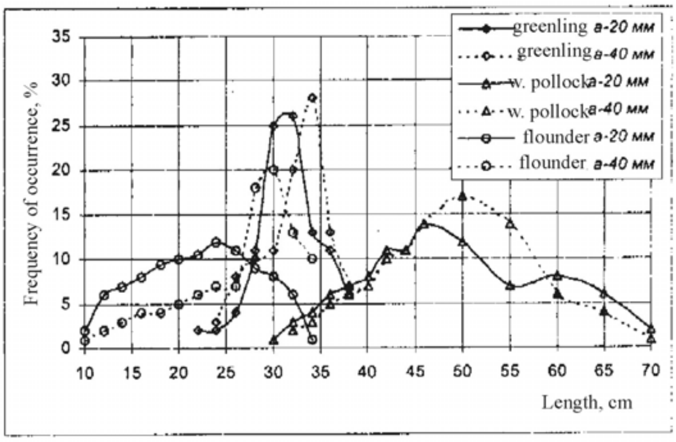


Рис. 32. Размерный состав камбал в круглых (тип А) и овальных цилиндрических ловушках (тип Е), обшитых делью с шагом ячеи 20–40 мм
Fig. 32. Size structures of flounder in circular (A type) and oval cylindrical (E type) with deli sew round and cell step a 20–40 mm

The increase of mesh size from 20 to 40 mm (Figure 33) leads to modal value shift on to larger sizes of studied objects and lets fulfill the requirements of the Regulations of fisheries on bycatch of non-commercial greenlings and walleye pollock.

Experimental trials using round cylindrical pots in order to define the influence of fisheries' parameters and pot's construction on catch size were carried out in the coastal zone of southern Kuril Islands from the board of middle fisheries vessel (Figure 34). It was determined that the increase of pots setting depth leads to an increase of the catch (Markin, 1981). Maximum catches were obtained when soak time was 2–3 days. Longer soak time leads to a decrease of the catch which may be explained by reduced attracting features of the bait and escape of fish from the pot. The increase the number of inlets from one to four leads to 2.8-times increase of the catch for pot with volume 2.5–12.5 м^3. The catch of pots with three, two or one inlet with 3 days soak-time constituted 83, 44 и 28% of the catch of pots equipped with four inlets, correspondingly.

Рис. 33. Влияние шага ячеи дели ловушек на размеры рыб в уловах
Fig. 33. Deli range impact to fish sizes



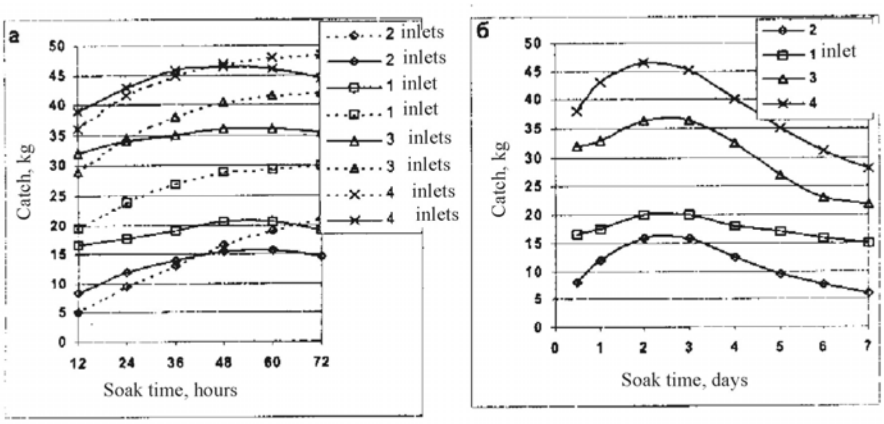


Рис. 34. Зависимость улова: **а** — от количества входных устройств (пунктир — гибкий, сплошная линия — складной каркас), **б** — от длительности застоя ловушек (Маркин, 1981)
Fig. 34. Dependence of catch: **a** — from numbers of inlets (dotted line — flexible, solid line — folding frame), **б** — traps standstill durations (Маркин, 1981)

The effectiveness of fisheries depends on the number of pots hauled in a day; therefore the size of the pot is a fundamental parameter. Pots with rigid frame are simpler technologically in production and guarantee working shape in the process of fisheries but take a lot of space on the deck. Pot size may be decreased if folding or flexible frames are used. Folding frame consists of upper and lower bases of round, rectangular or oval shape connected by vertical stands. During the movement of vessel to the site of fisheries and long-term warehousing stands are taken off the pots. Before the pots are set, they are assembled into working condition stands inserting into directing hubs welded on corner plates in the corners of the bases and fixated by two splint pins.

Pot designs with flexible frame consisting of upper and lower bases having the shape of a ring are considered as perspective fishing gear. Rigid base ensures the pot's shape, while mesh equipped with inlets and floating creates an accumulating volume for fish. Such pots gain their working shape on the bottom thanks to weighted lower base and ring-like polymer tube that has positive buoyancy. Such pots were used in the experimental trials. A total of 200 flexible pots were placed on the vessel with the following dimensions of the working deck – 2.5x3.0 m.

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