

EIFAC CONSULTATION ON EEL FISHING GEAR AND TECHNIQUES,
HAMBURG, Federal Republic of Germany, 10-17 October 1970

CONSULTATION DE LA CECPI SUR LES ENGINS ET TECHNIQUES DE PECHE A
L'ANGUILLE, Hambourg, République. fédérale d'Allemagne, 10-17 octobre 1970

edited by/sous la direction de

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET
L'AGRICULTURE
Rome, 1971

PREPARATION OF THIS DOCUMENT

The present study includes the papers submitted to the EIFAC Consultation on Eel Fishing Gear and Techniques, held in Hamburg, Federal Republic of Germany, 10–17 October 1970, which are reproduced in their original language. However, the “Foreword” and “Report of the Consultation” have been prepared in both English and French, the official working languages of the Commission.

PREPARATION DE CE DOCUMENT

Les documents formant oette étude ont été soumis à la Consultation de la CECPI sur les engins et techniques de pêche à l'anguille, Hambourg, République fédérale d'Allemagne, 10–17 octobre 1970. Dans oette étude, les documents sont présentés dans la langue dans laquelle ils ont été soumis à la Consultation. Cependant, l'“Avant-Propos” et le “Rapport de la Consultation” ont été préparés dans les deux langues de la Commission.

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* These documents were submitted to the EIFAC Fifth Session as working papers FI/EIFAC 68/SC I-3 and FI/EIFAC 68/SC I-4

FOREWORD

In the discharge of its primary objectives, which are to promote improvements in inland fisheries and to advise Member Governments and FAO on inland fishery matters and, specifically, in the exercise of one of its functions, i.e., to assist in the collection and dissemination of pertinent information, the European Inland Fisheries Advisory Commission (EIFAC) at the request of Ireland (FI/EIFAC 68/SC I-7) introduced the agenda item Biology and Management of Eels at the Fifth Session (Rome, May 1968). Questions of international cooperation in this subject were discussed at length by an ad hoc Working Party of Sub-Commission I. On its advice the Commission recommended:

Recommendation 68/6 - that Member Countries directly interested in this topic give consideration to the holding of a meeting of appropriate experts to pursue the eel study.

At the Sixth Session of EIFAC (Krakow, Poland, May 1970) following the review of Dr. Deelder's (Netherlands), "Synopsis of Biological Data on the Eel" which was presented to EIFAC Sixth Session (Krakow, Poland, May 1970) and in agreement with Recommendation 68/6, the Commission recommended:

Recommendation 70/5 - that a consultation be organized on eel fishing gear and techniques at Hamburg in October 1970 to be followed by a report on this topic. Mr. C.J. McGrath (Ireland) has been designated Convener for this Consultation.

The meeting was convened on 10–17 October 1970 by Mr. C.J. McGrath (Ireland) at Bundesforschungsanstalt für Fischerei, Hamburg, Federal Republic of Germany, at the kind invitation of its Präsidierender Direktor Professor Dr. K. Tiews. Professor Dr. A. v. Brandt, Direktor at the Institut für Fangtechnik of the Bundesforschungsanstalt für Fischerei, kindly consented to act as Host and Local Organizer.

REPORT OF THE CONSULTATION

(Hamburg, Federal Republic of Germany, 10–17 October 1970)

by

C.J. McGrath (Convener)

Department of Agriculture and Fisheries, Fisheries Division, Dublin, Ireland

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1. OBJECTIVES AND ORGANIZATION OF THE CONSULTATION

At its Sixth Session (Krakow, Poland, May 1970), the European Inland Fisheries Advisory Commission (EIFAC) endorsed the recommendation of Sub-Commission I at the Fifth Session (Rome, Italy, May 1968) for “a meeting of appropriate experts to pursue the eel study” and directed “that a consultation be organized on eel fishing gear and techniques at Hamburg in October 1970 to be followed by a report on the topic”.

In accordance with this decision, the meeting of interested experts took place in the Bundesforschungsanstalt für Fischerei, Hamburg, Federal Republic of Germany from 10–17 October 1970 by courtesy of the Government of the Federal Republic of Germany. The following countries were represented:

Denmark
Federal Republic of Germany
Hungary
Ireland
Italy
Netherlands
Sweden
United Kingdom

Mr. J.L. Gaudet, Assistant-Secretary to EIFAC, represented the Commission. There were two observers from Canada. The List of Participants is given in Appendix 27.

Technical papers were also submitted by Greece and Poland which were not represented at the consultation. Two papers submitted at the Fifth Session of EIFAC were also reviewed.

At the invitation of EIFAC, Mr. C.J. McGrath (Ireland) acted as Convener for the Consultation and Professor Dr. A. v. Brandt (Federal Republic of Germany) kindly agreed to act as Host and Local Organizer.

At the invitation of the Convener, Mr. C.I.D. Moriarty (Ireland) and Mr. D. O'Leary (Ireland) consented to act as Rapporteurs for the Consultation.

The Consultation was opened with an address of welcome by Professor Dr. K. Tiews, Präsidierender Direktor der Bundesforschungsanstalt für Fischerei. See Appendix 1.

The Consultation consisted of two and a half days of formal discussion. Each paper was presented by the author or his representative and illustrated in some cases by the projection of a film or slides. In the absence of the author or his representative, the paper was presented on his behalf by the Convener. To each paper is appended the salient points of the discussion on it. The papers are given in Appendixes 3 to 25.

Study tours of eel fishing operations took place on 14, 15 and 16 October 1970. In the course of these, the (Appendix 26) experts observed practical demonstrations of various kinds of eel fishing techniques. They also had the opportunity of discussing the gear and fishing techniques with the operators who very kindly made themselves available for this purpose and cooperated wholeheartedly.

2. CONCLUSIONS AND RECOMMENDATIONS

The final meeting took place in the Bundesforschungsanstalt für Fischerei on 17 October. Various matters discussed in the course of the formal Consultation and during the study tours were reviewed and the following conclusions and recommendations were put forward for consideration by the Commission at its Seventh Session. These were:

Recommendation No. 1

As the papers presented at the Consultation comprise a valuable source of practical information about eel fishing gear and techniques, it was recommended that these, together with a summary of the salient points of the discussion on each, should be incorporated in the Report of the Consultation which should be published as soon as practicable after the Consultation and distributed to diffuse more widely the information available. Thereafter this document should be presented officially at the Seventh Session of EIFAC in 1972.

Recommendation No. 2

That in due course at an appropriate time a further Consultation of experts be convened to consider the following aspects of the subject, which were not discussed during the Consultation due to lack of time. These are:

- (a) The food of eels
- (b) Intensive pond culture of eels with supplemental feeding with or without artificially heated water supply
- (c) Eel processing
- (d) Eel storage
- (e) Long distance transport of eels by sea and by land
- (f) Eel population studies

Recommendation No. 3

The delegates concluded from their discussions that there is urgent need for basic research into the reaction of eels to certain stimuli such as abrupt changes in water velocity, vibration and sound. In the interest of further development in eel fishing gear they recommend that Governments encourage research on these subjects.

Recommendation No. 4

The delegates noted with concern the evidence of declining eel catches due to over-exploitation of yellow eel stocks as practised in certain situations such as inshore fisheries which are open to the public, where no direct responsibility rests on those exploiting the eel stocks. To safeguard them against over-exploitation it recommended that Governments consider urgently the necessity of introducing and enforcing

regulations and to limit the catch of eels to the maximum sustainable level in the interests of the fishermen, themselves, and to prevent the collapse of the fishery.

Recommendation No. 5

The delegates noted with great interest the Hungarian report on recent developments of eel fisheries in that country which followed massive stocking with elvers of large areas of inland water barren of eels in the past and recommend that the opportunity these afforded to study the age of eels be availed of.

3. ACKNOWLEDGEMENTS

The participants in the Consultation requested that appreciation and thanks to all who made the Consultation possible and contributed to its success be recorded.

To the Government of the Federal Republic of Germany for the invitation extended to hold this meeting in Hamburg and for making the study tours possible.

To the Präsidierender Direktor of the Bundesforschungsanstalt für Fischerei, Professor Dr. K. Tiews, for kindly making the Conference Halls available and for providing the facilities necessary to mount the extensive display of eel fishing gear which had been arranged in conjunction with the Consultation and formed a very important adjunct to it.

To Professor Dr. A.v. Brandt, Direktor at the Institut für Fangtechnik of the Bundesforschungsanstalt für Fischerei, for the excellent manner in which all arrangements were made, both for the meeting and the study tours and for the generous manner he made himself and his staff available to ensure the success of the Consultation.

To the following eel fishery owners who welcomed the delegates to their establishments and have been unsparing in their time and efforts to ensure that the maximum benefit would be derived by the delegates from the inspection of their facilities.

Mr. W. Dobberschütz
Nienburg/Weser
Weserwall 14

Mr. Brauer
Landesbergen/Weser

Mr. Schweer
Fa. Schweer and Kuckuck
Steinhude am Meer

Mr. Willy Wichmann
Heiligenhafen
Danziger Strasse 14

Mr. Wilcken
Plön/Holstein

To the fishing gear manufacturers and eel fishery owners who supplied the eel fishing gear on display in the Conference Hall. A detailed list of Exhibitors is attached as Appendix 28, and, finally,

to the Rapporteurs for the Consultation - Mr. C.I.D. Moriarty and Mr. D. O'Leary.

AVANT-PROPOS

En s'efforçant d'atteindre ses objectifs essentiels, qui sont de promouvoir l'amélioration des pêches continentales et de conseiller les gouvernements des Etats Membres et la FAO dans les domaines qui s'y rapportent et, tout particulièrement dans l'exercice de l'une de ses fonctions - concourir au rassemblement et à la diffusion de renseignements pertinents - la Commission européenne consultative pour les pêches dans les eaux intérieures (CECPI), à la demande de l'Irlande (FI/EIFAC 68/SC I-7) a inscrit à l'ordre du jour de sa Cinquième Session (Rome, mai 1968) le sujet Biologie et exploitation des anguilles. Les problèmes de coopération internationale à ce sujet ont été discutés en détail par un groupe de travail ad hoc de la Sous-Commission I. Sur l'avis de ce groupe de travail, la Commission a adopté la recommandation suivante:

Recommandation 68/6 - que les pays membres directement intéressés à ce sujet considèrent la possibilité de la réunion d'un groupe d'expert, afin de poursuivre l'étude de l'anguille.

A la Sixième Session de la CECPI (Cracovie, Pologne, mai 1970), après examen du document de M. Deelder (Pays-Bas) soumis à cette Session "Etude synoptique de données biologiques sur l'anguille", et conformément à la Recommandation 68/6, la Commission a adopté ce qui suit:

Recommandation 70/5 - qu'une consultation soit organisée sur les engins et techniques de pêche à l'anguille, à Hambourg, en octobre 1970, suivie d'un rapport. Monsieur C.J. McGrath (Irlande) a été désigné comme organisateur de cette consultation.

La réunion a été convoquée du 10 au 17 octobre 1970 par M. C.J. McGrath (Irlande) au Bundesforschungsanstalt für Fischerei, Hambourg (République fédérale d'Allemagne), sur l'aimable invitation de son Président directeur, le Professeur Dr. K. Tiews. Le Professeur Dr. A. v. Brandt, Directeur de l'Institut für Fangtechnik du Bundesforschungsanstalt für Fischerei a bien voulu remplir les fonctions d'hôte et d'organisateur local.

RAPPORT DE LA CONSULTATION

(Hambourg, République fédérale d'Allemagne, 10–17 octobre 1970)

par

C.J. McGrath (Organisateur)

Ministère de l'Agriculture et des pêches, Division des pêcheries, Dublin, Irlande

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1. OBJECTIFS ET ORGANISATION DE LA CONSULTATION	

A sa Sixième Session (Cracovie, Pologne, mai 1970), la Commission européenne consultative pour les pêches dans les eaux intérieures (CECPI) a fait sienne la recommandation formulée par la Sous-Commission I à la Cinquième Session (Rome, Italie, mai 1968) concernant "la réunion d'un groupe d'experts afin de poursuivre l'étude de l'anguille" et elle a recommandé "qu'une consultation soit organisée sur les engins et techniques de pêche à l'anguille, à Hambourg, en octobre 1970, suivie d'un rapport".

Conformément à cette décision, la réunion des experts intéressés a eu lieu au Bundesforschungsanstalt für Fischerei, Hambourg (République fédérale d'Allemagne), du 10 au 17 octobre 1970, sur l'invitation du Gouvernement de la République fédérale d'Allemagne. Les pays suivants étaient représentés:

Danemark
Hongrie
Irlande
Italie
Pays-Bas
République fédérale d'Allemagne
Royaume-Uni
Suède

M. J.-L. Gaudet, Secrétaire adjoint de la CECPI, représentait la Commission. Le Canada avait envoyé deux observateurs. On trouvera à l'Annexe 27 la liste des participants à cette réunion.

Des documents techniques ont également été soumis par la Grèce et la Pologne, qui n'étaient pas représentées à la Consultation. Deux documents soumis à la Cinquième Session de la CECPI ont aussi été examinés.

Sur l'invitation de la CECPI, M. C.J. McGrath (Irlande) a assumé les fonctions d'organisateur de la Consultation et le Professeur Dr. A. v.Brandt (République fédérale d'Allemagne) a aimablement accepté d'agir en qualité d'hôte et d'organisateur local.

Sur invitation de l'Organisateur, MM. C.I.D. Moriarty et D. O'Leary (Irlande) ont accepté d'être rapporteurs de la Consultation.

Le Professeur Dr. K. Tiews, Bundesforschungsanstalt für Fischerei, a ouvert la Consultation en prononçant une allocution, dont le texte est reproduit à l'Annexe 1.

La Consultation a pris la forme de discussions formelles qui ont duré deux jours et demi. Chaque document était présenté par son auteur ou son représentant et illustré dans certains cas par la projection d'un film ou de diapositives. En l'absence de l'auteur ou de son représentant, le document était présenté en son nom par l'Organisateur. On a joint à chaque document le résumé des principaux points soulevés lors des discussions qui lui ont été consacrées. On trouvera ces documents dans les Annexes 3 à 25.

Des excursions sur les opérations de pêche à l'anguille ont eu lieu les 14, 15 et 16 octobre 1970. Au cours de celles-ci, les experts ont observé de démonstrations pratiques de diverses techniques de pêche à l'anguille (Annexe 26). Ils ont aussi eu la possibilité d'étudier les engins et les techniques de pêche avec les pêcheurs eux-mêmes qui ont coopéré sans réserve avec les participants.

2. CONCLUSIONS ET RECOMMANDATIONS

La séance de clôture a eu lieu le 17 octobre au Bundesforschungsanstalt für Fischerei. Diverses questions débattues au cours de la Consultation et pendant les excursions ont été passées en revue et les conclusions et recommandations ci-après ont été proposées aux fins d'examen de la Commission à sa Septième Session:

Recommandation No. 1

Les documents présentés à la Consultation constituant une source utile de renseignements pratiques sur les engins et les techniques de pêche à l'anguille, il a été recommandé que ces documents, ainsi qu'un sommaire des points saillants de la discussion qui a porté sur chacun d'eux, soient incorporés au rapport de la Consultation qu'il conviendrait de publier dès que possible après celle-ci et de distribuer de manière que les renseignements disponibles bénéficient d'une plus large diffusion. Par la suite, le rapport sera soumis officiellement à la Septième Session de la CECPI en 1972.

Recommandation No. 2

qu'une nouvelle consultation d'experte soit réunie en temps utile, à une date appropriée, pour examiner les aspects ci-après de la question que, faute de temps, la présente Consultation n'a pu étudier:

- a) Aliments pour anguilles
- b) Elevage intensif des anguilles en étangs à l'aide d'aliments de complément, avec ou sans approvisionnement en eau chauffée artificiellement
- c) Transformation des anguilles
- d) Entreposage des anguilles
- e) Transport des anguilles sur de longues distances par mer et par terre
- f) Etude des populations d'anguilles.

Recommandation No. 3

Les délégués ont conclu à l'issue de leurs débats qu'il est urgent d'entreprendre des recherches fondamentales sur les réactions des anguilles à certains stimuli, tels que les modifications soudaines de la vitesse des eaux, des vibrations et des sons dans le milieu aquatique. Dans l'intérêt du perfectionnement des engins de pêche à l'anguille, les délégués ont recommandé que les gouvernements encouragent la recherche sur ces questions.

Recommandation No. 4

Les délégués ont exprimé leur préoccupation devant le fléchissement patent des prises d'anguilles par suite de la surexploitation des stocks d'anguilles jaunes pratiquée dans certains cas, par exemple, dans les pêcheries littorales qui sont ouvertes au public et où aucune responsabilité directe n'est assumée par ceux qui exploitent les stocks. Pour protéger les anguilles contre la surexploitation, il est recommandé que les gouvernements envisagent la nécessité d'adopter et de faire appliquer des règlements et de limiter les captures d'anguilles au niveau maximum admissible dans l'intérêt des pêcheurs eux-mêmes, et pour prévenir l'effondrement de cette pêche.

Recommandation No. 5

Les délégués ont pris note avec grand intérêt du rapport sur les récents développements des pêcheries d'anguilles en Hongrie à la suite de l'immersion massive de civelles dans de grandes nappes d'eau vierge d'anguilles jusqu'alors, et ont recommandé que l'on profite de cette situation pour étudier l'âge des anguilles.

3. REMERCIEMENTS

Les participants ont tenu à exprimer leurs remerciements à tous ceux qui ont permis à la Consultation de se réunir et contribué à son succès, notamment:

au Gouvernement de la République fédérale d'Allemagne, qui a invité la réunion à se tenir à Hambourg et a organisé les excursions;

au Professeur Dr. K. Tiews, Président Directeur du Bundesforschungsanstalt für Fischerei, qui a aimablement mis des salles de conférence à disposition et fourni les moyens nécessaires à l'organisation des importantes démonstrations d'engins de pêche à l'anguille qui ont eu lieu à l'occasion de la Consultation et l'ont heureusement complétée;

au Professeur Dr. A. v.Brandt, Directeur de l'Institut für Fangtechnik du Bundesforschungsanstalt für Fischerei, pour les excellentes dispositions prises en vue à la fois de la réunion et des excursions, et pour la générosité avec laquelle lui-même et son personnel ont offert leurs services pour assurer le succès de la Consultation;

aux propriétaires de pêcheries d'anguilles, dont les noms suivent, qui ont accueilli les délégués et fait l'impossible pour qu'ils puissent tirer le profit maximum de la visite de leurs installations:

M.W. Dobberschütz
Nienburg/Weser
Weserwall 14

M. Brauer
Landesbergen/Weser

M. Schweer
Fa. Schweer und Kuckuck
Steinhude am Meer

M. Willy Wichmann
Heiligenhafen
Danziger Strasse 14

M. Wilcken
Plön/Holstein

aux fabricants d'engins de pêche et aux propriétaires de pêcheries d'anguilles
qui ont fourni les engins exposés dans la salle de conférence (on trouvera à l'Annexe 28
une liste détaillés des exposants); et enfin,

aux Rapporteurs de la Consultation, MM. C.I.D. Moriarty et D. O'Leary.

APPENDIX 1

OPENING ADDRESS

by

Prof. Dr. K. Tiews
Präsidentierender Direktor
Bundesforschungsanstalt für Fischerei
Hamburg, Federal Republic of Germany

Mr. Chairman, Distinguished Guests, Gentlemen,

As the present Presiding Director of the Federal Fisheries Research Board in Hamburg, it is my privilege and great pleasure to welcome you on the occasion of the EIFAC Consultation on Eel Fishing Gear and Techniques. I should like to express on behalf of my country our deep appreciation for accepting our invitation to hold this meeting in our Institute in view of the high esteem and the economic importance of eel in many countries.

In the past 10 years the production of eel in the world has doubled. In 1968, 51 000 tons of eel were caught and of these, 21 000 tons were produced in the member countries of EIFAC. The leading eel producing nations being Denmark, Italy, the Netherlands, France, Sweden and many others, including Germany. In the Federal Republic of Germany eel production is deemed to be the staple of inland fisheries because it is one of the few fish species which are affected least by water pollution and eutrophication problems and, furthermore, because it commands a very good price on the market. Present price to fishermen ranges between 7 – 9 Deutsche Marks per kg. The eel is considered to be a delicacy of the highest rank on the German market, and the German people are among the major consumers of eels in the world. Imports are steadily increasing and are estimated to amount at present to more than 4 500 tons. They come from 15 countries, including Denmark, Sweden, France, Ireland, Poland, Turkey, and U.S.A. This tasty fish is appreciated very much because it can be eaten in so many different ways, such as smoked, cooked, fried, grilled, baked and made in gelée. It is a popular saying that one does not wish to eat salmon more than once per week, but one would like to eat eel every day.

Although eel production in Germany amounts only to 1 500 tons per annum, half from coastal waters and half from inland waters, a great variety of fishing gear and methods are employed to catch it, perhaps more so than in any other country in the world. It was the recognition of this fact which prompted my Government to issue the invitation to EIFAC to hold this Consultation in Hamburg; and your Host and Local Organizer, Prof. v. Brandt has borne this in mind in arranging for the series of lectures to be given by the experts of this Institute, and the Study Tour of eel fishing gear and methods which he has planned for you.

Eels are caught in Germany by means of otter board trawls, traps and hooks in coastal waters, with stow nets from anchored fishing boats, otter board stow nets, bottom trawls, longlines, permanent barriers, traps and electrical fishing gear in rivers and lakes. The development of some of these methods are based on research work which has been carried out by the staff of this Research Board.

However, in this Institute we deal, not only with investigations aiming at improving eel catching methods but also with the study of its biological aspects both in

our coastal and inland waters. In recent years, eel migration has been extensively studied by means of tagging experiments both in the rivers and the sea.

Since natural eel resources are obviously limited in Germany as in other countries, much thought has been given to increasing eel production by carrying out large scale stocking of waters throughout the entire country with elvers and fingerlings.

However, here also there are limitations, so for the past few years, we have been exploring the possibility of introducing eel farming in Germany. In this connexion an experimental eel farm has been built at Müden on the River Mosel. This consists of 5 ponds having a total area of 6 000 m² for which there is a water supply of 400 litres per second. In this farm, we are experimenting various ways to culture eels. Although considerable progress has been achieved, for a variety of reasons we are still a long way from the practical application of this method on a large scale. We shall continue with our work, bearing in mind that Japan has succeeded in eel culture. In fact, in 1968, Japan produced 23 000 tons more eels than were produced in the whole of Europe.

The Federal Research Board of Fisheries comprises four fisheries research institutes; the Institute for Sea Fishery; the Institute for Coastal and Fresh Water Fishery; the Institute for Fishing Gear and Fishing Methods and the Institute for Biochemistry and Technology. In addition there is a radio isotope laboratory. Also, a documentation service is maintained. In all, there is a staff of nearly 200 in the Federal Research Board of Fisheries, 56 of whom are scientists working not only in Hamburg but also in sub-stations of the Institutes located in Bremerhaven, Cuxhaven and Kiel. A great variety of work is being carried out of which 90 per cent is concerned with marine fishery problems. It ranges from work on stock assessment for the entire Atlantic, water pollution, naval architecture, ship fouling, the development of an integrated fish catching system, to studies of how to improve the quality of fish and the development of new fish culture techniques.

I should like to conclude these opening remarks by expressing the hope that this meeting on Eel Fishing Gear and Techniques will be a successful one and that your discussions may bring fruitful results for all of us. On behalf of the Research Board, may I take this opportunity to cordially invite you to a reception which has been arranged in your honour and which will take place in our meeting room on the 4th floor of this building immediately after the afternoon session.

We are happy that you are with us and we hope that you will also find the time to enjoy your visit to Hamburg with its many possibilities. We will all be only too pleased to help you in finding your way around.

Before closing, I feel I must bring to the attention of such a distinguished group of experts one eel fishing method which, no doubt, will be strange to you but which has been described by one of our angry young writers - Günther Grass. He reports in one of his famous novels that the inhabitants of his home town Gdansk, were accustomed to place the skulls of cows in an advanced state of decay in the coastal waters overnight and next morning to collect the eels which were attracted and had collected inside. In conclusion, may I wish you good luck in your deliberations. Thank you.

APPENDIX 2

INTRODUCTORY REMARKS

by

C.J. McGrath (Convener)
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At the Fifth Session of the European Inland Fisheries Advisory Commission (EIFAC), Rome, 1968, it was advocated that a meeting of appropriate experts be held to pursue the eel study.

At that time Dr. Deelder was engaged in the preparation of his Synopsis of Biological Data on Eels. By now you will all have seen the final draft of Dr. Deelder's valuable synopsis. It is of great value to us in this Consultation, not only to have the advantage of using this valuable document in our work, but also the presence of the author to take part in our deliberations.

Following the Rome meeting, a series of exploratory discussions was held both by the EIFAC Secretariat and by your Convener with Professor Dr. v. Brandt as to the possibility of holding such a consultation at the Headquarters of the Federal Research Board of Fisheries in Hamburg. This culminated in a formal invitation to hold such a Consultation which was presented on behalf of the Government of the Federal Republic of Germany by Prof. Dr. K. Tiews to the EIFAC Sixth Session in Poland in May, 1970.

However, in drawing up the programme for this Consultation, it was realized that it would not be possible to cover all aspects of the subject in the time available and that it would be necessary to concentrate on one item only. Eel Fishing Gear and Techniques was selected. The urgent need to deal with all other aspects was appreciated but it was realized that this could not be done in the time available.

For instance, there is much to be learned from the various sources of information available about the biology and physiology of the eel at the various stages of growth with particular emphasis on the behaviour patterns and reaction to known stimuli at each stage of development which could be availed of and employed to further their growth and facilitate their capture.

There is a great need for information on practical methods of assessing the eel productivity of various kinds of water on which could be based a programme of rational exploitation of existing water bodies and many new water areas. This would, of course, embrace such matters as acquiring data on the natural mortality of eels at the various stages of growth. Fundamental to the whole exercise would be also the acquisition of information on the principles of artificial re-stocking with elvers to ensure maximum sustainable production at the most economic cost.

We would also like to learn more about a rational design of eel storage basins for long term storage and, in particular, about the optimum environmental conditions necessary for operational efficiency.

We would also wish to learn more about the best methods of preparing and processing eels for human consumption including such matters as optimum cold storage

conditions. Another matter of increasing importance is how to remove undesirable tainting of the flesh of the fish.

There is much to be learned about the transport of eels by tanker-trucks as well as by well-boats.

One aspect likely to grow in importance in future years and, therefore, deserving of serious attention at the present time is eel pond culture with supplemental artificial feeding with particular reference to eel culture methodology in heated effluents.

However, as has already been stated, we do not have the time on this occasion to deal with all these matters in the exhaustive way that would be desirable, but it is suggested that any expert attending this Consultation who possesses any practical experience of any of these subjects makes available the information he has acquired on the subject. Short statements of established practice in the matter would suffice at this stage. The more detailed statements and supporting evidence could await another meeting.

Our main objective, therefore, at this meeting will be to learn all we can from each other's field of competence and, in particular, from our distinguished panel of lecturers about the various kinds of fishing gear the development of which resulted from lengthy research. We will all wish to learn more about the factors governing the use of each gear in particular circumstances. We will also wish to learn all we can about the various kinds of material that can be employed for the manufacture of eel fishing gear, and the merits and faults of each in various situations.

Finally, we would wish to learn more about the theoretical basis of design of eel nets and of their supporting structures which are necessary in the various conditions in which they can be employed from those of still waters to those of fast flowing streams. So without further ado, let us begin our task so that at the end of our deliberations, as much information as possible will have been accumulated which I hope will result in the increased production of eel in interested EIFAC member countries.

APPENDIX 3

EEL FISHING METHODS - AN INTRODUCTION

by

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Successful fishing methods are based on a good knowledge of the behaviour of the fish to be caught. It has been truly said: fishing methods and tactics are applied knowledge of fish behaviour. This is especially so for eel fishing and it is not astonishing therefore, that eel fishermen generally are specialists in this subject. It will be understandable, therefore, that a detailed report by Dr. Mohr about eel behaviour is a fitting introduction to this series of lectures.

Under discussion is the freshwater eel only; not the conger eel. In Northern Europe the eel lives and feeds in freshwater for about 10 years and, during this period, can be attracted and caught by means of baited fishing gear and/or such as will offer a place of refuge. Thereafter, the eels begin to migrate back to the sea and fishermen try to catch them on their journey by means of fishing gear which filters the eel from the water current.

Eels are caught in lakes and rivers and also in coastal waters, especially in the estuaries of rivers. Commercial fishermen engage in eel fishing as so do sport-fishermen, both with increasing interest. In this discussion, commercial fisheries only are dealt with and the emphasis is on traditional (local) fishing methods rather than with

industrial ones. Eel fisheries are more a part of small, traditional fisheries; mechanisation is little employed even when heavy gear is operated.

Most methods used in eel fisheries are passive in nature; that means the eel has to come to the fixed or drifting gear, or it may be attracted by some stimulant or because a refuge is offered. Coastal fishermen, however, use active methods such as trawls to catch eels and the tendency nowadays is to use trawls in lakes and rivers as well.

Set out hereunder is a short synopsis of the different methods of eel fishing which I have set out in accordance with my own classification of fishing gear and methods. This classification is based on the principles of catching and the development of fishing methods. No distinction is made as between the importance of the different methods; neither is there any attempt to identify the efficiency of capture of each. In all, fifteen types of fishing gear are listed but not all are of interest as regards eel fishing.

1. FISHING WITHOUT GEAR

As far as is known, there does not exist a fishery for freshwater eels without the use of fishing gear; neither by gathering by hand, nor by digging out, nor by collecting by means of divers. The method of collecting fish by emptying ponds or any other small areas of water, such as is popular in some tropical fisheries, can be ignored as far as eels are concerned. It has been the experience of pond fishermen that it is very difficult to get the eels in ponds which have been emptied of water.

2. FISHING WITH WOUNDING GEAR

Eel fishing with wounding gear is much more important, especially with spears (Fig. 1). The spear is one of the oldest types of fishing gear used in eel fishing. Different types of spears have been developed for this purpose in many parts of the world: in Europe as well as in the Far East and South East Asia, and other areas besides.

Eel spears can have one or more prongs which are barbed in this case. In some countries, like in Germany, the distance between the prongs is regulated by law.

The eels are caught by being impaled. It often happens that the operator misses and only succeeds in wounding the eel which escapes although badly injured. It also can happen that very small fish can be caught. For this reason the use of spears is forbidden in some countries. In Germany special permission is necessary to use such spears and this is restricted to older fishermen, who are no longer able to handle heavier fishing gear or to go out with a vessel for a considerable time.

The prongs of fishing spears can be replaced by spring clamps. Such types of spears are used by Danish fishermen. In Denmark also, the distance between the clamps is regulated by law. Clamps are considered to be the best kind of spears making it possible to catch and hold the eel without wounding it.

Sometimes eel spears can consist of a combination of clamps and prongs such as occur in Germany and in Canada. In these the prongs are unbarbed. The so-called Canadian "summerspear" has two flexible wooden clamps bolted to a long iron spike. The design of these combined spears was devised originally to protect the sharp points against damage by hard ground.

In dealing with spears mention must also be made of the modern Danish eel tongs. These tongs are operated by a rubber band or a spring. They snap together when a trigger is released.

Eel combs are well known in Europe as well as in Asia (Fig. 2). The comb is usually towed through the mud piercing any eels which happen to be in its path. The eel can escape although badly wounded and for this reason these combs are forbidden in some countries.

In Japan a special needle comb is used for eel fishing. The eels, when observed swimming under a light, are struck on their heads with this gear and thus caught by the fishermen.

All spears have long wooden handles, the length of which is limited by the buoyancy which increases with the length. A length of 7 m is considered to be the practicable limit. This, however, does not exclude the possibility of spears with longer handles - these may be up to 20 m. The wood of the handles, however, has to be flexible and it is necessary to weigh the spearhead to offset its buoyancy.

Spears are usually employed to catch eels lying in the mud during daytime. In winter longhandled spears are used also to catch eels under the ice. Except with electricity it is not possible otherwise in Northern Europe to catch eels in winter. Spears can also be used during nighttime for eelfishing usually with the aid of artificial light. Special arrangements can be made to increase the efficiency of this method by forcing the eels to pass through restricted water channels. In Madagascar such an arrangement is employed at the outlet of lakes when the outflow is through small stonehouses where the migrating eels are caught with spears, as they pass under the light.

3. FISHING WITH STUPEFYING METHODS

The use of narcotics to capture fish, especially with ichthyotoxic plants is well known all over the world. But these plants as well as poisons of animal origin or even the new so-called "chemical fish collectors" are more successful for pelagic fish which rise to the surface of the water. Any other fish are difficult to collect. This may be the reason why narcotics are not used for the capture of eels.

Another stupefying method which has become very important in eelfishing during recent years is electrical fishing. In this case the affected fish is not lost but it can be caught without difficulty because of its anodic reaction to electric current. Electrical eelfishing has become so important that a special report has been prepared on this subject by Dr. Halsband (Appendix 7).

4. LINEFISHING

In linefishing, a natural or artificial bait is fixed to a line and is offered to the fish to be caught. The fish tries to swallow the bait and is lifted from the water before it can release it. In order to hinder the fish in its effort to reject the bait, fish hooks of different types are employed hidden in the bait.

A hookless linefishing method is known in many countries; in England this is known as "bobbing" or "blobbing", etc. In this method lob worms are threaded lengthwise on a rough twine (sometimes made up of a combination of hemp and wool). This wormline is crowded together and weighted with small lead shots (Fig. 3). It is fished at the bottom where the eel comes across the bait and becomes entangled by its teeth when taking the bait. The eel can then be caught if lifted very quickly out of the water and over a box or an open umbrella held upside down to receive the fish. This method is known not only in Western Europe but also in Turkey. Some Australian tribes also practice it. Modern eelbobs are made of a little bag of nylon hoses filled with bait and a

weight. Here also the eel is caught by becoming hooked by its teeth in the fabric when attempting to get at the bait as already described.

Lines with hooks are used in present-day eelfishing. These hooks can be curved in the usual form, but gorges are also known (Fig. 4). In France, gorges are used especially for eelfishing even today. In England, gorges in the form of needles are used for eelfishing in a method called "snigging".

Handlines are seldom used in commercial eel fisheries. They are therefore omitted from this account. In contrast to commercial fisheries handlines are an important fishing tackle used by sport-fishermen for eel fishing. Since Isaac Walton's "The Complete Angler" (first edition 1653) a lot of books have been published describing methods used by sport-fishermen for eelfishing.

The most important method of commercial eel fishing in freshwater or coastal waters is longlining with up to 3 000 hooks (Fig. 5a). Some people are of the opinion that this is the best method to catch eels which are still taking food. For this reason, this method is the subject of a special report by Dipl. Biol. Kaulin (Appendix 5).

There is, however, another line-fishing method practised by some commercial fishermen worthy of mention, that is eel fishing in lakes with driftlines. (Fig. 5b). Floats made of rush or other light-coloured materials are set in the evening in such a manner that they drift with the wind across the lake during the night. To each is attached one small single hook, baited and hanging 1 or 2 m deep according to the depth of the lake. "The driftline is searching for the eel itself!" say the fishermen. These driftlines are considered much more effective than longlines. On the other hand driftlines cannot be used on small lakes nor can they be used during periods of strong wind.

5. FISHING WITH TRAPS

The term "trap" is used in a wide sense in connexion with eel fishing. It can be a filtering barrier placed in the current of a river or a portable wooden basket or a fyke net made of netting. In coastal waters it can be a very large, more or less, permanent pound net.

Two methods only need be mentioned here: the filtering barrier and the trap in the form of a hiding place or refuge. The other types of traps used are discussed in another report (Appendix 8).

Filtering barriers erected in rivers or in the outlets of lakes to catch migrating eels are known in many parts of the world. In the Federal Republic of Germany these devices are incorporated in mill dams. The water flow is directed through a tank, part of which is made of lattice work which allows the water to escape but retains the eels (Fig. 6). In this country the space between the laths is regulated by law. The minimum distance varies in the different parts of Germany from 15 to 30 mm. In such devices, it is important to provide shelter for the captured eels in order to prevent their being damaged by being pressed against the lattice work by the water current. There is a trend in this country to support the building of new filtering barriers such as those as they are considered to provide the most efficient method of capturing the total quantity of migrating eels. It has been also proposed that these barriers should be owned by fishermen's cooperatives.

A special filtering method is employed in the Far East. This is employed to catch young eels migrating upstream against the current. They are caught by leading them into special channels in which are placed bagnets from which they cannot escape.

In Japan, there is another filtering method which is called Yana. This is a slanting screen placed in the current of a river. While the water escapes through the slats of this screen the fish are retained by the screen and are washed up the slope of the screen by the strongly flowing current. The eels stranded in this way are collected from the screen. This must be done constantly during day and night in the main fishing season. In some cases, however, openings are cut in the screen and fitted with net bags into which the eels can pass but cannot escape.

Mention must also be made of the filtering barriers built by the Italians to catch eels passing from the sea into brackish lagoons, or vice versa. The fish are concentrated in these traplike barriers and removed by scoopnets.

Quite another trapping method for eels is based on offering shelter or refuge for the eels. In Madagascar, fishermen dig out small underwater holes into which the eels enter for shelter. The fisherman dives and takes out the eels with the help of spears.

Bundles of brushwood were used at one time to capture eels searching for shelter, but only small eels are caught by this method. This method is also employed to catch shrimps in many parts of the world. In Japan, units made up of three bamboo tubes fastened together are submerged in the water and the eels like to hide in these (Fig. 7). The smallest such trap for eels measures 2 cm across and 70 cm in length. This trap has no retarding devices, such as valves and great care must be taken when lifting to make sure that the eel does not slip out.

However, wooden baskets (Fig. 8), fyke nets (Fig. 9), made of netting or chicken wire and pound nets (Fig. 10) are more important for eel fishing. The baskets are used in rivers mostly in groups connected with a line. The fyke nets are specially used in lakes or along the seashore, sometimes incorporated in large fishing arrangements. Large pound nets for eels are especially known off the Baltic coast of Denmark and Germany. As all these traps are so important they will be dealt with at length in a special report (Appendix 8).

6. FISHING BY AERIAL TRAPS

Aerial traps are special devices designed to capture fish and shrimps which jump out of the water. They are not applicable therefore, to eelfishing. Eels migrate sometimes over land from one water body to another as also do some other fish. The Burmese fishermen employ special pitfall traps for fish trying to make their way over land, but I do not believe that eels can be caught by this method.

7. FISHING BY BAG NETS WITH FIXED MOUTH

In this group are scoop baskets and all net bags, the mouths of which are retained in the open position with the help of a frame and the body of the net extended by the water current. The small scoopnets can be neglected as also can the large scrapenets used by the Japanese to catch eels in rivers (Fig. 11).

The large stownets are of great importance in fishing for eels in rivers (Fig. 10). They are employed fixed on stakes driven into the bed of the river or swimming free but held in place by anchors. They can be mounted on large frames and suspended from booms mounted on boats anchored in the river stream. The most modern development is the otter board stownet.

When the Dutch fishermen introduced the so-called "Ankerkuile" in the river Rhine at the beginning of this century, the selfishing increased very much. Stownets are

important today even in spite of pollution, canalization and increasing shipping traffic. A special report on stownets will be given by Dr. Klust (Appendix 6).

8. FISHING WITH DRAGGED GEAR

There are no dredges used for eelfishing. But coastal fishermen employ special bottom trawls for this purpose. These are small meshed trawls with a footrope 70 ft long (Baltic) or 135 ft long (North Sea). The eel trawls are towed with otterboards, or by two boats in pairfishing. In olden times eel-trawls were operated by sailing broadside single boats.

In recent years two-boat bottom trawls as used by the coastal fishermen have been introduced also in lake fisheries and in rivers and have been found to be very economical (Fig. 13). A special report will be submitted by Dr. Steinberg on this subject (Appendix 10).

9. FISHING WITH SEINE NETS

Sometimes seine nets and trawls are included in the same group of fishing gear. But with trawls a theoretically unlimited area can be fished according to the length of the towing time. In contrast, the catching area for seining is limited by the length of the wings of the net and by the length of the towing ropes. When the seine net is shot the set cannot be shortened or extended as can be done with trawls. The fishing unit for trawls is the towing hour; for seine nets it is the set.

Seine nets are used in freshwater eel fisheries and to some extent for beach seining along the sea coast (Fig. 14). There are special seine nets of large size for eels. More popular in this country are very small ones which can be handled by one fishermen only.

Nowadays mechanised and/or electrified seine nets are of some interest in eel fishing and a special report on this subject will be submitted by Dipl. Biol. Kaulin (Appendix 9).

This concludes the most important fishing gear used for the capture of eels. The last 6 groups referred to in my classification of fishing gear are only mentioned to complete this account.

10. FISHING WITH SURROUNDING NETS

There is no fishery for eels which employs gear like purse seines or lampara nets which have been specially developed for pelagic fish.

11. DRIVE-IN FISHERY

It is only in tropical countries that one will encounter the typical drive-in fishery for which special gear has been developed. On the other hand a drive-in fishery for eels has developed in connexion with electrical fishing. The eels are driven into stationary fishing gear with the help of electricity. This will be dealt with in a report by Dr. Halsband (Appendix 7).

12. FISHING WITH LIFT NETS

This fishing method can be omitted even though the Japanese use rectangular lift nets to catch eel fry.

There are no methods of eelfishing using (13) falling nets like case nets or coverpots. It will be also understandable that there are no (14) gill nets or (15) entangle nets used in eelfishing.

This summary demonstrates that there are many specialized methods employed in eel fishing. This specialization can be demonstrated by the fact that in Germany the particular names of the many fishing gears are derived from this specialization: eelspear, eelline, eeltrap, eeltrawl, eelpoundnet, etc.

Today all these gears are made from synthetic fibres. In general, the change from the natural fibres to synthetic ones has resulted in increased efficiency and very often also in a simplification in the construction of the gear. These improvements, however, have been confined in the main to traps and stownets and not much has been done for the improvement of other kinds of eelfishing gear. There is no doubt that efficiency could be increased if more research work could be done - especially work on the application of light and electricity to eelfishing methods.

It will be clear from this summary that many of the items are specially suited to particular kinds of fishing waters. The following list gives a rough summary where each can best be employed in the light of the experience on the subject gained in eel fisheries in the Federal Republic of Germany:

	Lakes	Rivers (b)	Estuaries (c)	North Sea	Baltic
Spears	+				+
Electric fishing	+	+			+
Longlines	+	+			+
Barriers	+ (a)	+			
Baskets		+	+		
Fyke nets	+	+	+		+
Poundnets					+
Stownets		+	+	+	
Trawls	+	+	+	+	+
Seine nets	+	+			+

(a) Barriers can be employed in the outlets of lakes only.

(b) In the case of rivers, apart from stownets, the other gear mentioned can be used at the side of river channels or in the backwaters only.

(c) The estuaries in question are those of the rivers Elbe, Weser and Ems.

DISCUSSION

Deelder presented v. Brandt with a Dutch eeltrap for the museum in the Institute. (This trap is described in Deelder's paper.) He stated that prohibition of trawling in the IJsselmeer has led to the increased use of this new simple device.

McGrath described traps used in Ireland which were very similar to the "Yana" Japanese trap. McGrath also referred to Canadian traps of a similar design. He also mentioned that eels when trapped will use their tail as a wedge to force their way out of traps. He had once witnessed an eel using its tail as a lever to get over an obstruction. It had been observed in Ireland when treating small lakes with rotenone for the purpose of clearing coarse fish for the better production of game fish, that eels emerged from the lake on to the land to escape the effects of the chemical.

Vickers referred to the more efficient methods of eel catching and wondered if the eel stocks of Europe would ultimately survive all the new methods of exploitation. He would welcome discussion on this point.

v. Brandt explains that it is the aim of gear research to develop fishing gear with a highest efficiency but lowest amount of money and manpower. Gear research

has nothing to do with limitations which may be necessary for biological reasons. The quantity to be caught is a problem of catch regulation and not of gear research.

Kaulin - a system is used to avoid plants and keep bait clear of mud.

McGrath - enquired whether stratification in the lake interfered with fishing.

Kaulin - no effect.

v. Brandt - mentioned use of unbarbed hooks in places such as Nemi Lake in Italy, such hooks required tight line at all times.

McGrath - asked for information of use in other countries: barbed hocks used in Holland, Ireland and Hungary.

A Discussion on bait followed.

Vickers - small fish preferred on Lough Neagh; stickleback for two weeks in July in shallows of Lough Neagh, catch broad-nosed eel. Normal bait-slices of Coregonus which catch sharp-nosed eel.

Deelder - Smelt during whole season; long crosslines are occasionally used on the lines, possibly due to habit of eels in swimming for some time before swallowing bait. In summer small perch and ruff used.

Vickers - Coregonus bait seems to be positively liked by eels; small pieces of perch and pike fail.

Deelder - considers smelt perfect bait but mentions that IJsselmeer smelt will not catch eels in other waters.

Mohr - Arenicola very effective in Germany. Coregonus should come from same lakes as eels to be effective.

Thuranszky - slices of bream effective in Hungary.

Conflict of sport and eel fishing.

McGrath - in Ireland longlines used over mud catch eels, over gravel catch trout.

Thuranszky - no report of conflict between interests.

v. Brandt - branchline should be long so that eel does not notice attachment of bait.

Moriarty - asked information on depth of fishing.

Koops - very variable, depending on season, lake, etc.

McGrath - asked for information on conservation.

v. Brandt - any size may be taken in enclosed lakes.

Koops - mentioned general 30 cm size limit.

Mohr - H₂S concentration in deep water may poison eels caught on longlines.

Larsen - H₂S gives trouble in Denmark at 12 m and deeper.

Thuranszky - 2 m is usual depth for fishing in Hungary.

Larsen - Eels are pelagic in larger lakes and dive for food, their visits to dangerous deep water are therefore normally brief.

- Mohr - confirms pelagic habits, mentioned that eels feeding on Coregonus caught in nets 10 m above the lake bed.
- Koops - salted herring is a good bait but suggested that as the food animals change frequently longlining success could be increased by noting stomach contents. Described method of attaching hook to bait in rivers.
- McGrath - described use of pilchard oil on cotton wool in perforated plastic bag to attract eels to location where they can be removed by electro-fishing.
- Vickers - refers to Koops; mentions that fish is rarely found in stomachs although Coregonus is an excellent bait; does not think that stomach contents would be useful guide.
- Mohr - live Guppies were good food for aquarium eels, males were eaten largely. The females were better swimmers and usually escaped.
- Moriarty - eels below 30 cm rarely eat fish; asked for information on size of fish-eating eels.
- Koops - considers this depends on habitat.
- Moriarty - asked for information on size limit.
- Larsen - in Denmark overall 25 cm; in Limfjord 28 cm and in West Jutland 29 cm.

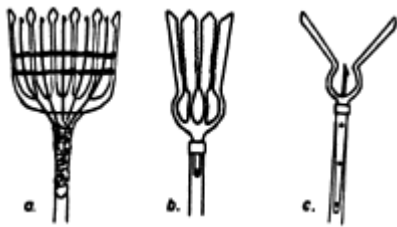


Fig. 1 a. Eelspear of northern Europe
 b. Danish eel clamp
 c. German combined eelspear

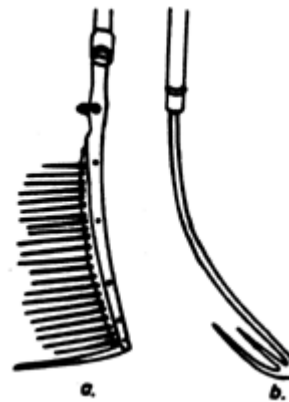


Fig. 2 a. Eelcomb from the Baltic area
 b. Japanese eelcomb



Fig. 3 Hookless handlines: "eel bob"



Fig. 4 Hook and gorge

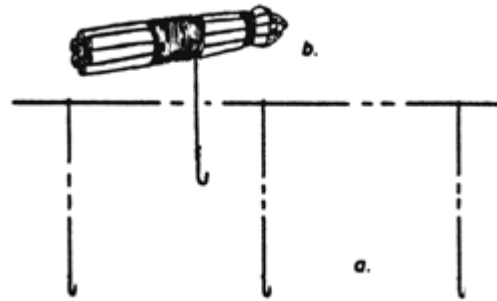


Fig. 5 a. longline b. driftline

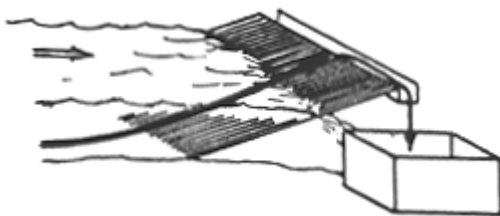


Fig. 6 Principle of a filtering barrier
 White arrow: water current
 Black arrow: way of the migrating eel over the grating in a collecting box

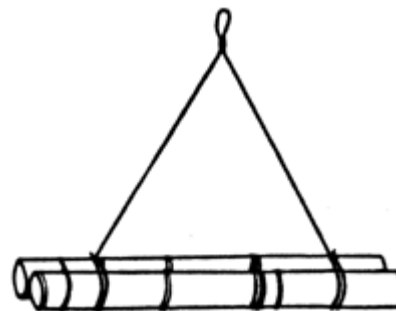


Fig. 7 Shelter of bamboo reeds

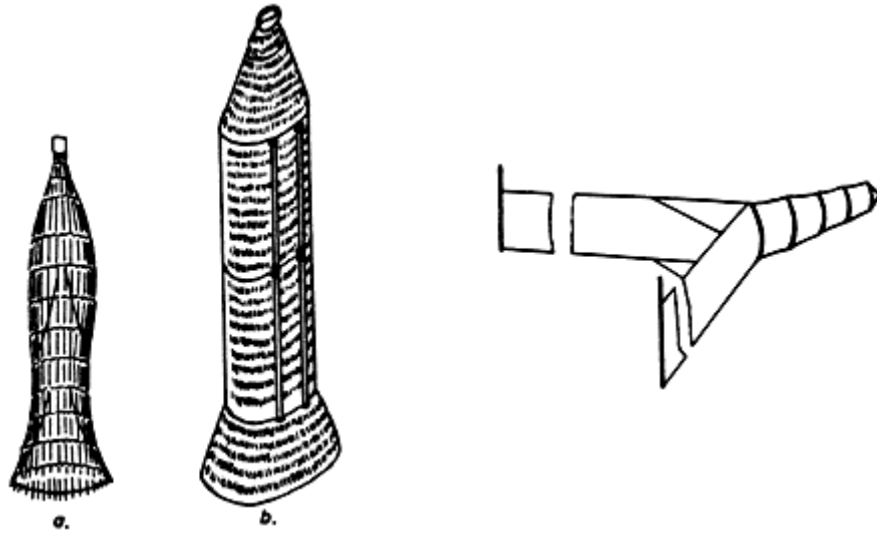


Fig. 8 Baskets made of wood (a.) and Fig. 9 Fyke net with wings plastic (b.)

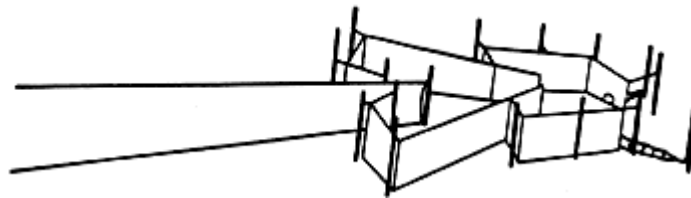


Fig. 10 Poundnet for eels off the Baltic coast



Fig. 11 Japanese scrape net

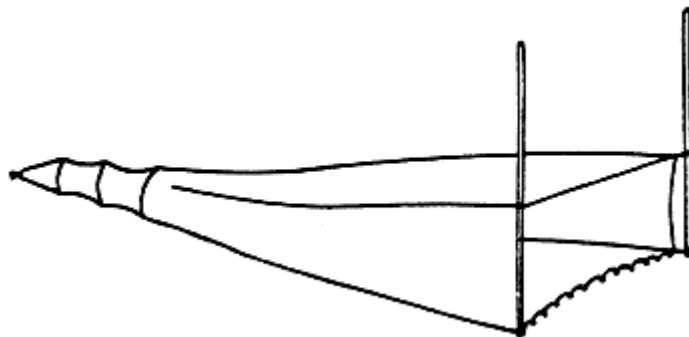


Fig. 12 Stow net fixed on stakes

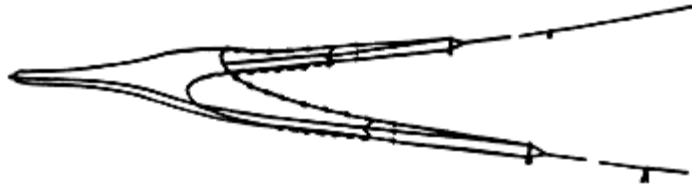


Fig. 13 Two-boat bottom trawl for lake fishery



Fig. 14 Seine net with bag

APPENDIX 4

THE EFFECT OF SOME BEHAVIOUR PATTERNS ON THE CATCHING TECHNIQUES FOR EEL

by

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Most fishing methods are based on the exploitation of behaviour patterns peculiar to the fish sought after. Schooling is perhaps the most important feature, because it concentrates fish naturally for mass capture by suitable gear. But in the case of eel, schooling can be observed only in elvers or glass eel, when they enter the rivers, and this stage will not be considered in this report, which deals only with the adult or at least the larger sized eel. Eels live in different habitats widely distributed and special methods have to be employed in order to concentrate them so as to catch them in numbers. I may here refer to the gear classification of Prof. v. Brandt and repeat, that the more usual applied techniques for this purpose are:

- (i) To direct the eels by weirs or fences, which lead them into traps;
- (ii) To attract them by shelters, which serve also as a trap;
- (iii) To attract them by food placed in a trap or attached to hooks on lines.

All this gear belongs to the so-called passive or stationary gear, and this means that the fish has to be active in order to enter the trap to take the bait. On the other hand, for moved or active gear it is favourable if the fish is passive or lethargic. In wintertime, when hidden motionless in the mud, eels are - or were at one time - pierced with spears or forks. During the warm season, in daytime, when burrowed not so deep in the bottom and so active that they leave their hiding place just before the approaching gear, eel are trawled or seined, where a flat and smooth bottom allows these fishing operations to take place.

The application of electrical gear will not be considered in this context, as fish are stunned by these means and the anodic reaction, which is induced even in a decapitated fish, is not behaviour in the proper sense of the term.

It has already been mentioned that phases of swimming activity are often the deciding factor in the capture of eels. Therefore it might be useful to examine in detail these periods of activity and the factors which cause them. But we have to consider separately the activity of the yellow eel and that of the sea-going silver eel, because different motivations prevail in these different stages of development in the eel.

As regards the yellow eel, an experiment was conducted recently in our Institute. The results I may discuss in a few words:

The eels were kept in an artificial rectangular pond, which was divided by a diagonal lattice into two unequal parts. Each contained shelters for the eel. When the eels were in motion, they were guided by the diagonal screen through a funnel, into the other part of the tank. When passing through the funnel, they activated an electro-mechanical counting mechanism and their passage was indicated on a clockwork-driven graph recorder. The period during which their activity was monitored by this means extended from 14 June to 14 August. The results obtained were as follows:

Usually the eels were active only at nighttime. As the season progressed, the length of the period of activity increased with the increase of night and the decrease of light intensity. In the diurnal rhythm two periods of maximum swimming activity were recorded, the highest peak occurring after dusk and the lowest before dawn.

It was also noted that the atmospheric pressure influenced the activity of the eel with peaks at any tendency of the pressure to fall; the actual value of the pressure was of no importance.

An extreme restlessness was always observed during thunderstorms, even during daytime. As the change of atmospheric pressure occurring during thunderstorms often did not exceed that of other days, this high activity might have been due to the electro-static charge.

Within the range 14° – 21°C the influence of temperature was not noted. It is known that below 5°C eels become somewhat inactive and at temperatures less than 9°C food bait is ignored. This limits the period of eel fishing with passive gear in our climate to that from May to October/November, and makes the rearing and fattening of eels in artificial ponds problematical.

The moon phase is obviously an influence also. Maxima of activity coincide with waning and especially the new moon, minima with full moon. Because of the relatively few data - the experiment lasted only two months - it cannot be decided if this is an effect of the moonlight or an intrinsic rhythm associated with the moon constellation.

It has been established by several investigators that the spawning migration of the silver eel depends mainly on the direct influence of the moon and it does not matter if it is visible or completely covered. Peaks of activity and greatest catches occur always in autumn with waning moon and drop nearly to zero at full moon.

In this context it should be mentioned that in recent years in the Baltic and in Eastern German rivers, chains of underwater lights were used as barriers in order to guide migrating silver eel into the traps.

The fact that the eel enters voluntarily into traps which simulate a shelter has already been discussed in the paper presented by Prof. v. Brandt. The motivation is not only a negative phototaxis but also a strong thigmotaxis; the desire is that the whole body will come into contact with a solid surface and this induces the eel to enter a shelter or to burrow into the bottom. When both possibilities are provided in a tank, the eel first digs into the bottom, but when it becomes accustomed to the environment it prefers the more convenient tubes and other shelters.

In the introduction it was mentioned that next to leading weirs the attraction of bait is the most important incentive to the concentration of eels. For this it is necessary that the eel be hungry and the bait be attractive; swimming activity alone is not sufficient. This leads to the question: which stimuli attract - or scare - eel, and more particularly, which are the most important sense organs in the eel?

In many other fish vision is the superior sense for the detection of food and they can be caught by dummies, which superficially resemble their food organisms. As indicated by its small eyes during the feeding stage, which are incapable of colour discrimination, and by its nightly activity, this is not so for the eel.

In recompense for poor vision the eel has the most efficient and sensitive smell organ, as well as the most complicated, of all fishes investigated in this respect.

In the course of conditioning experiments, Teichmann found that an eel can discriminate certain chemicals in a dilution of about one part per ten raised to the eighteenth power. That means it can detect this chemical, when 1 cm³ is distributed in sixty times the whole water of the Lake of Constance, the largest lake in Germany. Moreover, it means that a single molecule can stimulate the fish. In this respect the eel is similar to the dog.

Eel fishermen know well that eels are only attracted by very fresh natural bait and that stories of eel feeding on human corpses or caught in rotten horse skulls are fairy tales. The smell of the most attractive bait for eels often has for the human nose a peculiar odour, such as smelt, which smells somewhat like cucumbers; shrimps and pier worms which smell like iodine and so forth. As eel-bait in commercial fisheries is often lacking, it would be useful to have a chemical substitute. In some experiments we prepared less attractive food with chemicals that smelled like smelt or iodine or like fish meat. We tested many amino-acids and other substances, but up to now without obtaining a really positive result. In journals of sport-fishermen one finds numerous advertisements of lures such as "Ready Bites", "Gypsies Secret", "Ali Baba" and of other obscure and mystic names, but I daresay that this is all humbug. These substances usually have the smell of anise, musk, civet, castor valerian and even faeces - odours which indeed have a function in the sexual sphere of mammals, but which are of no biological meaning for the eel. In our experiments some of the lures even proved poisonous to eel, others were an effective repellent.

In another series of experiments it was investigated if chemicals which were used for preservation of the netting or which accidentally often came into contact with the gear, were repellents. Indeed some tar products and chemicals used to finish off netting or to fix the knots were first avoided, but were washed out after a few days and did not scare the fish further. Tubes of polyethylene were not accepted as shelters, because its solvents are soluble in water. These facts may explain the observation that new gear is usually inefficient for some days.

Despite their sensitive odour perception, eel, while in their refuges, were very resistant to strong and unpleasant odours. By means of an arrangement of tubes which served as eel shelters and into which chemicals could be introduced, a test was made of how strong a solution had to be before the eel was forced to leave the tube. I must mention that during the experiment the eel could not see the operator. It was discovered that the concentration of many acids of caustic solutions and copperacetate, which is said to be fish repellent, had to be of the order of 1:10 000 or 1 per 1 000 even, before the eel would leave the tube.

It was found that these concentrations were such that they could easily be tasted by the human tongue. This may explain why eels stay in waters contaminated to such an extent that their meat becomes unpalatable.

Among the most efficient deterrents was ammonia, which was effective at concentrations of the order of 1 per 100 000, and also strong irritants for mucous membranes (which are used as lachrymants and tear-gas) like Allyliscthiocyanate and Phenacyl chloride. These chemicals induced an avoidance reaction at a dilution of 1 per 1 million. It should be pointed out that these were unconditioned reactions, whereas the sensitive reactions mentioned earlier, in respect of which the eel was found to react in a manner comparable to the dog, were conditioned reactions.

Lastly I would like to mention some of the experiences noted of the behaviour of the eel when put into tanks or aquaria. Whereas elvers and very small pigmented eel will

feed immediately, larger eel refrain from food for up to 4 weeks after their capture. Little by little they become somewhat tame, but habituation to the experimenter is less obvious than in most other fish. Homing to a certain tube or other refuge does not usually take place. This can easily be demonstrated by using eels of different colour or by tagged ones. Yet on a larger scale homing was observed by Tesch, who found that eels returned to their original habitat when released at distances up to 180 km away in the southern North Sea.

Newly caught eel when placed in a tank obviously feel rather uncomfortable and are nervous and gregarious. They gather together into a mass or try to force themselves into the same tube. They do not bite each other and do not bully the smaller ones.

During the following 4 weeks, however, when they become acclimatized and feel secure from danger, their behaviour changes to grossly selfish habits. They do not tolerate another eel in the same tube, although there would be sufficient room, and smaller eels are driven out of their shelters and bitten seriously. This different behaviour in poor conditions and in comfort is a feature the eel has less in common with the dog, but more in common with man.

DISCUSSION

- O'Leary - asked about the effect of light colour.
- Mohr - according to the investigations of Wunder the eel is colour-blind as it has no cones in its retina.
- Moriarty - are the fish movements in any way affected by the electrical field of the detecting device?
- Mohr - the counting mechanism was released by strings: there was no electrical field.
- O'Leary - is any information available on the effect of noise, because at the Electricity Supply Board Eel Weir at Killaloe there was considerable noise due to the vibration of steel bars used in the traps?
- Mohr - eels tended to show movement away from the source of vibrations.
- McGrath - is any information available on the effect of sudden changes of water velocity on eels?
- Mohr - very little information is available and this might make a basis for further study.
- O'Leary - the maximum velocity in a river usually occurred about 0.3 D (D = depth). In small runs of eels the maximum intensity of the run was practically on the bottom. During periods of heavy floods and muddy waters the eel run appeared to be uniform over the cross sectional area.
- Vickers - is any information available on the effect of artificial lights on eels kept in total darkness for the 24 hours of the day?
- Mohr - information on this subject is not complete but it appeared that eels will feed during the normal night period even though kept in darkness over the full 24 hours.
- v. Brandt - commercial considerations often compel fishermen to take their gear out of the water before the entire swimming activity had ceased. It is therefore not possible, due to marketing conditions, etc., to reap the full benefit of scientific information on this matter. He also recommended that a trap should be 14 days in the water before an assessment could be made. Chemicals used in the manufacture of a trap will then be washed

away and it should be possible to get a true assessment.

Deelder
v. Brandt

- the vibration from larger meshes in nets was adequate to deflect eels.
- the problem of nets was difficult. With large meshes you must have a heavier material. With small meshes the material can be lighter. This will affect the assessment of the effect of vibrations.

McGrath

- they have found by experience that galvanized mesh perch traps work more effectively when painted black, than when left unpainted.

APPENDIX 5

FISHING FOR EELS WITH LONGLINES

by

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In the introductory report about eelfishing methods it was mentioned that eel fishermen generally are specialists. Among these specialists is the group of fishermen who operate with longlines only. This method needs a lot of experience. The successful fisherman has to know how to construct the longline; where in the lake or river, backwater or sidewater, it has to be set and at what time and how; finally which kind of bait is the best one to use. This knowledge can only be acquired by many years of practical work.

In this report about longlining for eels a summary of this important fishing method will be given.

1. THE GEAR

During the feeding season good catches of eel can be made with longlines. For this fishing method a relatively small expenditure of material and manpower is necessary.

Generally speaking the basic construction of a longline for eels does not differ from any other one. Each longline consists of a mainline to which the branchlines with hooks are attached at equal distances.

There are many variations in the construction of the eel-longline as regards the twine numbers for main and branchlines; the length of branchlines; the distances between the branchlines and, last but not least, the shape and size of the hooks. Therefore in describing the gear some examples only are given.

Today all eel-longlines used in German freshwater fisheries are made of twisted or braided synthetic yarns, mainly polyamide-continuous, sometimes staple fibre. The specification of yarns used for mainlines varies from 23tex × 21 to 23tex × 36; the yarn

numbers for branchlines vary between 9 and 23tex × 18. Sometimes for the branchlines polyamide-monofilament is also used, with a diameter of 0.40 mm to 0.60 mm. To these branchlines the hooks are attached with special knots (Fig.1). Generally the material of the branchlines is weaker than that of the mainlines.

In our eelfishery longlines the distances between the branchlines range from 1.8 to 4.5 m and the lengths of the branchlines themselves vary from 0.3 to 1.8 (Fig. 1). Branchlines should never be longer than half the spacing between them, in this way the entangling of the hooks with each other will be avoided.

Normally an eel-longline is made up of sections, each consisting of from 100 to 250 hooks. Ten or four sections respectively with one thousand hooks in all are set out. But there are also fishermen who operate with up to three thousand hooks.

The choice of the right shape and size of hooks is also of great importance in eelfishing. A small hook can be swallowed too deeply by the eel, which is undesirable. On the other hand a large hook cannot be taken by a small eel. In handling the longline and when baiting the hooks, they must also be of a suitable size and be of a good shape. Two types of hooks (Fig. 2) of the following numbers are used by the German fishermen:

- (i) The "Kirby hook", with a point bent sideways, of sizes No. 2/0 to No. 2 and
- (ii) The "Carlisle hook", with a straight point, of sizes No. 18/10 mm and No. 18/7 mm.

Of these two types the first one is mostly preferred. In the opinion of fishermen the hook with the point bent sideways allows of quick baiting with small fish: the other hook, the so-called "Carlisle hook", made of finer wire, is preferable for baiting with dew worms.

Before speaking about baits some remarks are appropriate about the characteristics of hook-sizes. The size numbers for hooks do not give a clear indication of the true size of the hooks. These numbers have been more or less introduced arbitrarily. The size of a hook may be better indicated by its hook spread (Fig. 3). This means the widest distance between the outside edge of the hookshank and the outside edge of the bend. It is not the distance between the point and the inner edge of the shank. This is called the hook opening or the gap of the hook.

In the case of the "Carlisle hooks" the hook spread has already been added to the size number by the manufacturer. The hook spread for the "Kirby hooks" has been measured in addition. It ranges from 12.3 mm for No. 2/10 to 9.5 mm for No. 2.

2. THE BAIT

The provision of bait causes many problems. This refers not only to the question of which kind of bait is the most attractive for catching eel with longlines, but also sometimes to the difficulty of procuring the bait in sufficient quantity. The fishermen use dew worms which are collected during the night after the rain by the light of a hand-lamp. But with this kind of bait small eels mostly are caught. Crayfish, after the moult, or crayfish tails are also considered to be effective baits, but they are seldom available in a sufficient quantity. Crushed freshwater snails are sometimes used. But the most important baits in eelfishing are small living, sometimes also dead, fish of the following species:

smelt (Osmerus eperlanus L.),
bleak (Alburnus lucidus Heck),
gudgeon (Gobio fluviatilis Cuv.),

small roach (Leuciscus rutilus L.),
small perch (Perca fluviatilis L.), and
stone perch (Acerina cernua L.).

According to some fishermen the following fish are sometimes useful:

red eye (Soardinius erythrophthalmus L.)
white bream (Blicca björkna L.) and
stickleback (Gasterosteus aculeatus L.).

Fishing for live bait is carried out by means of special bait seines; with lift nets; with skimming nets; with double stick bait nets (Fig. 4) or sometimes with small trawls with very small mesh in the codend.

The small fish caught with one of these methods are held in small meshed net bags or bait cans until they are needed for baiting the longline.

3. STORING THE LONGLINE

In order to keep the longline from becoming entangled it is necessary to store the hooks separately. The fishermen do this in different ways. Very popular is the use of clamps in which the hooks are inserted one after another (Fig.5). In each clamp the hooks of one longline section are stored. The mainline is put loosely in a wooden tray. Another method of storing the hocks is shown in Figure 6. Here the hooks are stuck into strips of cork nailed upon cross battens of a ladder-shaped framework. The strips of cork can also be attached to the edge of a basket or box (Fig. 7). Lastly a method of storing the hooks is mentioned where neither clamps nor cork-strips are used. The hooks are hung upon a piece of strong wire on one of the narrow sides of the box (Fig.8). During transportation the hooks are prevented from falling down by being bound with a piece of yarn.

4. HANDLING THE GEAR

After the longline and the hooks have been stored in one of these ways, they are ready for baiting and setting. If the fisherman is using living small fish for bait, then the hooks are baited during setting. These fish are fixed to the hook by sticking the point through the dorsal muscle, sometimes also through the lips without unduly wounding the fish. In this way the fish can be kept alive for a longer time. Dead fish are also useful for baiting but only as long as the water is not too warm. These baits are attached to the hook by sticking the point through the head or through the operculi.

Normally two men are necessary on board a motor or rowing boat for setting the longline. One man baits the hooks and throws out the line while the other one keeps the boat on the right course and at the right speed. The man setting the line has to ensure that the mainline is not stretched out too tight on the ground. Setting the line loosely on the ground (Fig.9) is preferable because otherwise the eel taking the baited hook would soon feel the resistance of the line and would let the bait go. The beginning and the end of the longline are marked by anchored buoys. But because of fish thieves in some lakes the fishermen sink the ends with sinkers down to the bottom without any bouy. For hauling the line, one end is caught and taken up by a little searching anchor.

In this connection it must be mentioned that the eel-longline is not always a groundline. In some cases, if the fishing conditions make it necessary, the mainline is lifted up more or less from the ground by attaching little floats and sinkers alternately (Fig. 10).

Another method of setting the line is used if the hooks are baited with dew worms. In this case the hooks are already baited on shore. The baited hooks are put one after another in rows into wet sand in a special box and covered with sand. The mainline is then put loosely on top of the sand. One side of this box must be left open, in order that during setting the line with the hooks can run off freely by itself after the start of it has been sunk in the water.

The time for setting the line is the late afternoon or the evening. Fishermen advise that it is advantageous to start hauling the line early in the morning because later the caught eel becomes too active, and some of them escape.

Two men are necessary also for hauling the eel-longline. One of them hauls the line and places it in the wooden box from which the line has been set out. The second man follows the line with the boat.

The eels caught are out from the branchline and put into a waterfilled tank or net bag in the boat in order to keep them alive.

After cleaning the longline and replacing the missing hooks on shore, the gear is made ready for setting again, the hooks being stored on clamps, cork-strip etc. as described before and the line coiled down in the box.

DISCUSSION:

McGrath - asked for information on removal of hooks.

Kaulin - the eels are cut open when the hooks are swallowed deeply, otherwise the hooks are pulled out.

McGrath - suggested that pulled-out hooks could result in death in transit.

Kaulin - not aware of damage.

McGrath - was sinker and float arrangement required to counteract effects of thermal stratification?

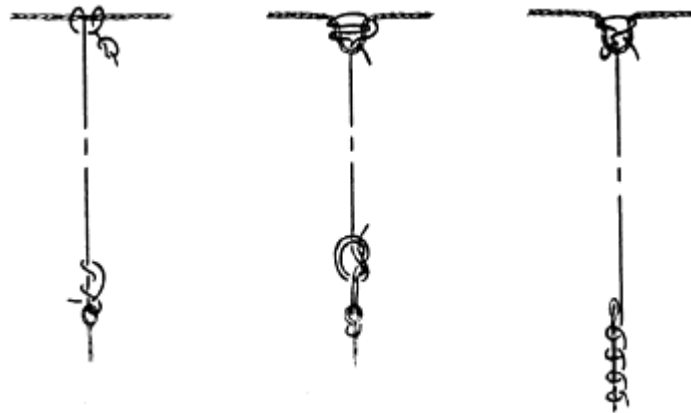


Fig. 1 Construction details of an eel-longline with descriptions of different knots for attaching branchlines to the mainline and hooks to the branchlines

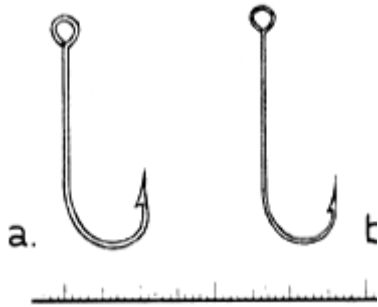


Fig. 2 "Kirby hook" (a) and "Carlisle hook" (b)

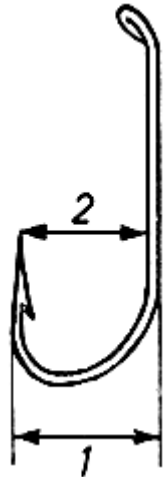


Fig. 3 Hook spread (1) and hook opening (2)

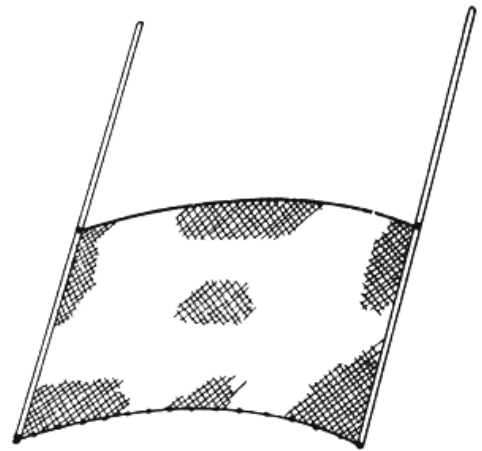


Fig. 4 Double stick bait net

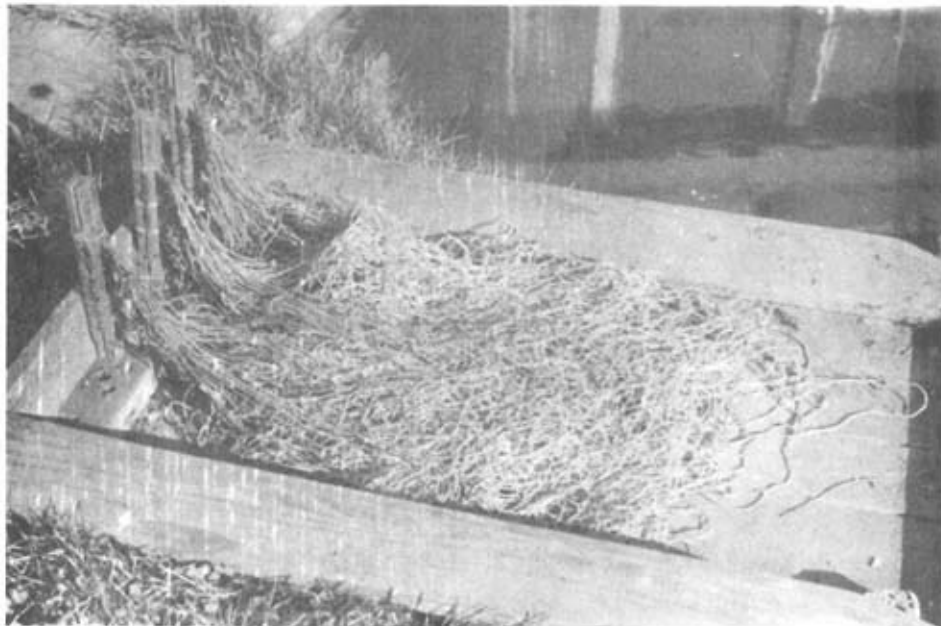


Fig. 5 Storing the longline for eel. The mainline has been coiled in a wooden box, the hooks are put into clamps.



Fig. 6 The hooks have been stuck into stripes of cork upon battens of a ladder shaped frame-work.



Fig. 7 Sticking the hooks into the border of the wooden box. To the border also stripes of cork can be attached.

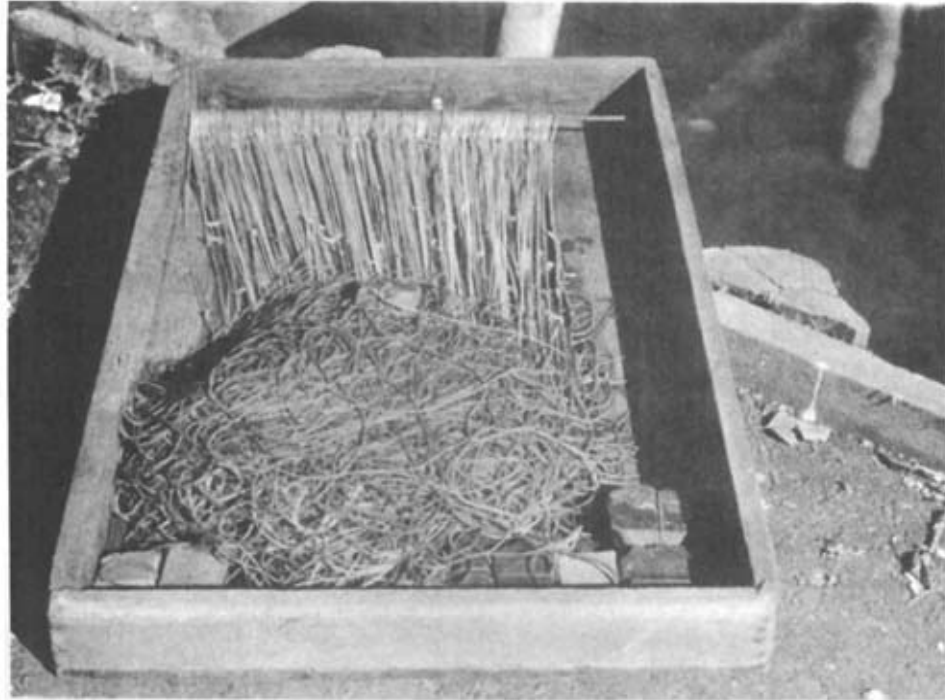


Fig. 8 For storing the hooks they have been hanged over a piece of stronger wire.



Fig. 9 Setting the longline loosely to the ground.



Fig. 10 Lifting up the eel-longline from the ground by attaching floats and sinkers alternately to the mainline.

APPENDIX 6

EEL STOWNETS IN GERMAN RIVERS

by

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1. INTRODUCTION	

Stownets are long, cone-shaped netbags with a large net opening. The typical shape of a stownet is demonstrated by Figure 8c. Only the net entrance is fixed by a special device, the netbag must be kept opened by relatively strong water current. Stownets, therefore, are gears of the running water of rivers and of coastal regions with tidal water. According to the device by which the entrance of the net is kept opened, three main types may be distinguished:

- (i) stownets at stakes
- (ii) stownets at anchors, and
- (iii) otter board stownets.

All three main types are still used in German rivers, though it should be mentioned that their quantity decreases from year to year. As an example, mention should be made of the situation in the biggest German river, the river Rhine. Here, several hundreds of large stownets connected to anchored vessels (see Figures 5 and 8) were operated before the Second World War. Until 1961 the number had diminished to about 90 gears, and in 1969 only 32 stownets were still fishing in a length of about 700 km of the Rhine. Similar observations could be made in all big German rivers. There is no room left for such gears in the rivers of highly industrialised countries. In order to display their great efficiency in catching migrating silver eels, the stownets should be set in the midst of the current.

As already mentioned in the paper of v. Brandt, canalization, barrages, weirs, increasing shipping traffic and pollution of water frequently make the use of these gears impossible. The Rhine, for instance, does not only belong to the rivers with the highest density of shipping traffic in the world, but is also one of the most polluted rivers in Europe.

2. TYPES OF EEL-STOWNETS

In the following, brief descriptions of the various types of eel-stownets are given. In addition, some details may be taken from the tables and figures.

2.1 Stownets on Stakes

These gears are usually set in rows, side by side, between stakes driven into the bottom. The stakes are made of wood (see Fig. 1) or are strong iron tubes (see Fig. 2). The rectangular net entrance is surrounded with a frame rope which, at the four corners, is connected to the stakes by rope loops or metal rings.

Dimensions of stownets on stakes:

River	Ems, estuary	Middle Weser
Net opening	6.30 m × 3.30 m	4.50 m × 3 m
Length of the net	about 20 m	18 m
Stretched mesh at the entrance	80 mm	80 mm
Last part of the net	codend with 1 funnel	fyke net with 2 funnels

2.2 Stownets at Anchor

Various types of stownets at anchor are used in German rivers.

2.2.1 Stownet at anchor without vessel

These gears have a closed, four-sided frame, mostly made of wood. Four steel-wire ropes go from the corners of the frame to an anchor which is anchored in the bottom of the river. In former times this kind of gear was operated in many German rivers also with deeper water and hard bottom, where stownets on stakes could not be set. Inasmuch as this type is stationary and immovable in the same way as stownets on stakes, it has disappeared from big rivers.

2.2.2 Stownet at anchor with vessel

Many vessels used for this purpose do not possess an engine (e.g. in the rivers Rhine, Moselle, Maine). They have only the function to hold the catching gear, to serve as a platform for the work of the fisherman and sometimes as his lodging during night catching. Such vessels are illustrated in Figures 3 (Moselle) and 5 (Rhine). As an example the anchoring system of a vessel (called SCHOKKER) in the Rhine and the connexion between vessel and gear is shown by the three drawings of Figure 8. By lengthening or shortening the two ropes connecting the vessel with the bank and the gear, it can be shifted to a limited extent. All vessels fishing in the estuary of the big rivers are provided with engines by which they are enabled to change the catching place. These vessels have a length of 12 to 18 m with 60 to 120 hp.

In former times the entrance of the nets at anchor with vessel were mounted on a closed four-sided frame as indicated by the small drawings of Figure 6. Nowadays, however, most fishermen have replaced this frame by two beams, as shown by Figure 7, and as it is usual for a long time in the Rhine fishery (see Figs. 5 and 8). The wooden

lower beam is loaded by chains. Vessels fishing in the estuary ever have two gears, fitted to either side of the vessel (Fig. 6).

Several fishermen in the Moselle and the Middle Weser do not use one gear on each side, but two smaller gears on each side of the vessel (Figs. 3 and 4).

A special, unique arrangement of stownets in the river Moselle is shown by Figure 9.

2.3 Otter Board Stownet

Figure 12 will give an idea of this most modern and most effective gear for catching eels in rivers. It consists of a large bagnet of about 32 m in length with a net opening of 16 m × 3 m, two wings, each of a length of 20 to 25 m, and a floating otter board. This gear was developed by the river-fisherman Koethke, 30 years ago.

The construction of the otter board may be seen from Figure 13, further details are mentioned in Table IV.

Advantages of the otter board stownet in comparison with the other types of stownets:

The large net opening and the wings give a much higher catching efficiency. The river can be shut off at a width of about 50 m.

No vessel is required if it is possible to anchor the two main ropes (Fig. 12) on one side of the bank.

The gear can easily be operated from the bank by only one man. By moving the rudder of the otter board by means of a rudder-line ("c" Fig. 12) the gear can be brought in a short time either into the free water in catching position or to the bank. In this way the gear is no hindrance for the shipping traffic. There are no ropes in front of the net opening, which possibly could scare away the fishes.

During the whole fishing period - from April to November - it is not necessary to take the gear (which is made of synthetic netting yarns) out of the water. If it does not fish it is lying in inoperative position near the bank under water.

3. NET MATERIALS OF STOWNETS

Nowadays most of the stownets are made of polyamide filament netting yarns. The netbags are knitted from 3 or 4 sizes of netting yarn. Examples are given in Tables II and III. Experiments carried out by the author have shown that netting yarns made of polyethylene monofilaments are still more suitable for stownets, especially in very polluted waters. This floating and waxy material does not pick up so much dirt, and it is easier to clean the nets. Examples for the fineness of the netting yarns used for otter board stownets are given in Table IV.

Ten years ago all types of stownets have been knitted by hand in the form of rings with a great number of gradations in mesh size and fineness of netting yarn. (See the various mesh sizes of the stownet in Table II).

Nowadays most fishermen are making their nets from machine-made netting of different mesh size. The nettings are mostly out into rectangular strips and sewn together. The manufacturing of the nets from trapezoidly-out panels, as shown in Figures 10 and 11, is of recent date and was introduced by the Institute.

Table I

Stownet at anchor with frame - Type River Moselle

In running water, used in conjunction with vessels without motor. Special type with 5–6 units (see Fig. 9) (Generally the vessels on the river Moselle have only two units).

Netting

Net material: Usually the nets are made of PA netting yarns (staple fibres or continuous filaments) and are knitted by hand. Here, the most modern gear is described, made of polypropylene split fibres and out from machine-made netting.

Panel	Rtex	Wet knot break load Kp	Opening of mesh mm	Number of meshes			Cutting rate
				upper edge	lower edge	depth	
1	2	3	4	5	6	7	8
A	1 110	50.8	140	450	450	5	-
B	1 110	50.8	140	4×112	4×72	31	1N4B
C	785	41.6	110	300	300	10	-
D	785	41.6	110	4×75	4×51	40	5×1N1B+2N1B
E	383	23.4	70	210	210	15	-
F	383	23.4	70	4×52	4×30	55	2N1B
G	196	11.6	24	276	276	100	-
H	196	11.6	24	182	182	100	-
In G and in H a valve							

a: Frame rope, length 6 m × 2.80 m, diameter 15 mm, made of polypropylene monofilament.

Table II

Stownet at anchor with frame - Type River Rhine

In running water, used in conjunction with vessels without motor. Only 1 unit per vessel (see Figs. 5 and 8).

Netting

Net material: Braided or twisted netting yarns made of PA continuous filaments.

Panel	Rtex	Wet knot breaking load kp	Opening of meshes mm	Number of meshes	
				circumference	depth
1	2	3	4	5	6
A, 1*	2 800	160	240	640	4
2	2 800	160	232	620	4 ½
B, 3	2 000	110	226	600	4 ½
4	2 000	110	220	580	5
5	2 000	110	212	560	5
6	2 000	110	206	540	5
7	2 000	110	200	520	5 ½
C, 8	1 600	90	192	500	5 ½
9	1 600	90	186	480	5 ½
10	1 600	90	180	460	6
11	1 600	90	172	440	6
12	1 600	90	166	420	6 ½
13	1 600	90	160	400	6 ½
D, 14	1 250	65	152	380	7
15	1 250	65	146	360	7
16	1 250	65	140	340	7 ½
17	1 250	65	132	320	8
18	1 250	65	126	300	8
19	1 250	65	120	280	9
20	1 250	65	112	260	9 ½
21	1 250	65	106	240	10
E, 22	800	45	100	220	11
23	800	45	92	200	11 ½
24	800	45	86	180	12 ½
25	800	45	80	160	14
26	800	45	72	140	15
27	800	45	66	120	17
28	800	45	60	100	18
29	800	45	56	80	19

* The net is composed of netting rings (in this example 29 rings, which are knitted by hand. At the opening of the net, in each of the four corners, 2 × 15 meshes are gathered up.

F: terminal fyke net

total length in the hoops : 4.5 m, two funnels,
 opening of meshes at the beginning : 32 mm
 opening of meshes at the end : 24 mm
 height (diameter) of the 3 circular hoops : 500 mm

Ropes				
Item	Material	Diameter mm	Breaking load Kp	Length m
a	steel wire	18	14 000	10–15 (2x)
b	steel wire	14	8 000	15 (4x)
c	steel wire	12	6 000	
d	steel wire	16	12 000	
e	steel + manila combin.	14	3 000	30

Accessories

Two beams, wood, round, diameter 200–240 mm, length 11–12 m, under-beam loaded by thick chains.

Four winches: 1 anchor winch (motorised),
 1 winch for the lower beam of the gear (motorised),
 2 winches (by hand) for the upper beam.

(Owing to the variations in conditions at the different fishing places in the river Rhine - rapidity of current, depth of water - there is no uniformity in the construction of the stownets. The gear described above is used at a fishing place with a strong current.)

Table III

Stownet at anchor with frame - Type River El be (Estuary)

In running water, used in conjunction with vessels of 15–16 m LOA, 60–120 horse power - Crew - 2 men. 2 units per vessel (see Figs. 6 and 7).

Netting

Net material: Twisted netting yarns made of PA continuous filament.

Panel	Rtex	Wet knot break load Kp	Opening of mesh mm	Number of meshes			Cutting rate
				upper edge	lower edge	Depth	
1	2	3	4	5	6	7	8
A	1 100	56	80	750	750	12	-
B	1 100	56	80	700	700	12	-
C	1 100	56	80	650	650	12	-
D	720	44	60	6x133	6x93	83	2N1B+1N1B
E	550	36	40	6x136	6x90	150	3N1B
F	400	26	24	6x150	6x39	333	3N1B
G	320	22	24	200	200	125	-
H	320	22	20	220	220	200	-
valve G	20	22	24	200	2x20	62	1N4B
valve H	320	22	20	220	2x20	90	1N2B
Hanging ratio at the net opening (A) = $\frac{a}{A} = 0.61$. In each corner 2 × 25 meshes connected to 2 × 15 cm line.							

Ropes

Item	Material	Construction	Diam. mm	Break load Kp	Length m
a	PP+steel combination	6 strands. Z	16	2 900	28–30
b	Steel wire		20	17 000	20
c	Steel wire		14	8 000	2x50
d	Steel wire		12	6 000	12x10

Accessories

- I: a round (cylindr.) beam, wood, length 9 m, diameter 140 mm
- II: an iron tube, round (cylindr.), length 9 m, diameter 80–90 mm

Table IV

Otter board stownet (Developed by H. Koethke)

This gear can be employed in the main stream of large rivers. It is operated from the bank of the river, without using a vessel. It consists of a large bagnet - (with a net opening of about 16 m × 3 m) - and of two wings, each of which is 20 to 25 m in length. One of the wings is attached to a large floating otter board “swimming” in the main stream, by means of which the net is kept stretched open away from the side of the channel (see Fig. 12).

Netting

Net material: Twisted netting yarns made of polyethylene monofilaments. The codend consists of netting yarns made of polyamide contin. filaments.

Panel	Rtex	Wet knot break load kp	Opening of meshes	Number of meshes		
				Upper	Lower	Depth
1	2	3	4	5	6	7
A (wing)	1 437	76	140	200	200	3m
B	1 437	76	140	1 000	1 000	8meshes
C	1 437	76	140	1 000	800	72meshes
D	1 096	48	110	800	800	8meshes
E	1 096	48	110	800	600	72meshes
F	709	37	70	600	600	10meshes
G	709	37	70	600	200	140meshes
H(codend) PA	320	22	24	400	400	600meshes

Hanging ratio of panel A (wings) : $\frac{b}{A} = 0.78$

Hanging ratio of panel B (net opening): : $\frac{b}{B} = 0.33$

Colour of PE netting: green (coloured during fibre manufacturing process); without preservation.

Ropes

- a: anchor ropes made of steel wire; diameter 14 to 18 mm, breaking load 8 000 to 14 000 kp;
- b: frame rope made of polypropylene film or of polypropylene monofilaments; diameter 16 mm, breaking load 3 000 kp
- c: rudder-line made of steel wire with a diameter of 4 mm or made of polypropylene monofilament with a diameter of 8 mm

Otter board

(For details see Fig. 13)

Material : wood and iron
Shape : rectangular
Length : about 4 m with rudder
Height : 2.50 to 3.00 m

Float of the otter board:

Material: galvanised iron plate, 2 mm thick, diameter
of the cylindrical float: 0.30 m length: about
3.50 m

Danleno

to be fitted between net opening and wings and at the end of
the wing going to the bank.

Material : galvanised iron plate, 2 mm thick
Shape : cylindrical, the ends are closed
Diameter : 70 to 100 mm
Length : about 3 m

Buoys projecting out of the water to be fitted as shown in
Figure 12.

DISCUSSION:

McGrath asked for definition of stownet.

v. Brandt- Stownet is an English word, equivalent to the German 'Hamen'. The essentials of the stownet appear to be that the mouth is held open by rigid frame or by floats and weights and that the net itself is supported mainly by the current. The limiting factors where stownets are used include the strength of the current, the nature of the holding ground for anchorage and the burden of leaves and other material in the river.

O'Leary asked if there were any figures available for the efficiency of a stownet in relation to the cross sectional area of the mouth. He would also like to have available some figures for the drag of net expressed in kg/m². He also would like to know the minimum economic catch per annum, which would justify the cost of installing a large stownet.

V. Brandt said that current meters have been used to try to measure forces involved but results had been contradictory. The changes in material used in net making also made reliable assessment difficult. It was not clear whether two small nets in an opening or one big one would give the better result. Materials such as polyethylene and polypropylene are good for ease of cleaning. Stiff material is preferred since soft materials tend to be too flexible. No general information was available on the size of the minimum catch which would justify the use of a particular kind of net. The minimum economic catch per annum should be 1 000 to 1 500 kg under German conditions.

Moriarty asked why the nets were hung close to the surface.

v. Brandt - Surface is chosen by experienced fishermen who have found that the greatest number of eels are found there. According to tests made in the river Elbe the silver eel does not migrate near the bottom of the river channel. The otter-beard stownet can be used at any point on a river but traditionally good places are used. A licence duty is payable.

McGrath asked if there was any problem in removing trash from stownets moored to ships.

V. Brandt stated that the fishermen do not usually live on the boats, but would usually visit the nets during the night.

Vickers - was there any advantage to be gained in hanging the stownet between two boats?

V. Brandt saw no objection to using two boats, but thought it would be a rather expensive method which would not normally be justified. The size of the net is limited by boat traffic. Better to fish without a vessel and to use an otter board instead.

McGrath asked for information on the factors which determined the net length in proportion to width.

v. Brandt - length depends largely on angle of cutting of the mesh.

O'Leary asked if V. Brandt would state the best angle with the river section for the mouth of a stownet.

v. Brandt said this figure seemed to vary from site to site and there was no defined angle.



Fig. 1 Stownets at stakes in the River Ems
(from G. Klust)



Fig. 2 Stownets at stakes in the River Middle-Weser
(from G. Klust)



Fig. 3 Vessel without engine with stownets at another with two beams in the River Moselle
- two small nets at one side of the vessel
(from G. Klust)



Fig. 4 Vessel with engine with stownets at anchor with two beams in the River Weser
- two small nets at each side of the vessel
(from G. Klust)



Fig. 5 Vessel without engine with the two beams of the stownet in the River Rhine
- here only one big stownet at one side of the vessel is used
(from G. Klust)

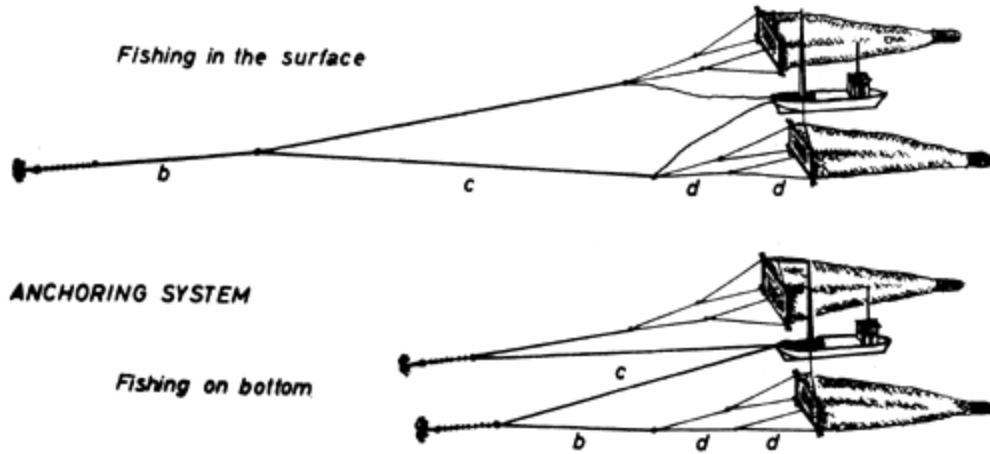


Fig. 6 Stownets at anchor in the estuary of the River Elbe. Vessel with engine; one stownet at each side of the vessel. Eelfishing: fishing in the surface.
(from Klust-Kaulin)

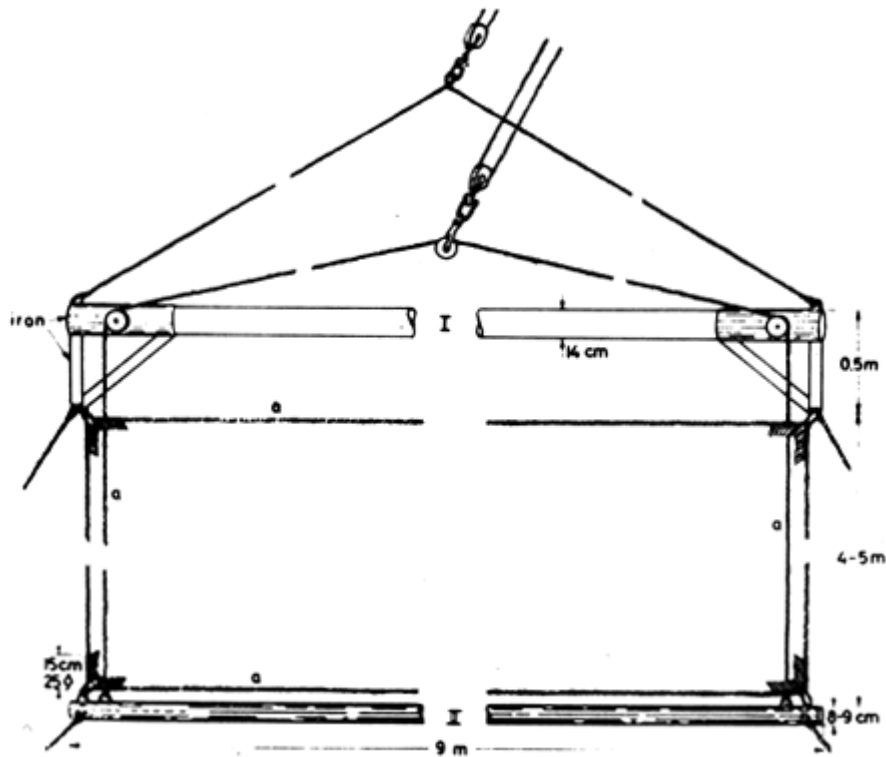


Fig. 7 Stownet at anchor in the estuary of the River Elbe (see Fig. 6 and Table III). Connection between the frame-lines of the net-opening and the two beams (modern type).
(from Klust-Kaulin)

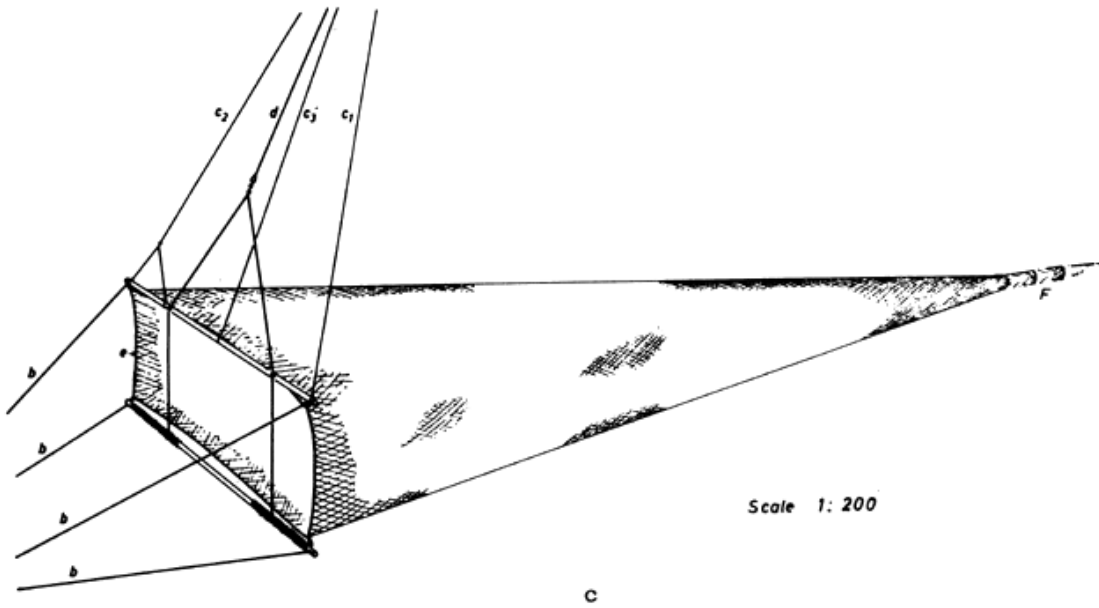
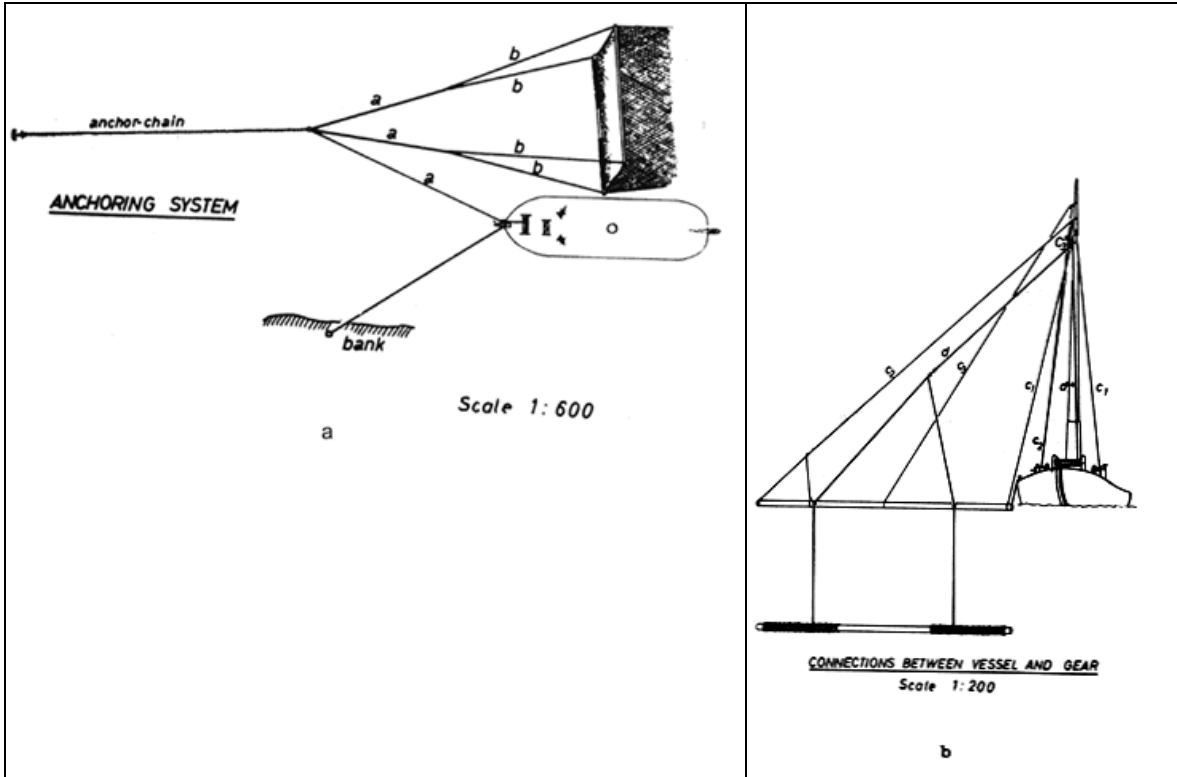


Fig. 8 Stownet at anchor - River Rhine type (see Table II).
(Klust-Kaulin)

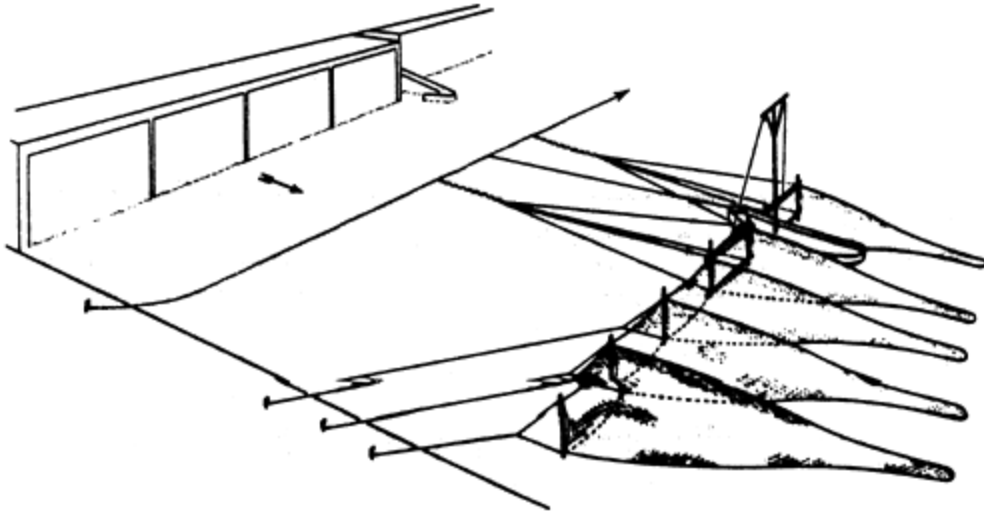


Fig. 9 Stownets at anchor in the River Moselle; 5–6 gears in a row behind a barrage. (Klust-Kaulin)

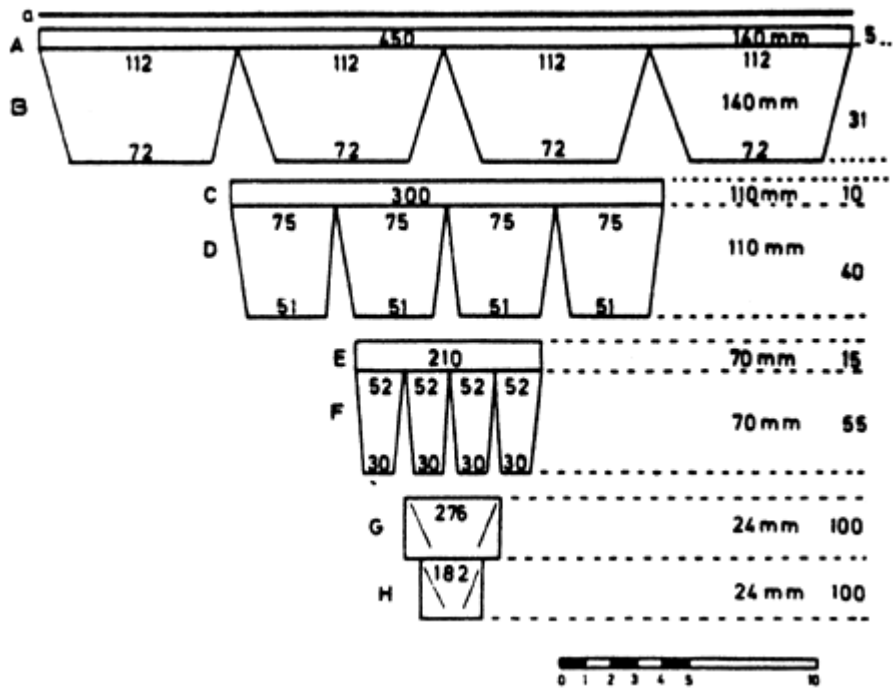


Fig. 10 Panels of one of the stownets (River Moselle, Fig. 9) (Klust)

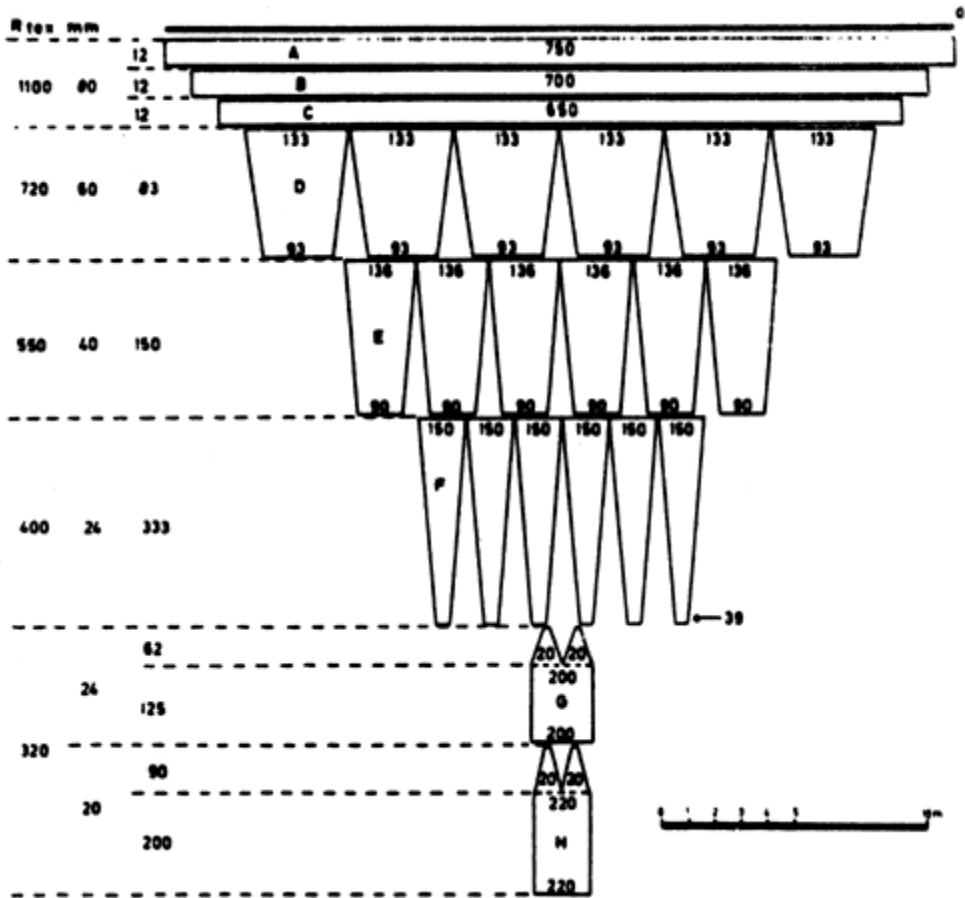


Fig. 11 Panels of the stownet at anchor, type estuary of the River Elbe. (described in Table III, see Figs. 6-7). (Klust-Kaulin)

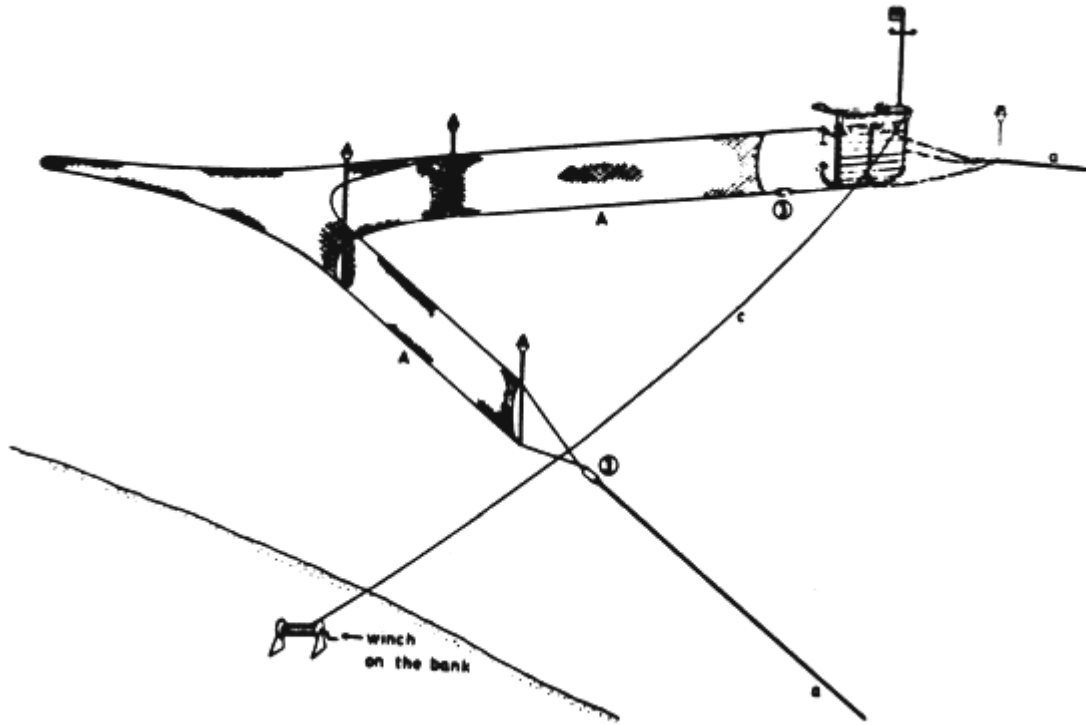


Fig. 12 Otter board stownet (Koethke) operated from the bank of rivers without vessel (schematised) (see Table IV).

- A : wings, each of which with a length of 20 to 25 m.
- a : steel wire ropes by which the two wings are anchored on the same side of the bank.
- c : rudder wire by which the rudder of the floating otter board (see Fig. 13) is connected to the winch on the bank.
- (3) : Buoys, to prevent shafing of the wire ropes on the bottom.

(Klust-Kaulin)

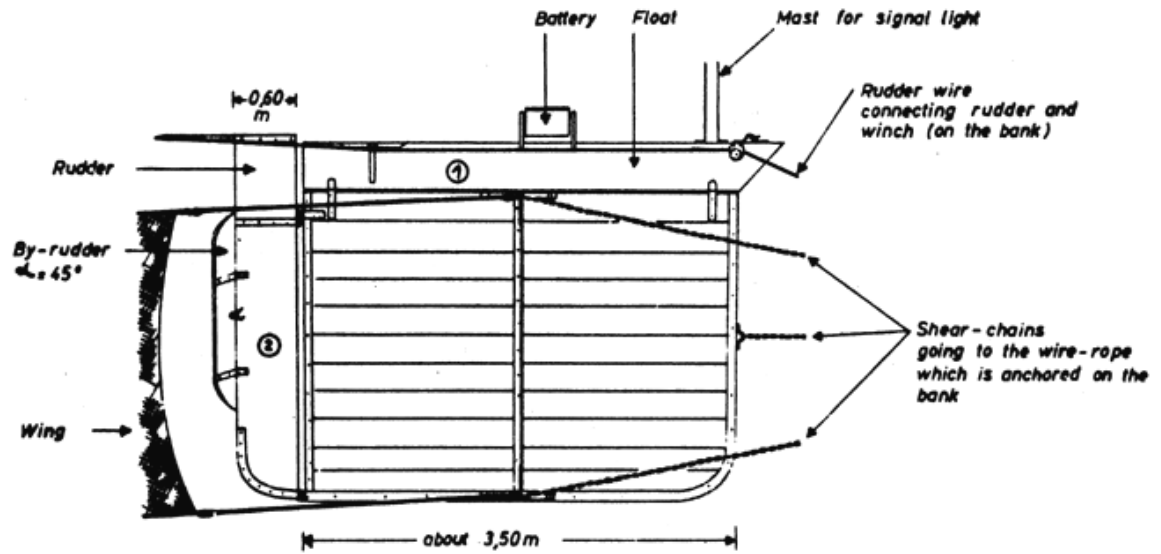


Fig. 13 Floating otter board of the otter board stownet (see Fig. 12).

- A : Cylindrical float made of thin galvanised iron plates.
- 2 : Rudder with by-rudder. (Klust-Kaulin)

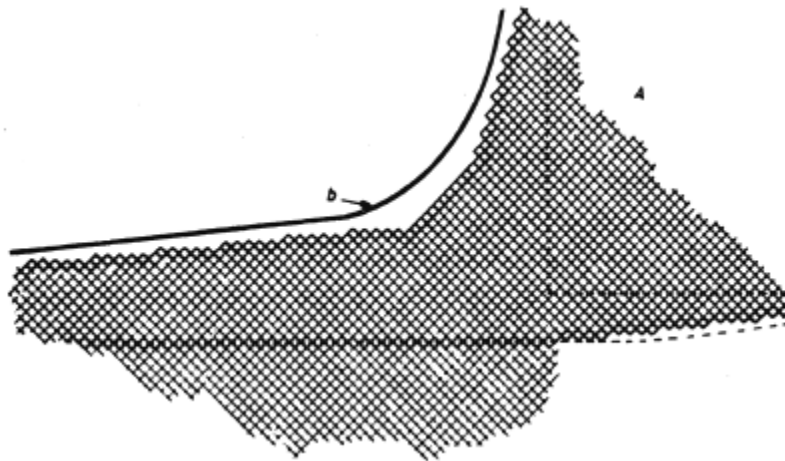


Fig. 14 Cutting of the netting in the corner between wings and net opening (Otter board stownet, Fig. 12).

- A : wing.
- b : frame-rope, made of polypropylene monofilaments or combination rope made of steel wires and polypropylene monofilaments (Klust).

APPENDIX 7

FISHING FOR EELS BY MEANS OF ELECTRICITY

by

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The electric fishing technique has aroused great interest in many countries in recent years. The reason could be the increased interest in fisheries - particularly sea fisheries - from which many people have expected great results by using electric current for fishing.

Moreover, the introduction of pulsed currents (which have a considerably greater physiological effect on the living organism than direct currents, and which have been used for a long time in human medicine) into electric fishing, has increased considerably the possibility of using electricity for fishery purposes.

It is now possible for the first time to design impulse generators driven by gasoline engines, which affect and even narcotize the fish by means of electrical impulses. In the eel fishery also great progress has been achieved by using electric fishing machines.

It will be of value to state some of the basic principles of electric fishing:

When direct current is passed into a fish tank, it can be observed that nearly all fish swim toward the anode, but before reaching it, they usually become stupefied and turn upside-down. When the current is switched off they recover and swim away.

There are several phases of reaction with the gradually increasing current density. The first visible reaction of the fish, if in a parallel position to the current direction, is that their bodies are vibrated by the current. The second reaction which occurs, if in the same position relative to the current direction, is that the fish swims towards the anode. The third reaction occurs when the fish turn on their sides towards the anode and are no longer able to move of their own accord. This reaction is called galvanonarcosis.

It has always been observed that the same relation exists between the reaction of the isolated nerve and that of the whole animal.

Polar excitability of the electrophysiology is valid also for the reaction of the whole fish. In the range of the cathode the nerves and muscles and also the whole fish are excited, in the range of the anode we have a narcotizing effect.

The best type of current to catch eels is direct current or else that produced by the discharge of a condenser - that is with a quick increase and a slow decrease. As regards the impulse frequency there exists a characteristic limiting number for each species of fish examined at which the paralysing effect is achieved with the use of the minimum power. The limits for eels are between 30 and 100 Hz, the optimum frequency being 30–50 Hz. In the laboratory we have made many experiments to establish the basic principles necessary for practical eel fishing. The present stage of technical development makes possible the manufacture of standard equipment, which can be

applied effectively in several different ways. It is only necessary to adapt the ancillary fishing gear (electrodes, cables and similar equipment) to the local requirements, and to the species and size of fish to be caught.

Such standard equipment should be adjustable over a wide range as regards voltage, impulse rate and impulse period, so that it can be employed in both fresh water and salt water.

Before electric fishing commences it is necessary to know all the details about the type of fishing to be done; the condition of the water and the bottom (conductivity, current etc.) and any special local conditions. The optimal data, such as intensity, voltage, rate of impulse and impulse period should be ascertained by means of a universal testing apparatus. With the aid of modern techniques several types of electrical fishing gear have been developed and designed to operate with either direct or impulse current.

One can catch eels by the electrified hoop-net method, in which the hoop net consists of a net with a metal ring, which acts as an anode and attracts the fish to this positive pole where they are narcotized and can be lifted out of the water. The cathode is a metal net or a metal plate. Practical experience has shown that the ratio of the sizes of the anode and cathode should be about 2:3.

The efficiency of electrical fishing gear depends very much on the size of the electrodes, especially on their relative sizes. The size of the electrodes is naturally limited by the nature of the waters to be fished. They must be of a handy size because the waters are frequently overgrown by shrubs and trees or are difficult to pass along and sometimes are shallow. The size used depends also on the energy of the electric fishing machine, because there is a relation between the surface area of the electrodes and the amperes which are produced.

The electrodes are connected to the electro-fishing apparatus which can be a direct current gasoline generator or an impulse gear. The impulse gear consists of an alternating current gasoline generator fitted with an impulse producer operated by thyristors. Voltage, frequency and impulse time can be regulated. For catching eel the best frequency lies between 30–50 Hz.

A method has been developed to make the eel-schokker-fishery more efficient. Heretofore, when fishing for eels by the so-called “schokker” a great number of fish escaped because the fishing net created a back-watering effect in the water which the eel experienced and as a result passed along the front of the fishing-net and avoided it. To overcome this, a guiding arrangement, comprising two chains of electrodes (the outer electrodes) as cathodes and one chain of electrodes as anode, was constructed.

The first outer electrode leads from the draw net of the first “schokker” to the bank of the river and is 40 m long. It consists of two steel cables one of which lies at the surface of the water and is attached to and insulated from the upper beam of the trawl net and from the bank, by a system of cordage (rigging), while the other is on the bed of the river.

The second outer electrode chain also consists of two steel cables, one laid on the bed of the river, the other being attached to the upper beam of the draw net of the second schokker and continuing to the front side of the first “schokker” (Fig. 1) being fixed and insulated from both nets in the manner already described.

The anode consists of two galvanised iron pipes threaded on a nylon cable which is fastened between the draw net of the first "schokker" and the bank of the river as shown in Figure 1. The pipes are 0.75 m long and 1 m long and are located within a distance of 5 m from the mouth of the net. The electrodes are connected with an impulse gear of 12.5 kW which consists of an alternating current generator and the impulse gear operated by thyristors. By using this electrified guiding system in the river "Rhine" it was possible to catch between 80–100 per cent more eels than with the unelectrified net.

In a lake in the north of Germany eels were caught by means of the so called "cathodic net". The cathodic net is a large net wall, whose head rope and sole rope are fitted with a cable. These cables are connected to the negative pole of the electric fishing gear and act as electrodes. By drawing the net by means of two boats across the water the fish are frightened and driven in front of the net to a place near the bank where the water is shallow and where they can be caught by the usual electrified hoop-net (Fig.2).

Another method of catching eels is the electrified seine net. I have tested this method at first in the south of France, in the lakes and channels of Camargue.

In view of the trend towards further intensification of fishing in lakes, more efficient seine nets are desirable. It is generally believed that by using electricity one will be able to improve the results being achieved by the net itself. This is also the case as regards the use of the electrified trawl for the capture of eels.

In the use of seine nets the problem is that the encircled fish escape in large numbers during the last phase of fishing, when the nets are being drawn and the concentration of fish becomes too great. In the Camargue a net with wings of 20 m width and 10 m length was drawn through the water. The upper and lower line were electrified by a 20 kVA gasoline generator which produced direct current. Because of the conductivity of the water, 130–150 V and 20–30 amperes were necessary for best results.

The width of the mouth of the net was 25 m. The length of the cables was 50 m. The catch with this net was very good. Within one hour 15 hundredweights of eels were caught, due, in part, to the great population of eels in the area fished.

In a lake in the north of Germany a seine net, 10 m long, was drawn across the water. Here again the upper and lower line of the net were supplied with cables. The length of the cable, which was drawn by two boats, was 80 m long. The electrodes employed in the fishing were connected with an apparatus of 7.5 kW, 100 volts and 20 amperes. By drawing this net over a distance of 500 m, 12 hundredweights of eels and other fish were caught. With an unelectrified net a fisherman would catch the same quantity of fish only by drawing the same size net over a distance of 6 km. This means that the rate of catching by the electrified net was increased 12 times over the normal rate for an unelectrified net. The following ideas and requirements emerged from these results:

- (i) Fish should fall into the net bags from which they are not able to escape during the whole process of drawing and not only in the last phase, after being concentrated by wings, as is the case with the conventional seine net.
- (ii) The electric field should be produced at the net mouth. By immobilizing the fish there, the possibility of escape is expected to be prevented. In this way the number of fish falling into the net bags during the whole process of drawing should be substantially increased.

- (iii) Fish should be under the influence of the electric current for as short time as possible. In order to achieve this, the end side of net bags must be located at a minimum of 10 m away from the electric field.

A model of the electric seine net is illustrated in Figure 3.

In Poland Mr. Chmielewski has carried out tests with another electrified net where a net partition of 30 m was placed in between the wings of a seine net. An alternating current of 50 Hz was switched on when there was still 400 m of wings to be drawn. The result was 700 – 1500 kg of fish for one operation.

Figure 4 shows the conventional seine net with the electrified net partition between the wings as employed in Poland. The seine net itself was modified for the purpose of electrification. The seine net, which has been used, was 600 m long. After the first 200 m the electrified net partition of 30 m was fixed between the wings.

Another model which was constructed in Poland and which is seen in Figure 5, consists of a number of net bags, attached to the frontal part of the seine net with rather short wings. The length of the frontal part is about 100 – 150 m. The wings are 50 – 75 m long. The net bags are fitted with special devices which make it impossible for fish to escape. The length of the net bags is 25 – 30 m. Electrodes are installed only in the frontal part of the net and are energized by a petrol engine driven A.C. generator, or two of them in parallel if necessary.

It is assumed that the net will be drawn by two anchored boats. With the width of the front being 100 m, the area fished by the net will be 10 – 20 ha. The hauling rate lies between 1 – 2km/h. Four or five people will be enough to operate the whole gear.

The Prototype of the Polish trawl was constructed in the Laboratory of Olsztyn. Tests under practical conditions were carried out at the State Fish Farm “Gizyoko”.

The net portions of the trawl are formed in the shape of a sack with short wings. The horizontal opening is about 8 m. Top and bottom lines are about 18 m apart and are fitted with electrodes. The electric energy is supplied from a petrol-driven A.C. generator, with step-down transformer and insulated electrical conductors fastened to one of the towing lines. No rectifiers or impulse units are used. The trawl is towed by two boats at the rate of about 1.5 km/h. The best type of boats for this purpose are those fitted with Diesel engines, with special belt transmission provided. With such an arrangement two people can carry out the whole operation. The length of towing line and the distance the boats are apart when towing depends on the depth of the water. The relationship between these two factors is given in Table I.

TABLE I

Water depth in m	Length of towing lines in m	Distance the boats are apart in m
3	30	40
5	40	50
7	50	60
10	65	80
15	90	100
20	115	130

The electric field, created in the plane of the net mouth of the trawl paralyses the eels in its path. Escape becomes very difficult and the eels fall back into the sack located about 15 – 20 m away from the net mouth. The voltage gradient is very low there.

Because of this the eel recovers quickly and is therefore in good condition when caught and reaches the market alive.

Fishing performance per one hour of towing depends on the population of eels in the area fished.

By means of the methods described above it is possible to make eel fishing with nets more efficient and more productive.

DISCUSSION:

McGrath - the experience in Ireland had been that a triangular wave-form D.C. pulse of 10 Hz was effective for the capture of silver eels while a pulse of 40 – 50 Hz was more efficient for the capture of yellow eels.

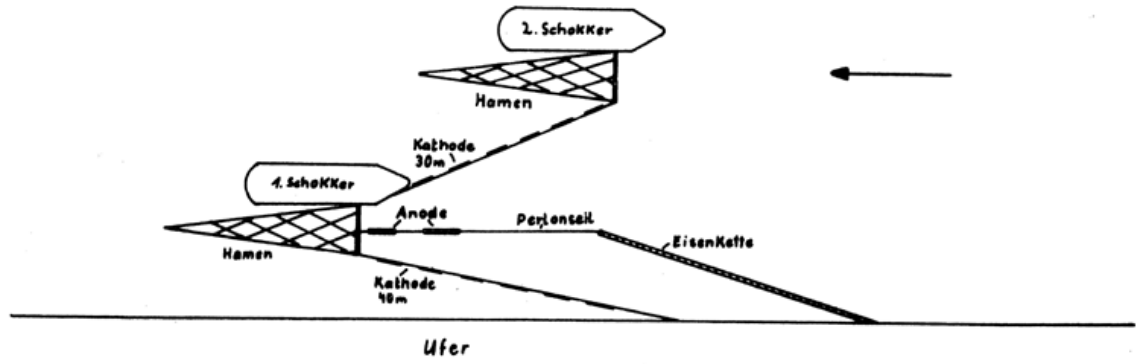


Fig. 1 The eel-shocker fishery with electric current

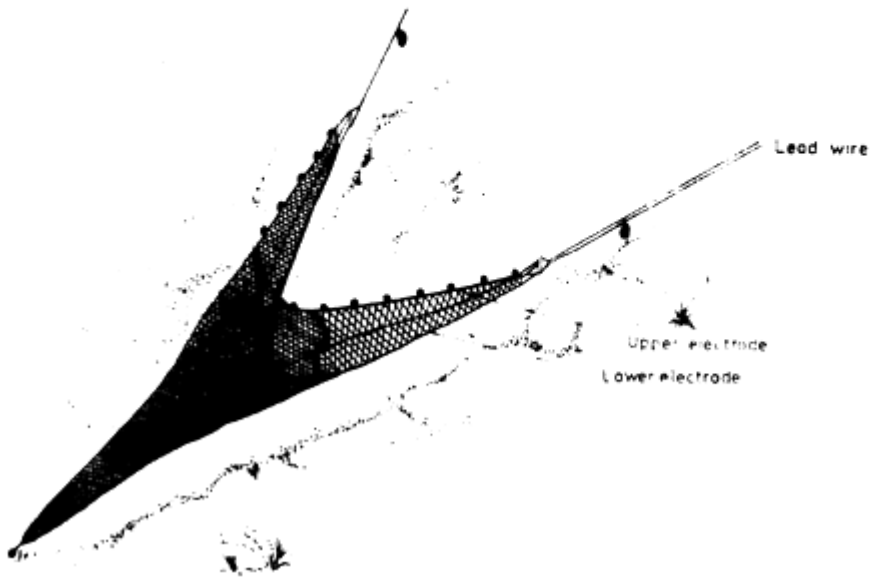


Fig. 3 The model of the electro-trawl for eel-fishery

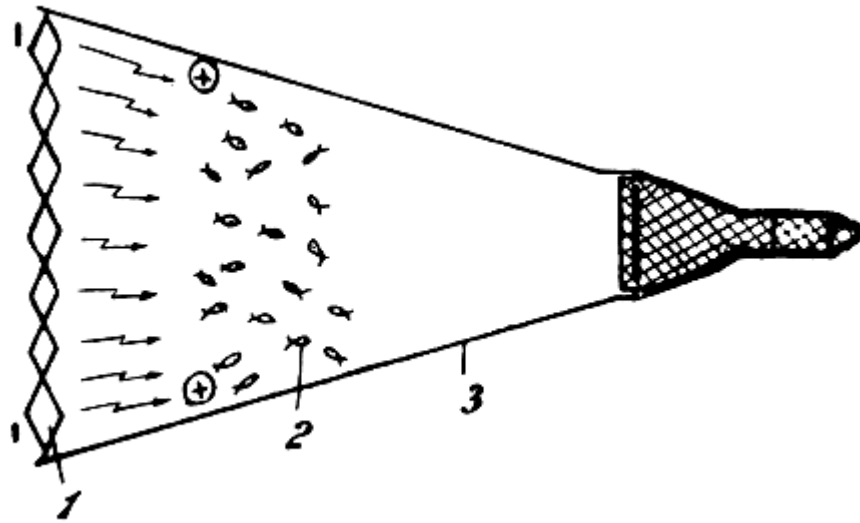
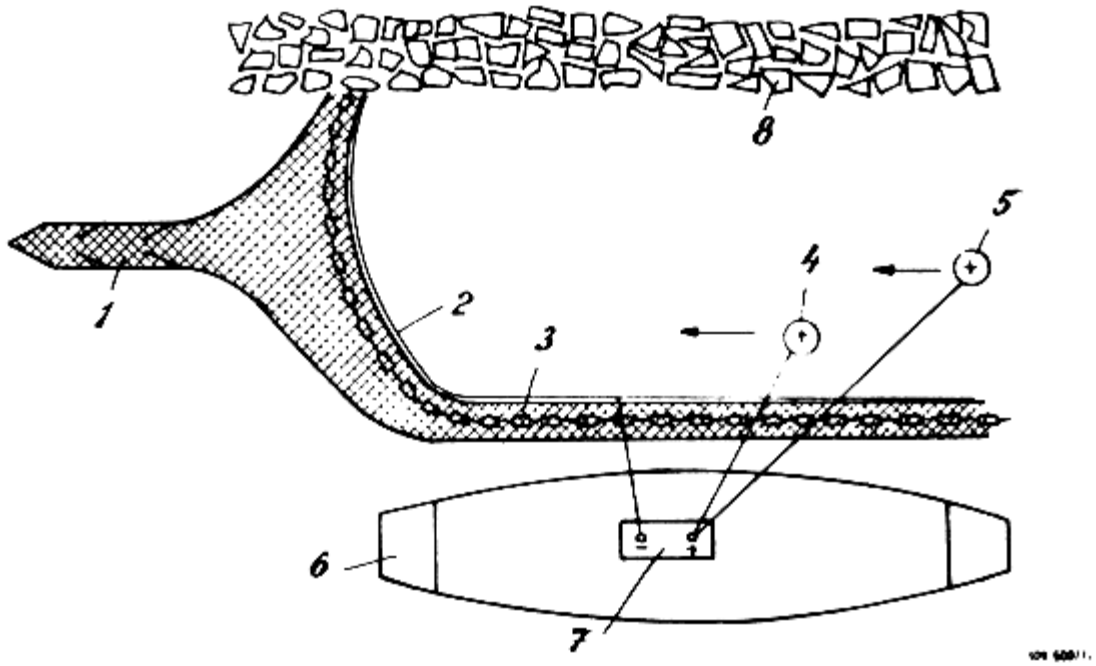


Abb. 2: Fang-Scheuchvorrichtung mit 2 Kathodennetzen
 1 = bewegliches Kathodennetz, das von 2 Booten gezogen wird
 2 = gescheuchte und in den Bereich der beiden Anoden + gelangte Fische
 3 = Fixiertes Kathodennetz, das als Leitarm dient.
 2

Fig. 2 The "cathodic net" of Hager.

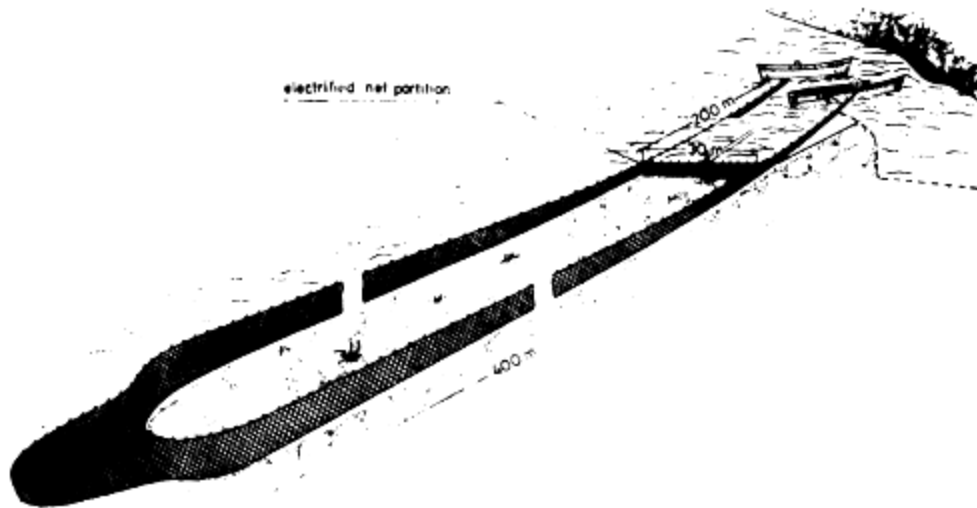
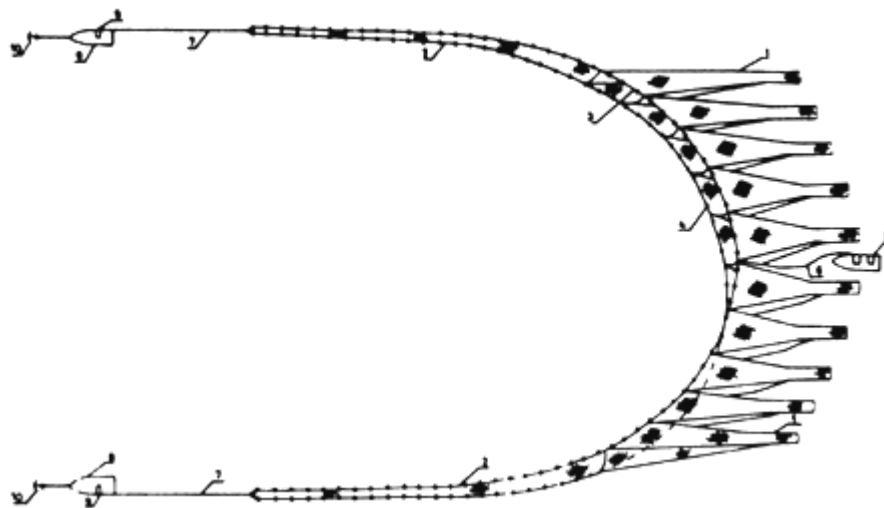


Fig. 4 Polish electrified net for eel-fishery.



- | | |
|-------------------------------------|-----------------------------|
| 1 Bags (in a number of 10) | 6. Electric supply wires |
| 2 Wings | 7. Towing lines |
| 3 Upper electrode (upon bag's side) | 8. Boats of the seine |
| 4 Lower electrode (upon bag's side) | 9. Mechanical seine houlers |
| 5 Boat with a c generator | 10. Anchors |

Fig. 5 Polish electrified net with several net-bags.

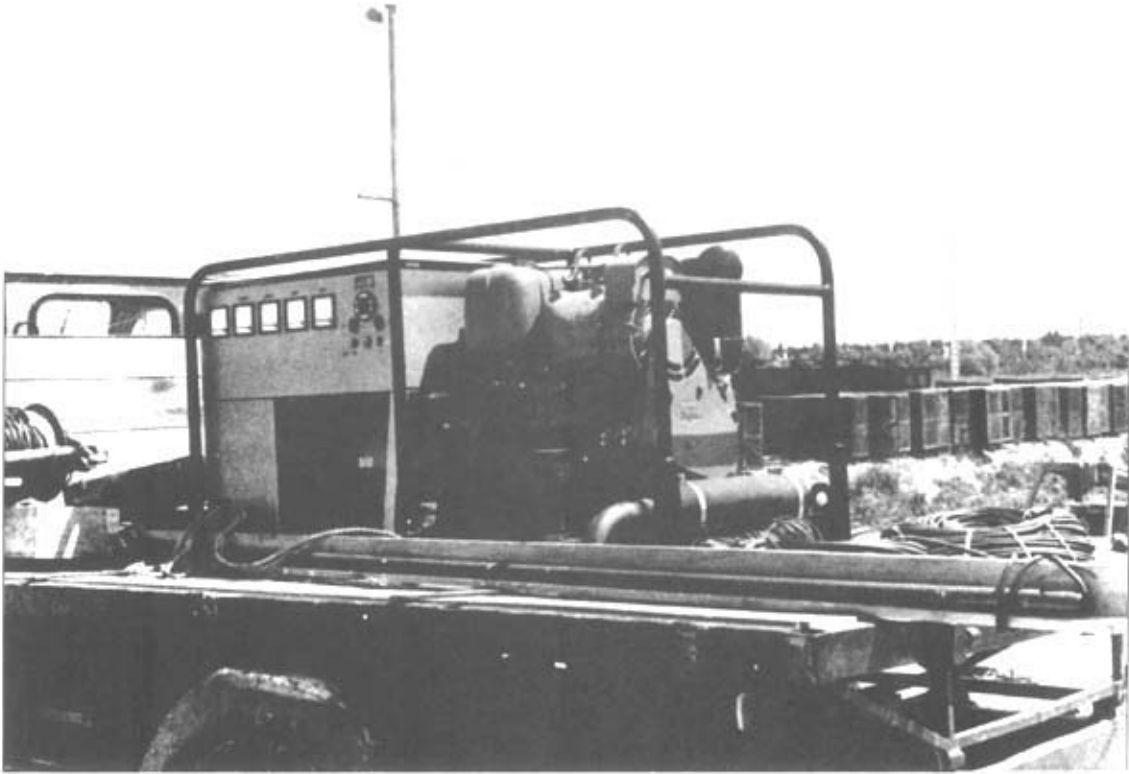


Fig. 6 Fishing gear to make the eel-fishery of Camargue more intensive

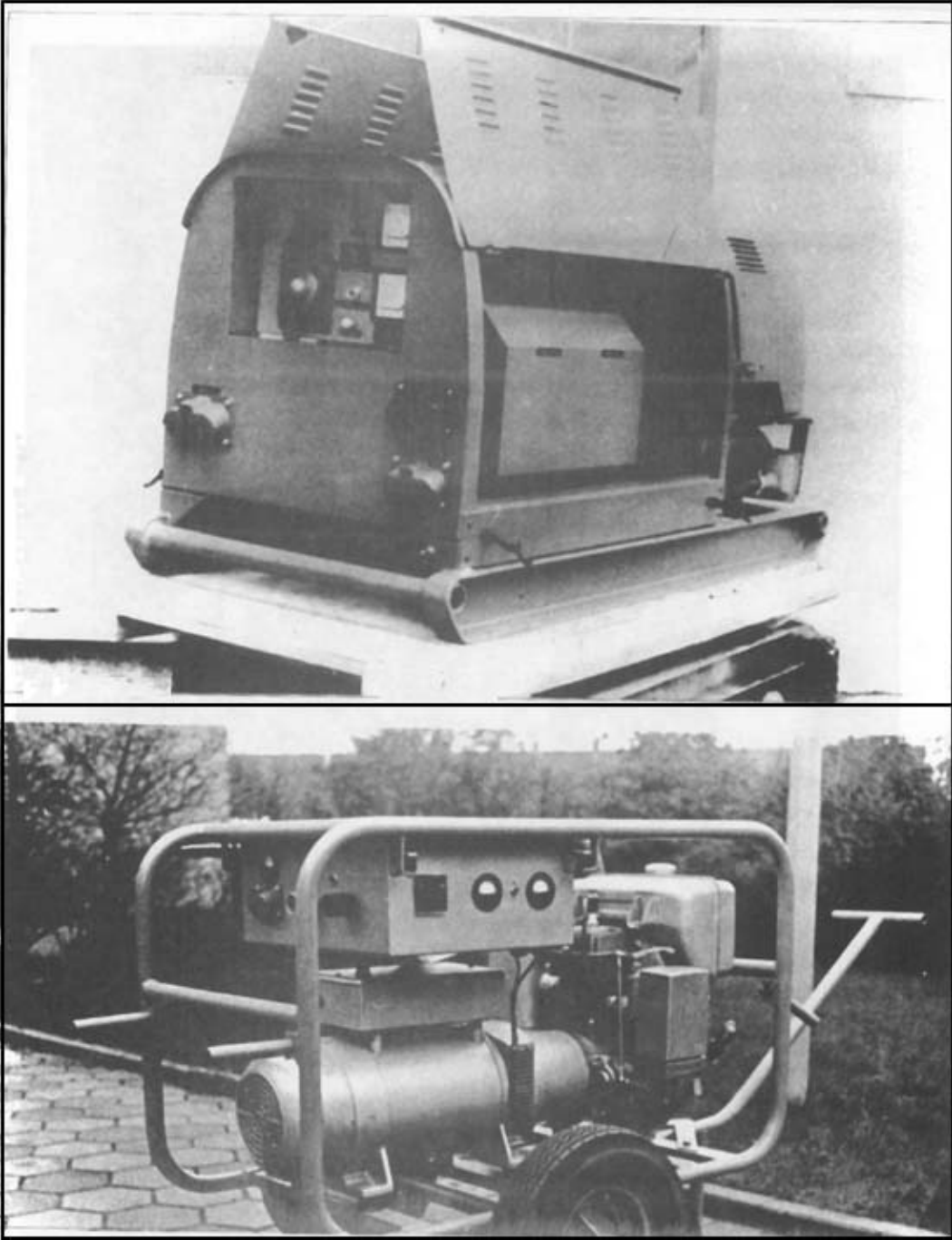


Fig. 7 Fishing gear of 7.5 and 12.5 KVA for eel-fishery

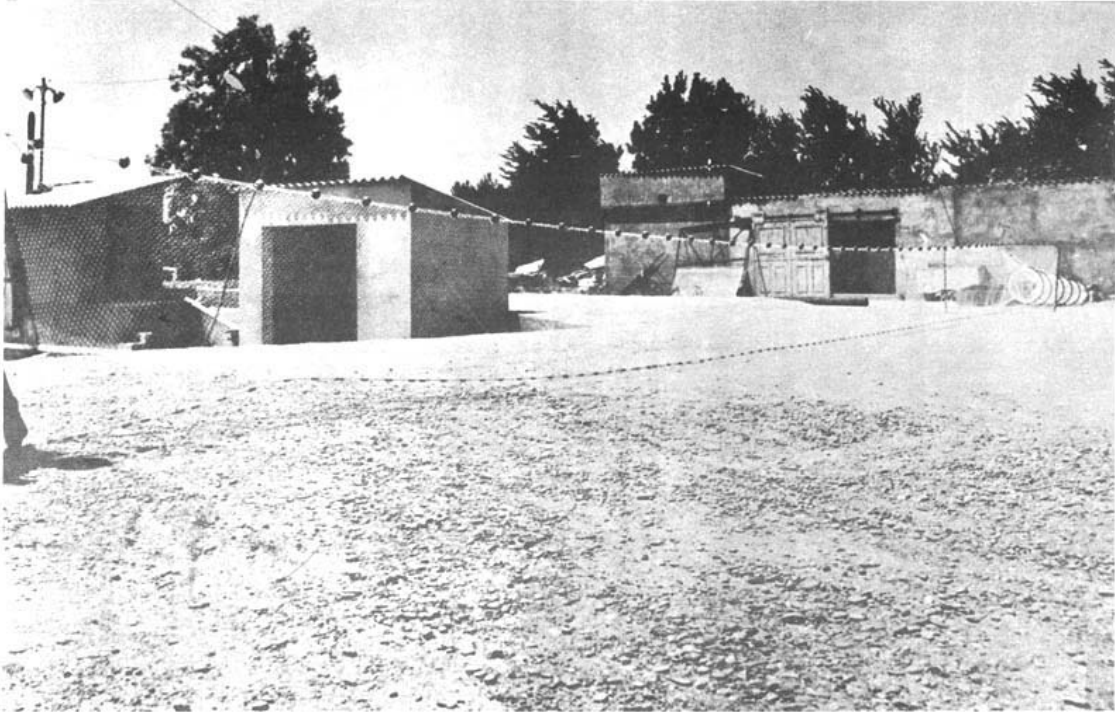


Fig. 8 French electrified eel-fishing net.

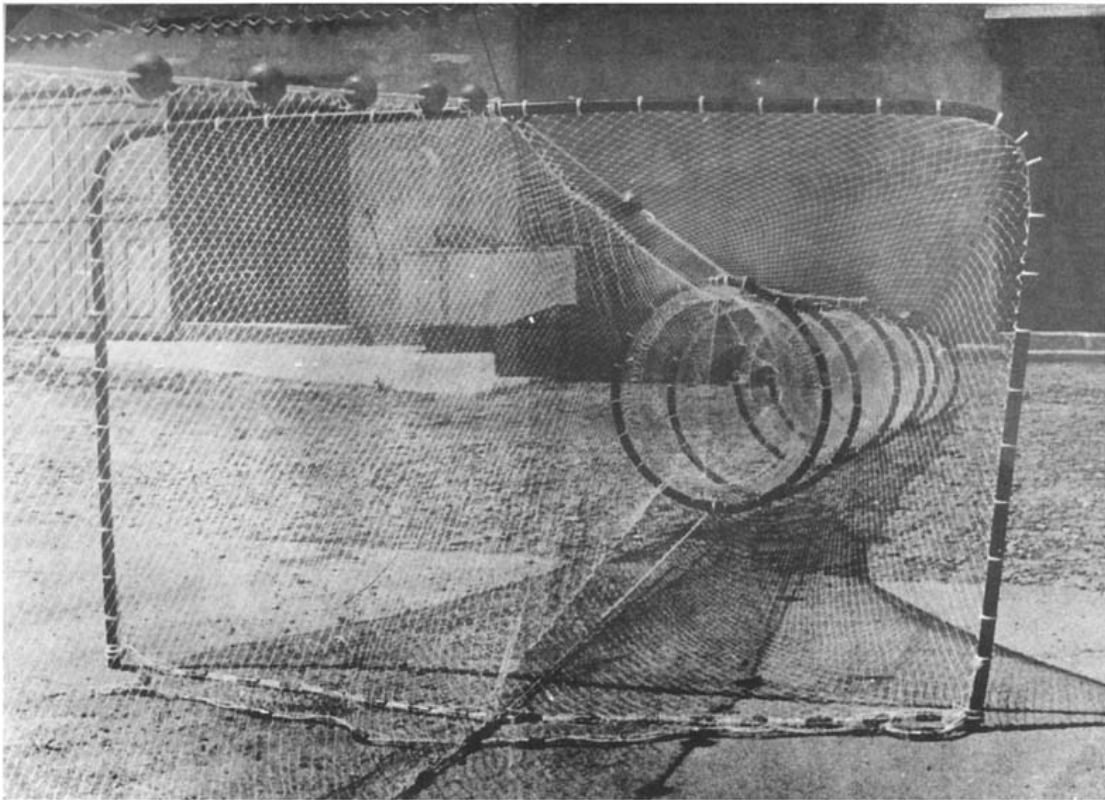


Fig. 9 French eel-buck (electrified).

APPENDIX 8

AN ACCOUNT OF THE VARIOUS KINDS OF TRAPS EMPLOYED FOR THE CAPTURE OF EELS

by

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Some people are of the opinion that traps are the most important type of fishing gear for eel fishing in rivers or lakes as well as along the seashore. There are fishermen who own some hundreds of portable traps, or else poundnets with leading nets of more than 200 or even 600 to 1 000 m. In both cases a somewhat considerable amount of money has to be invested in equipment. Therefore, large pound nets are often operated by families or cooperatives. On the other hand small numbers of traps may be used effectively in small fisheries by commercial fishermen as well as by sport-fishermen.

Formerly, and even today, the eel traps are homemade. Therefore, we have a tremendous number of types all over the world. But there are certain fundamental requirements common to all if they are to be effective. In recent times there has been a change from hand knitted traps to ones of cut machine made netting, and, furthermore, plastic traps manufactured by factories become more and more popular especially in small fisheries.

1. EEL TRAPS FOR RIVERS

Wooden baskets or pots are considered to be best for rivers. They are specially made for eel fishing in the current of the river and not in the side and backwaters. An anchored line some 100 m in length is set across the river. On this line the traps are fixed with by-lines of 2 m in length at a distance of 4 to 6 m apart. The baskets are placed with their opening downstream in the direction of the current. In the estuaries the baskets change their position automatically with the set of the tide. The traps are baited

with small fish or shrimps according to the season and the experience of the fisherman. One fisherman can operate up to 120 baskets. The baskets are serviced 2 to 4 times a day depending on the season and the local situation. Nowadays, these wooden baskets are replaced by ones similar in type made of plastic or netting.

1.1 Wooden Baskets

The eel baskets for rivers are slim, bottle-like tubes usually 1 m in length. They can be shorter or longer. Baskets of 1 m in length have a maximum diameter of 30 cm. They are made of willow rods, rattan or pine laths and have one or two funnels. At one end the baskets are closed by a wooden stopper. The opening must be large enough for the hand to enter the basket.

The spacing between the laths is decisive. According to the size of the eel to be caught, the distance can be between 2 and 8 mm. The sticks are laced together with copper wire or plastic-coated wire. The shape of the opening especially is secured and strengthened with this material. It is important that the traps are not too heavy; otherwise they will sink into the mud on the bottom of the river.

As already mentioned, these baskets have one or two funnels. To make these funnels more effective some fishermen add to the top of the funnel a small hose of small-meshed netting. Monofilaments especially are used for this purpose¹.

The hose is fixed with a ring or wire to the inner opening of the last funnel and is extended by a netting yarn tied to the body of the basket. By this arrangement the funnel opening is diminished in size. The eel can squeeze itself through this flexible netting but it will be hampered by it if it tries to come out again.

Wooden baskets are often in need of repair after one year. After two years they have to be replaced. Moreover, the manufacture of these traps needs experience and patience. Not many people are able or willing to make these baskets by hand nowadays. Therefore, experiments have been made to replace the wooden laths by those made of plastics² in order to extend the period of use. PVC in a special form to provide high resistance against low temperature was considered to be the best material. These traps were at least as efficient as wooden ones. They need less care in handling, and do not rot. They are not heavier than wooden traps which have been in use for some time in water. But their initial price is about three times as much as those made from willow. Therefore, fishery interests have tried to solve this problem in another way.

¹ It may be of interest that this was the first netting made of monofilament in Germany

² FAO, Modern Fishing Gear of the World 2, Fishing News, London, Eel traps made of plastic, 1964 H. Mohr, pp. 277–79

1.2 Plastic Eel Traps

Plastic traps made of mould-cast lattice work have been made in many countries. At each fishery exhibition new types for fish and crabs are demonstrated. For some years now similar types for eels have been introduced in the German fishery.

These traps are composed of four pieces; there is a funnel-shaped opening with an oval cross section incorporating the first funnel; a middle piece composed of two parts with the second funnel, and an end piece for taking out the catch. This plastic trap has two galvanized iron rods fitted on the bottom to bring the trap into the right fishing position when sinking to the bottom. Sometimes fishermen replace the iron rods fitted by the factory by heavier ones when the trap is used in rivers with a strong current. The

upper part of the plastic trap is a solid sheet, in order to provide cover and to give the eel a hiding place.

These plastic traps are set in rows; just like the wooden baskets, in rivers. They are also used individually in small bodies of water.

In the estuaries there are some difficulties with baiting the traps. The spacing in the machine-made plastic trap is too large and the bait falls out, when no special bag is used to hold the bait. With hand-made traps the distance of the laths can be varied as necessary, as required in the different places. Because the construction of moulds for casting plastic is very expensive, up till now one pattern of plastic basket only has been available.

1.3 River Traps Made of Netting

In recent years another new type of trap has begun to replace the old wooden baskets in rivers. This is a trap formed from netting suitably cut to size which is retained in proper shape by five hoops spaced apart and kept in position by two spreading sticks (Fig. 10). Traps made of netting are identified by the number of meshes in the circumference. The trap under discussion has a circumference of 60 meshes.

This trap is composed of three pieces of netting, as can be seen from Figure 1b. The entrance is made of a piece of netting with a meshwidth of 14 mm (stretched mesh 28 mm). This piece is 59½ meshes broad and 5 meshes deep.

The forepart ("kitchen") of the trap with the first funnel is made of a netting with a meshwidth of 12 mm. Naturally this piece is also 59½ meshes broad and has a depth of 40 meshes, including the funnel, 12 meshes deep. For the construction of the funnels four wedges are cut out, each 7 meshes broad in the opening. The cutting rate is 1K1B, that means alternately one knot - or point-out and one bar-cut. As can be seen in the Figure 10 cutting has to begin with a single bercut.

The last part ("parlour") of the trap with the second funnel and the codend is made of a netting with a meshwidth of 10 mm, 59½ meshes broad and 60 meshes deep. The second funnel is out of two wedges, 15 meshes deep. The cutting rate is 1K3B, beginning with the bar-cut (Fig. 1d). The codend usually remains unshaped. The wedges of the funnels are folded inside and their meshes on the edges are joined with each other. This can be done in a simple manner.

Also the edges of the single pieces are joined and the three pieces are fixed together. The trap is mounted with 5 hoops with a diameter of 35, 32.5, 30, 27.5, and 25 cm. The netting is attached in the usual manner to the hoops.

The funnels are held in the following manner: the first one is fixed with four netting yarns (mostly double) tied to the third hoop; the second is tied to the last hoop. Using four netting yarns the opening of the first funnel has the form of a square, standing on one edge, the opening of the last one, with two yarns, is like a vertical slit.

The codend is closed by a stronger netting yarn threaded through the last meshes of the trap. Sometimes these last meshes are made by hand with double netting yarn.

The trap is stretched by two spreading sticks of 150 cm each. The sticks are fixed to the hoops of the trap.

The data given are as an example only. Variations especially in the mesh size are possible according to the local situation and the size of the eel to be caught.

It must be pointed out that there is a special relationship in the various dimensions of eel traps as will be explained later.

The mentioned type has replaced the wooden baskets. Because these baskets are cast from a boat they are also named "cast trap" (Wurfreusen). Another important type for river fisheries are the "chain traps" (Ketten-Reusen) which are fixed together like a chain as can be seen in Figure 4k.

2. EEL TRAPS FOR LAKES

Mention has already been made of traps which can be used in the current of rivers, mostly for eels migrating in one direction or the other. In this chapter are discussed traps which are used for eel fishing in lakes, and also in side - and backwaters of rivers or even along the seashore.

Generally speaking these are fyke nets made of netting held by vertical hoops and stretched horizontally between sticks or anchors. The netting is made from polyamide fibres or monofilament. There are also eel traps which are made from galvanized wire mesh. The life of this material is short so that it can be used for a limited period only. For this reason it is not mentioned here. Fyke nets made from polyamide, continuous fibres (23tex × 12 to 23-tex × 18) or monofilament (∅ 0.45 to 0.60 mm) are important. It has been discovered that traps made from monofilament catch more eels than all other ones, just as fyke nets made from nylon yarns catch more eels than those made from cotton. It has not been established whether the explanation for this is one of visibility or whether some other physical property is involved.

The fyke nets under discussion are fitted with leading nets and/or wings in order to guide the fish into the trap. Some hundreds of traps can be used at the same time. Usually a unit consists of two or more traps (Fig. 4).

It has already been mentioned that there is a special size relationship between the various parts of a trap. The main point is that eel traps should be as long as possible. The reason is that the eel should lose contact with the first funnel before he encounters the next one. Otherwise, on making contact, he will back out using his tail as the guide.

The proportions of the different parts of the fyke nets are specified by the number of meshes. For fyke nets consisting of two parts these are as follows:

$$\begin{aligned} \text{length of the first funnel} &= \frac{\text{circumference of the trap}}{5} \\ \text{length of the first part} &= \text{length of the first funnel} \times 1.5 \\ \text{length of the second funnel} &= \frac{\text{circumference of the trap}}{4} \\ \text{length of the second part} &\text{ at least the length of the second funnel} \times 2.5 \\ \text{of the trap} & \end{aligned}$$

Where the fyke net has more than two funnels, the first and subsequent ones are calculated in the same manner and only the last one is longer in accordance with the specification of the second funnel as mentioned above.

Before more details are given, the calculations for the diameter and the circumference of a hoop should be mentioned. These are:

$$\text{Diameter} = \frac{\text{circumference in meshes} \times \text{mesh size}}{3 \times 14} \times E$$

$$\text{circumference} = \frac{\text{diameter} \times 3.14}{\text{mesh size} \times E}$$

The mesh size is the length of the stretched mesh in cm¹: E is the hanging factor. For fyke nets E is mostly 3/5 or 0.6.²

¹ Usually the mesh size has to be calculated in mm

² More details can be seen in: v. Brandt, A. and M. Kaulin: Netze knüpfen - Netze schneiden (in Schriften der Bundesforschungsanstalt für Fischerei, No. 8, 1971).

2.1 Double Traps

Along the Baltic coast and also in some lakes double traps, so-called “couples”, are used. These consist of two fyke nets, with 4 or 5 hoops each, which are connected by a leading net, with the openings facing each other (Fig. 2a). Many double traps are joined together to form a long chain up to 300 or even 500 m in length. The following specification is given for a double trap containing five hoops and two funnels and with a circumference of 80 meshes. The panels of netting are cut from three types of netting made from polyamide continuous 23tex × 6, 23tex × 9, and 23tex × 12. They can be made also from monofilament ø 0.35 mm, which may be helpful where it is found that the larvae of caddis attack the netting.

The first part of the netting at the entrance is made up of a piece with a meshwidth of 16 mm, 79½ meshes broad and 7 meshes deep (Fig. 2b).

The forepart of the trap in which the first funnel is located is made from netting with a meshwidth of 14 mm. The piece is 79½ meshes broad and has a depth of 40 meshes. The funnel is formed from four wedges of the same material each 10 meshes broad at the opening and 15 meshes deep (ca 1/5 of the circumference). The cutting rate is 1K1B, beginning with a bar-cut.

The afterpart of the trap with the second funnel and the cod end is made of netting with a meshwidth of 12 mm, 79 ½ meshes broad and 74 meshes deep, including the funnel. For the construction of the funnel two wedges are cut out, each 20 meshes broad. The cutting rate is 1K2B, beginning with the two bar-cuts.

The wedges are turned inside and the edges are joined together as usual. The five hoops have a diameter of 45, 35, 30, 28 and 27 cm. The hoops are fixed in the manner shown in Figure 2c. The funnels are secured with four or two netting yarns fastened to the third and fifth hoop, respectively.

The leading net between the two traps has a length of ca 3 m and is 25 meshes deep. The meshwidth is 16 or 18 mm. The hanging ratio is ½ or ⅓. The floatline, e.g. polyamide, plaited, ø 5 mm, has only a few floats. The lead line is weighted with lead in a distance of 30 cm. Mostly patentlines (8–13 kg per 100 m) are used. It is very important that the line makes firm contact with the bottom. The leading net is fixed to the trap in such a manner that it ends at the beginning of the first funnel.

Each row of double traps is securely fastened at each end. Usually, two fishermen work in partnership. They can own 700 or even 1 000 double traps.

2.2 Cross Trap

A successful eel trap, especially for lakefishing, is a unit consisting now of three traps but originally of four. A large main trap (circumference 80 meshes) is combined with two (originally three) smaller ones (circumference 60 meshes). The combination of traps and connecting leading nets produces a pattern something similar to a cross as

can be seen from Figure 3a. Nowadays the trap nearest to the shore is dispensed with because it had the lowest efficiency. The two types of traps are cut from machine-made netting. The main trap with a circumference of 80 meshes has an entrance made of netting with a meshwidth of 30 mm. The piece is $79\frac{1}{2}$ meshes broad and has a depth of 5 meshes (Fig. 3b).

The forepart of the trap, including the first funnel, is made of netting with a meshwidth of 25 mm. This piece of netting is also $79\frac{1}{2}$ meshes broad and, including the funnel, 37 meshes deep. For the construction of the funnel four wedges are cut out as shown in Figure 3b. The cutting pattern is the same as that already mentioned: 1K1B, beginning with a bar-cut.

The afterpart of the trap, including the second funnel and the cod end, is made of netting with a meshwidth of 20 mm, $79\frac{1}{2}$ meshes broad and 71 meshes deep including the funnel. For the formation of the funnel, wedge pieces are cut out, each 8 meshes broad and 19 meshes deep. The cutting ratio is 1K1B, beginning with a knot-cut.

After cutting, the wedges are folded inside and joined together in the same manner as the edges of the netting. The five hoops have a diameter of 92, 86, 61, 59 and 58 cm. The funnels are tied by four or two netting yarns to the third and fifth hoop respectively.

The smaller traps with a circumference of 60 meshes are cut in a similar manner (Fig. 30). The entrance is made of netting with a mesh width of 30 mm. The piece is $59\frac{1}{2}$ meshes broad and 5 meshes deep.

The forepart of the trap including the first funnel is made of netting with a meshwidth of 25 mm, $59\frac{1}{2}$ meshes broad and 29 meshes deep. The four wedges for the construction of the funnel are cut in the manner shown in Figure 30. The cutting ratio is 1K1B, beginning with a knot-cut.

The afterpart of the trap with the second funnel and the codend is made of netting with a meshwidth of 20 mm, $59\frac{1}{2}$ meshes broad and 57 meshes deep, including the funnel. For the funnel wedges are cut out as can be seen in the drawing. The cutting ratio is 2K1B, beginning with a bar-cut.

The cut netting is joined together as mentioned above. The five hoops have a diameter of 68, 57, 46, 44 and 42 cm. The funnels are tied by four or two double netting yarns to the third and the last hoop respectively.

The three traps are joined together by wings extending from the main trap. The wings are made of netting with a meshwidth of 25 mm. The netting is made of polyamide 23tex \times 12 and has a depth of 15 meshes. The wings have a length of 4.5 m unmounted, and of 3 m mounted. The hanging factor is $\frac{2}{3}$, that means that the meshes are nearly quadratic in shape. The main trap has also a leading net of the same material and the same hanging factor. The length unmounted is 24 m and mounted 16 m. The leading net begins in the opening of the main trap and at its other end has two loops by means of which it can be fixed to a stake driven into the bottom.

One end of the wings is attached to the outer half of the first hoop of the main trap. The other end is fixed to the middle of the entrance of the smaller trap, with some meshes fixed at the entrance itself and extending into the beginning of the first funnel.

There are many more types of eel traps: for instance, in Denmark there are very long ones with more than 10 hoops. There are also smaller ones with wings connected

at the beginning by special netting (tongue) which is the basis for larger type traps which are discussed here.

2.3 Systems of Traps

The traps mentioned above can be combined to form units with high efficiency, especially near the outlets of lakes. In these combinations the arrangement of wings and guiding nets is important. Figure 4 illustrates some arrangements which have been made to increase the efficiency of traps in such systems. In fact, the double traps and the cross traps are also samples of such systems, but there are many more, as can be seen in the diagrams. The object is to guide eels which avoid the entrance of one trap into another. It has been mentioned that double traps are joined together to form rows, some hundred metres long. However, the "chain-traps" used by fishermen in rivers are not as long as this (Fig. 4k). In this case, four to six traps are combined in a distance of 2 m without leading net in the manner shown in Figure 4k.

The actual system chosen for each locality depends on the site conditions obtaining where the eels have to be caught. Finally it has to be pointed out that the systems shown in Figure 4 can be combined together to form even larger units.

3. LARGE EEL TRAPS

The length of traps can be increased from ones with 5 hoops to ones with 6 hoops and 3 funnels. In this case the first hoop is made horse-shoe in shape the bottom rod being made of iron. Such an entrance can have a height of more than 1 m. Furthermore, as already mentioned above, Danish coastal fishermen employ fyke nets for eel fishing which contain more than 10 hoops.

Another idea to increase the size of the fyke nets is to provide an additional catching arrangement before the entrance to the first hoop. To a certain extent a trap fitted with wings formed like hooks (Fig 4c) can be considered as an enlarged trap. This arrangement usually has in addition the triangular area between the trap proper and the beginning of the wings filled in with a piece of netting laced across the top as well as at the bottom (Figs. 5a and 5b). It is usual to provide a rectangular chamber before the first hoop (Fig. 5a). The top of this chamber may be either closed or open but the bottom is always closed with netting. Sometimes two such additional chambers are used (Fig. 5c). In this case a third retarding device is needed in the form of a step or in the form of a vertical slit. The construction of these so-called "box traps" varies very much according to the local situation. The larger extended fyke net arrangements are set especially at the outlets from lakes to catch the migrating eels.

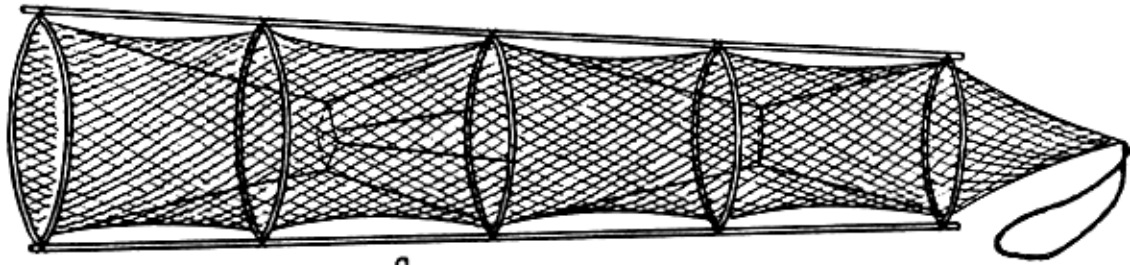
Off the Baltic coast Danish and German fishermen operate very large pound nets for eel fishing (Fig. 6). The local name is the Danish word "bundgarn": this means bottom-net. In this case very large chambers are set up to concentrate the fish which are guided into it by leading nets which are 600 m in length and more, and in depth up to 6 m. The capture of the eels takes place in two fyke nets with 4 to 6 hoops which form part of the installation. Further details of such installations can be found in the FAO Catalogue of Fishing Gear Designs.

These pound nets are used especially to catch migrating eels in autumn. Fishing at this time is very much influenced by weather conditions. The highest catches are made during the new moon beginning with the lart quarter. Dark nights with winds directed to the land are especially effective.

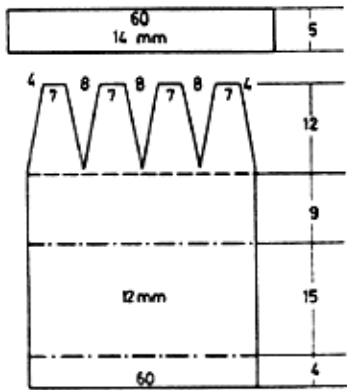
DISCUSSION:

McGrath pointed out that it was desirable to have the top of the leader line 50 cm over the water for silver eels, but the top of the leader can be at the surface for brown eels.

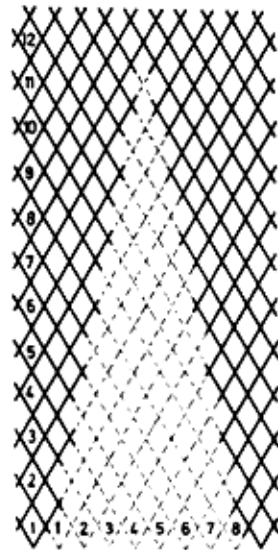
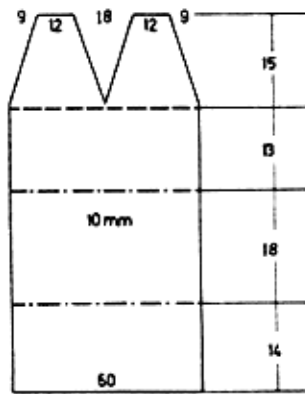
Deelder referred to the composition of the hoop materials and pointed out that in Holland fishermen constructed fyke nets up to 3 m in diameter with split willow hoops.



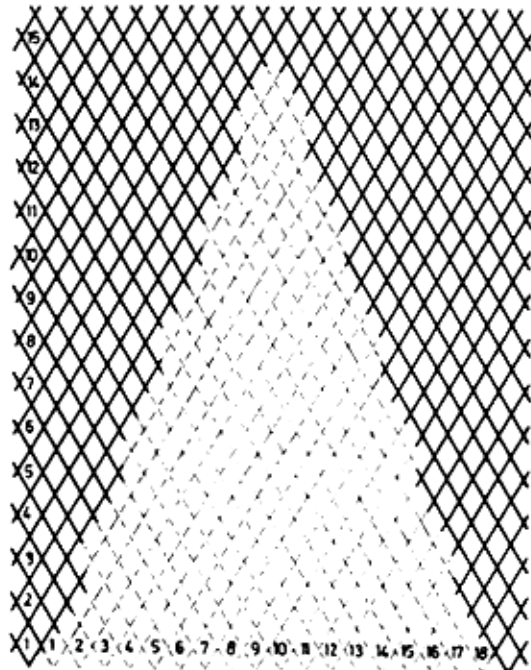
a.



b.



c.



d.

Fig. 1 Eel trap for rivers.

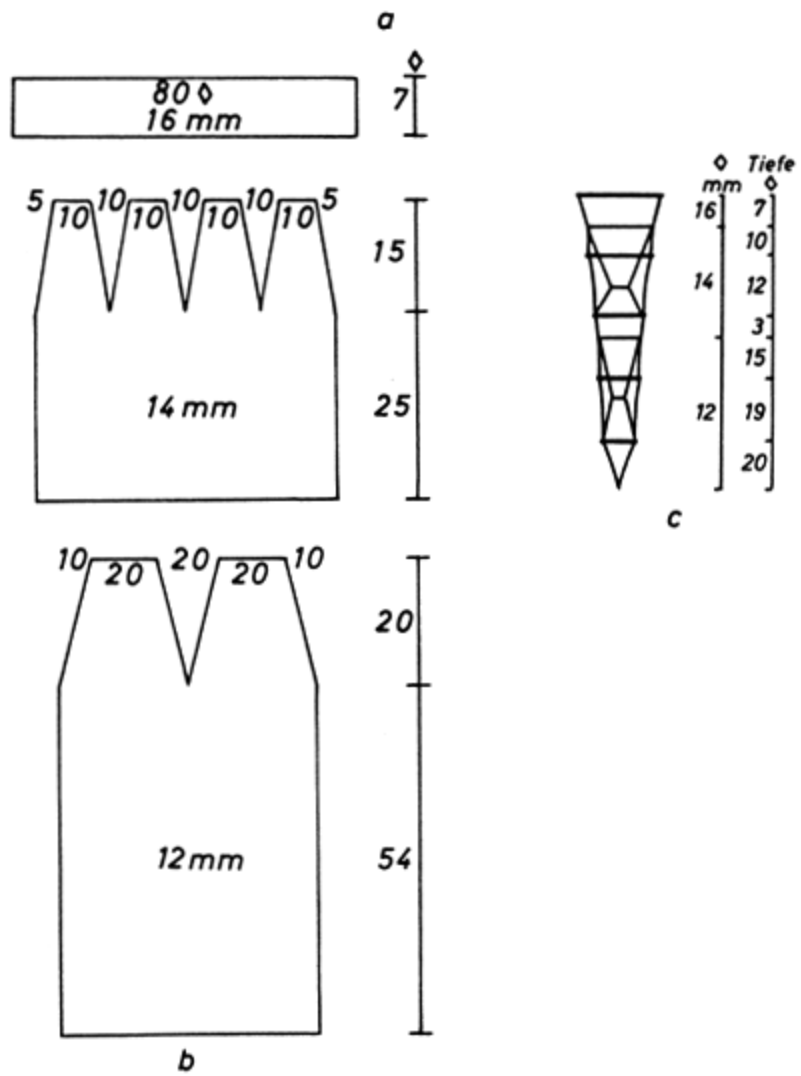


Fig. 2 Double trap.

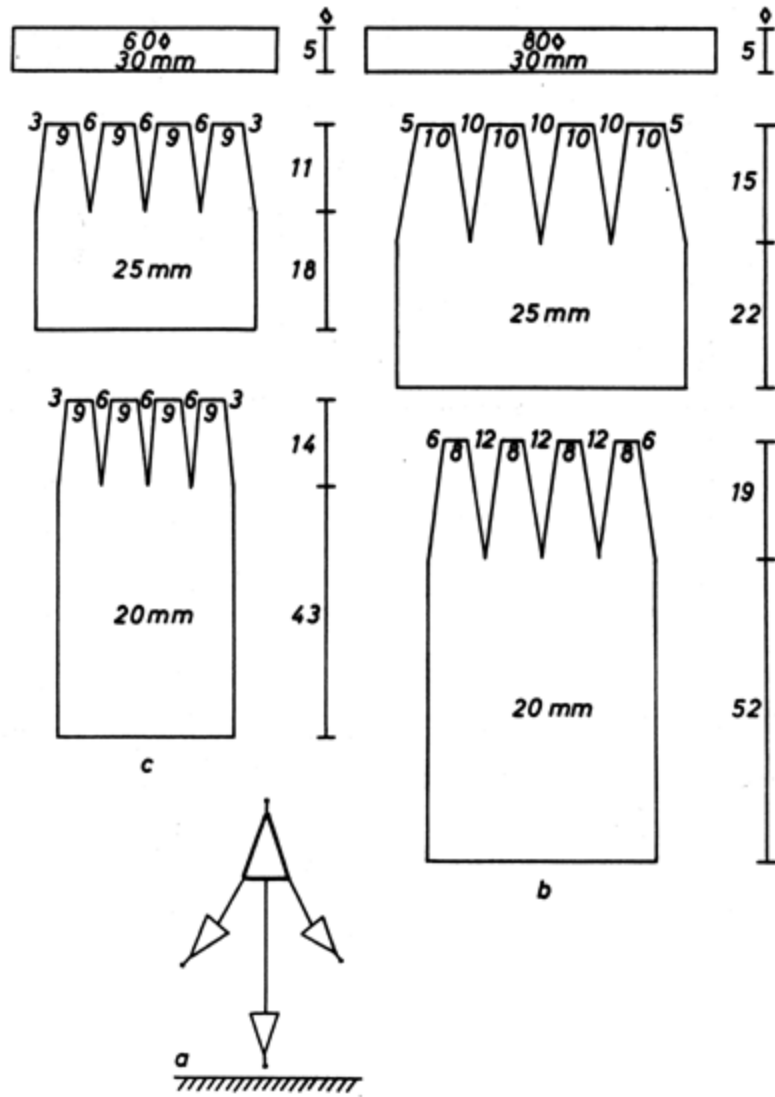


Fig. 3 Cross trap.

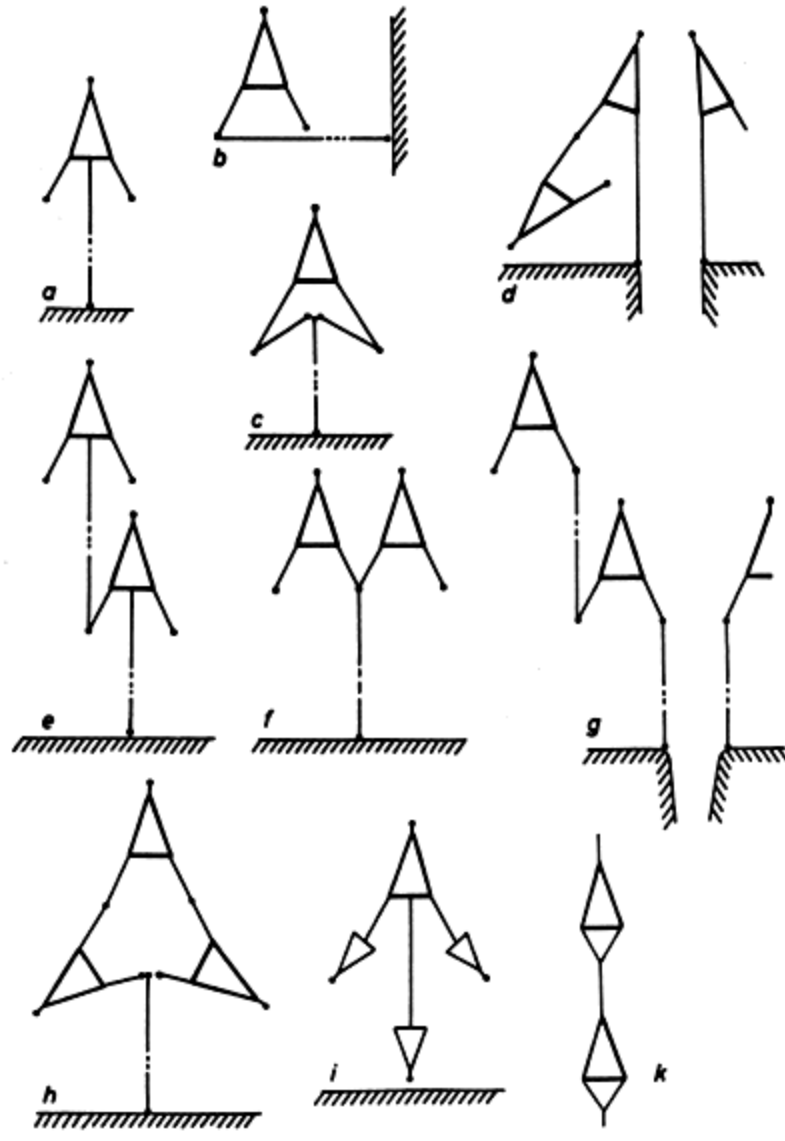


Fig. 4 Systems of traps for eelfishing.

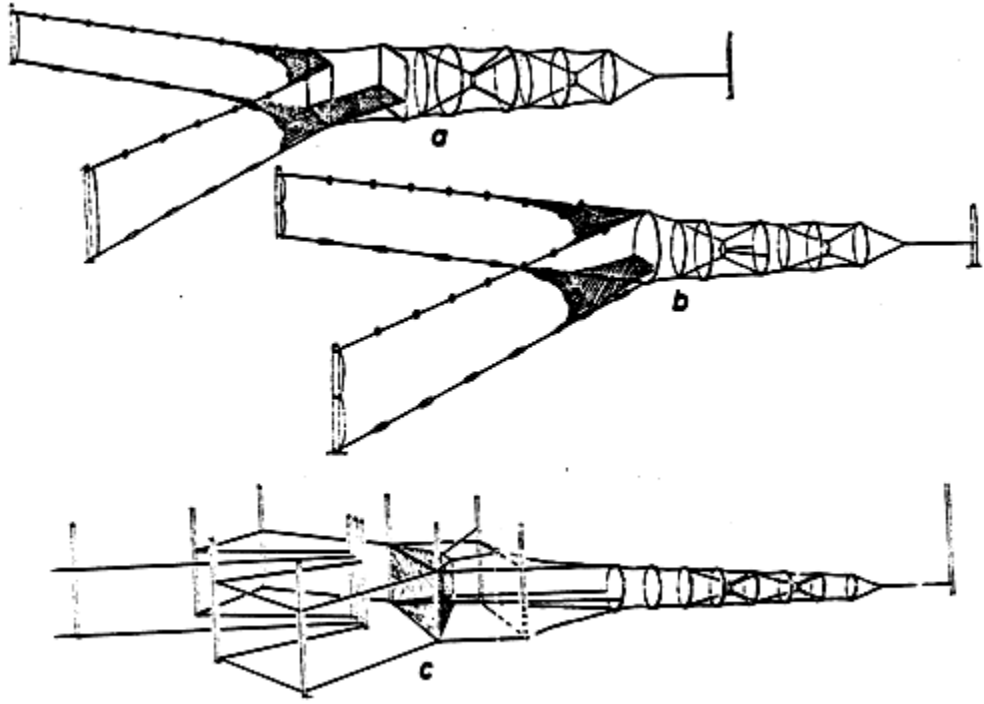


Fig. 5 Box traps.

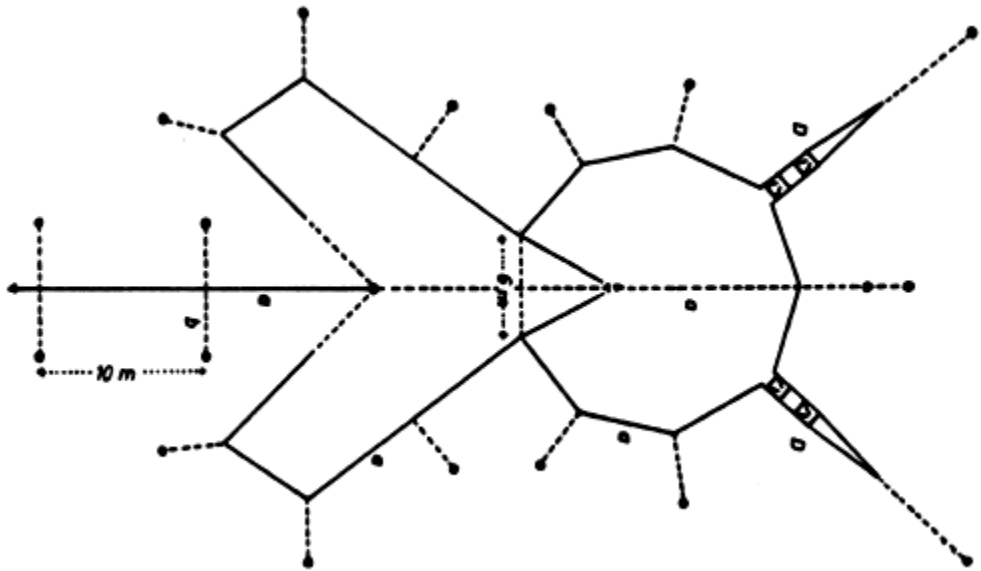


Fig. 6 Danish "bundgarn" for eels.

APPENDIX 9

THE USE OF SEINE NETS FOR THE CAPTURE OF EELS

by

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Freshwater seine nets discussed here belong to the group of large-scale fishing gear. They enable large areas to be fished and the larger the area the better the catch. This means that the degree of success is dependent on the size of the gear used. Therefore, seine nets may have a wing length of up to 1 000 m.

It is obvious that this large-scale fishing gear requires a high expenditure in material. Moreover, for handling seines of such large dimensions a great amount of labour is necessary. This may be the reason why in our freshwater fisheries large seines have decreased in importance. Furthermore, it now is possible to obtain equally good catches especially of valuable fish, by improving other fishing methods and by introducing new fishing gear. However, because of the particular fishing conditions in some lakes the introduction of new fishing gear, especially of small trawls, has not been successful. In these places seine nets have remained in use, especially for catching eel. But it has to be mentioned, that nowadays in the majority of cases the hauling of the gear has been mechanized.

This report will describe the construction and handling of the seine net as well as outline its importance for eel fishing. However, only those seine nets fitted with a bag will be dealt with.

1. THE GEAR

The seine net described here consists of a bag with two long wings on each side (Fig. 1). Here as in the case of other eel fishing gear, there exist various methods of construction. The differences relate to the size of the seine net and the basic construction of the bag. Of the many types in existence only one from a lake fishery in Northern Germany has been chosen, which is described in detail below.

The details of construction of this seine are shown in Figure 2. Each of the two wings consists of three rectangular pieces of netting, each stretched, has a length of 65 m and a depth of 300, 350, or 400 meshes respectively. The mesh size is either 20 or 18 mm. Polyamide netting yarns of the number 23tex × 9 and 23tex × 12 are used. The two polyamide ropes have a diameter of 8 mm; one for the headline and one for the groundrope, of which one is left-hand twisted and the other right-hand twisted. With a

hanging coefficient of 5/9 all netting is attached to the two pairs of ropes (Fig. 3). After the mounting of the netting each wing has a length of 108 m and a depth of 12.5 to 13 m, as measured at the entrance to the bag. The fore-ends of the wings are spread apart by a one-metre stick to which a crowfoot is attached. The towing rope is connected to the crowfoot. This is a wire rope with a diameter of 4 to 6 mm and a length of at least 500 m for each wing.

In order to keep the wings close to the ground sinkers must be fastened to the groundropes. In this example they consist of lead weights of 100 to 120 g lined up and fixed to one of the ropes at distances apart of 1 m. Sometimes an additional lead line with a diameter of 2.5 mm is attached to the ground ropes.

To one of the headlines the floats are fastened. These are cylindrical in shape and are made of plastic 40 mm thick and with a diameter of 80 mm. These floats are also lined up and fixed to the ropes at distances apart of 60 cm in the first third of the wing, and in the following two thirds at distances apart of 50 cm.

The bags of seine nets are made of rings of netting or of wedges of netting. In some cases a combination of rings and wedges is used.

The bag of the seine net described in this report is made of strips and wedges of netting. The side parts of the bag are formed by the wedges, the lower and upper parts by the strips. All parts of the netting have a length of 450 meshes. With a diagonal cut at one edge the wedges are tapered from 450 to 200 meshes. The strips have a width of 75 meshes. By cutting all bars on both sides the strips are also tapered to one end. After these four parts have been put together the bag is closed by a rectangular piece of netting (400 × 100 meshes). In order to prevent fish from escaping, a funnel is fitted midway along the seine net bag (Fig. 2).

2. HANDLING OF THE GEAR

To fish seines of this type, three towing boats usually are required, i.e. two netboats and one boat for the catch. Each netboat must be big enough to take aboard one wing of the seine net and have a winch installed in the middle of the boat. In this case a boat length of 7 m is sufficient. The catchboat or master fisherman's boat has a length of about 5 m only. This boat is equipped with a well for storing the catch alive.

Before paying out the seine the netboats keep together while the bag of the seine net is being lowered into the water. The boats then draw away from each other (Fig. 4). They proceed in opposite directions while the wings are set out in a straight or semi-circular line (Fig. 5). After setting the wings the netboats make for the hauling place. The boats are connected to the gear by the towing ropes, of which one end is attached to the crowfoot on the spreading stick and the other is running off the winch. By shooting additional towing rope, it is possible to increase still further the area to be fished. Before the fishermen commence hauling the towing ropes, the boats are anchored some distance from the actual hauling place. The hauling ground for the wings and bag of the net should be carefully chosen. The ground should be smooth, free of obstructions and slope gently to the land.

In former times the towing ropes were hauled by hand-winch. This involved much labour and work. In order to reduce the manpower necessary the net material was changed from cotton to polyamide and motor-winchs were introduced, so that now instead of seven or nine workmen only five or four are required for seining.

After the towing ropes have been hauled in by the motor-winch as far as the spreading sticks (Fig. 7), the net boats change position and are now rowed to the actual hauling place, where they are anchored again. The towing ropes which, during this manoeuvre, are wound off the winch, are now hauled again.

The next phase of the hauling action is the hauling of the wings which are also hauled by the motor-winch. Formerly, the fishermen used to attach an additional line parallel to the headline for the purpose. Now they fix the wing to the stem of the boat after they have attached the towing rope to the anchor rope on the opposite side of the boat (Fig. 8). Together with the boat, the wings are now towed by the motor-winch. Thus, step by step, the wings are hauled. The various phases of this operation are shown in Figure 9. The last third of the wings immediately in front of the bag is hauled by hand. During this phase of hauling it is necessary to keep the ground rope close to the ground to prevent the fish from escaping. By beating the water with a stick, i.e. "pulsing", the fishermen try to drive the fish into the bag of the seine net (Fig. 10).

The type of gear to be used as the main fishing gear in eel fishing depends on the fishing conditions obtaining in the respective waters. In many cases the greater number of eels is caught by traps, trawls and stow nets, but where these methods are not successful the seine net can be used as described above.

DISCUSSION:

- McGrath - it had been the experience in Ireland when using seine nets for the capture of pike and perch, that it was necessary to attach small bundles of brushwood to the sole rope at intervals in order to prevent the net from rolling and also to prevent the wings cutting into the ground.
- Kaulin - this practice was observed also in Germany.

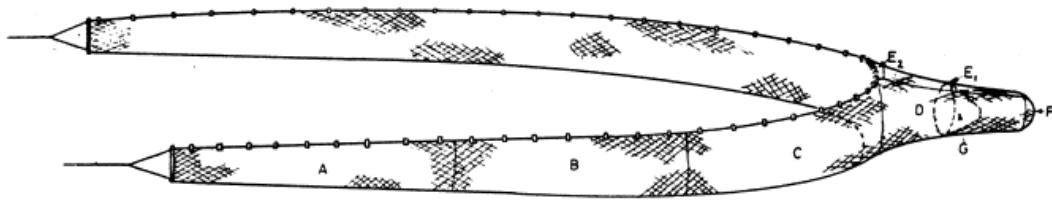


Fig. 1. Boat seine with wings

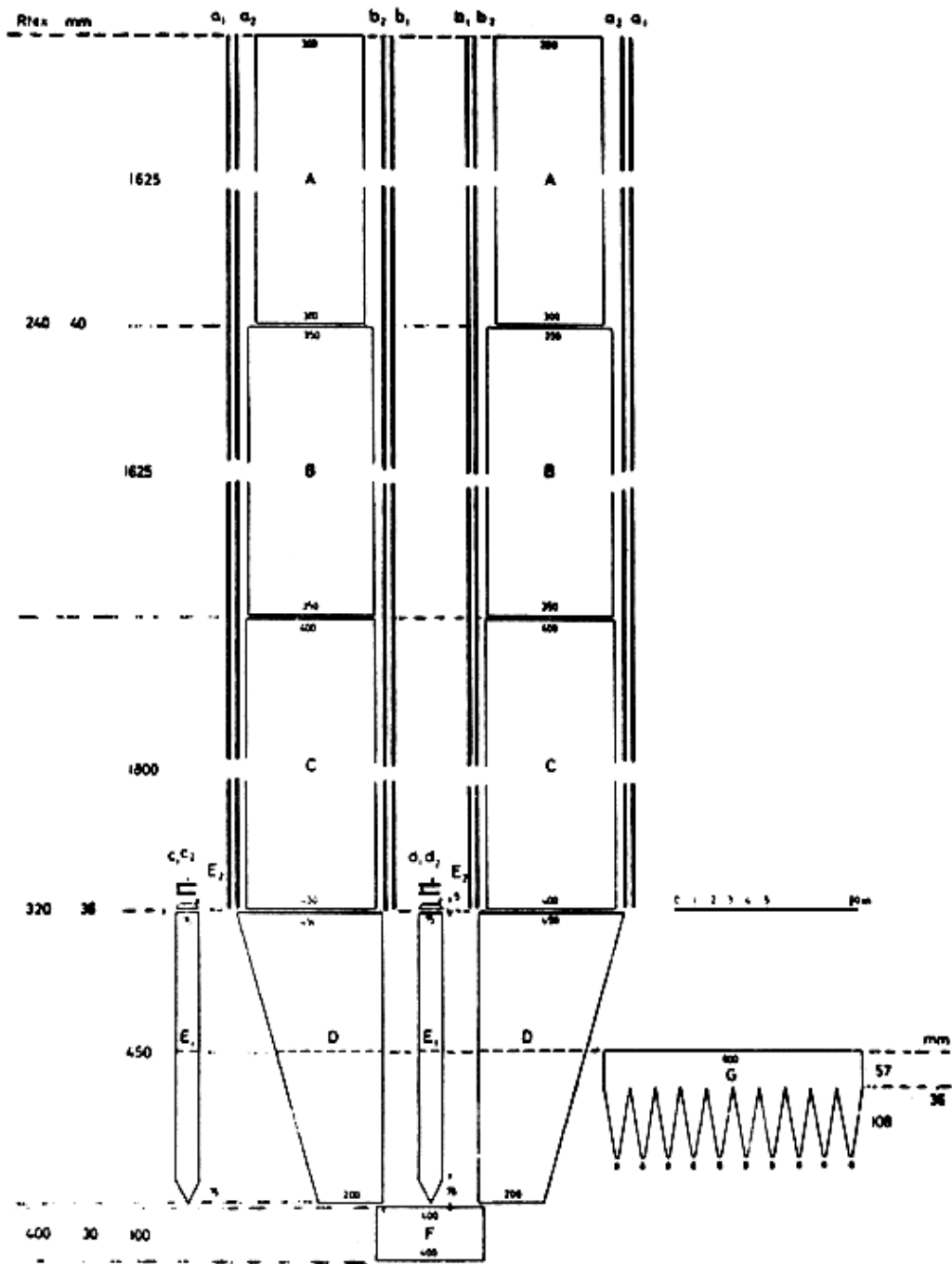


Fig. 2. Construction details of a boat seine.

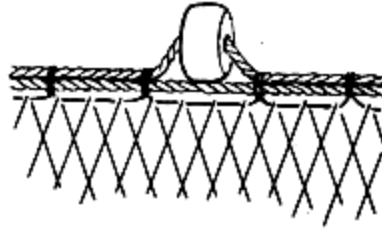


Fig. 3 Attaching the webbing of the wings to the headline or groundrope respectively.



Fig. 4 Setting the boat seine. The bag has just been set into the water.

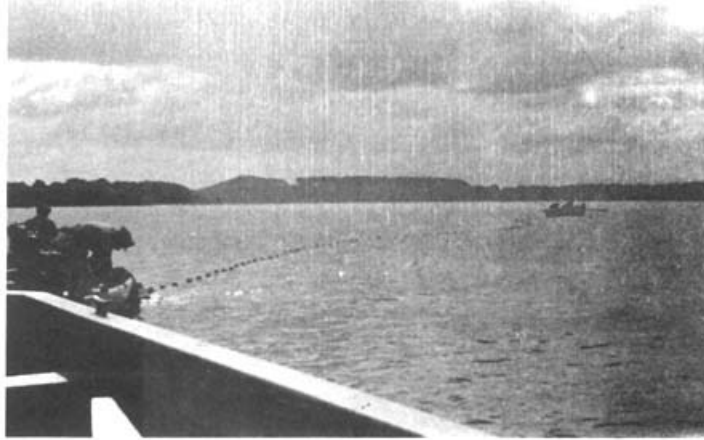


Fig. 5 Setting the wings of the boat seine.

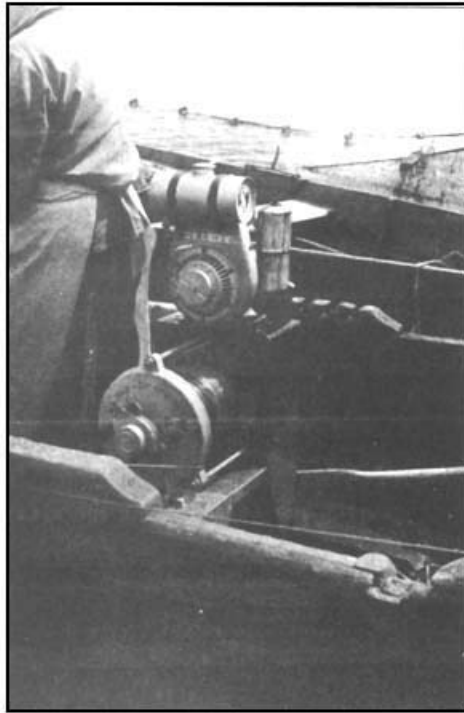


Fig. 6 Motor winch for hauling the wire and the wings.



Fig. 7 Hauling the seine net by the wire.



Fig. 8 Hauling the wings of the seine net.

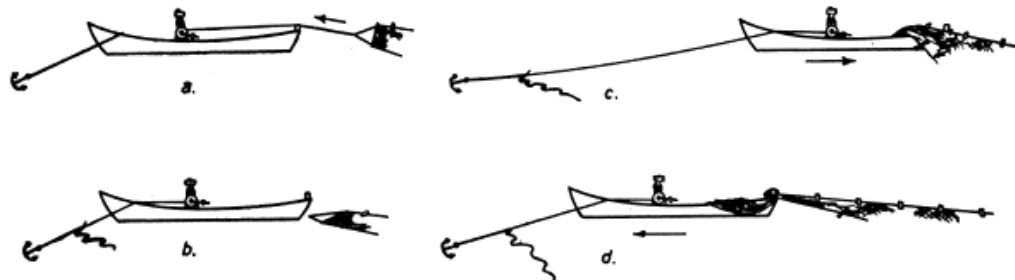


Fig. 9 Several phases of hauling the wings with the aid of motor winches.



Fig. 10 The boats were in close proximity for hauling the last parts of the wings and the bag of the seine net.

APPENDIX 10

THE METHOD OF TWO BOAT TRAWLING FOR EELS IN FRESHWATER

by

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Because of the increasing scarcity of labour it is necessary to introduce mechanisation into freshwater fishery operations. Another way to reduce manpower would be to introduce new fishing methods, which would not require as much labour. Such methods should make it possible to catch fish of a special kind in the desired quantity at the proper time. In this connection the tourist season in summer is the period of importance to many fisheries. During the season, therefore, those fish species which are most remunerative must be fished intensively. In German freshwater fisheries this is usually the eel.

The Institute for fishing techniques, accordingly, has devoted much time since 1964 in collaboration with various freshwater fishery interests to increase the amount of the eel catch by the use of trawl nets in fisheries. From the beginning all efforts were concentrated on the two-boat bottom trawl, as under the special conditions obtaining in freshwater fisheries, this method has several advantages compared with the one-boat method. In freshwater fisheries only small vessels with relatively low-powered motors are usually available. However, since in the two-boat method two motors are used instead of one, sufficient power is available. The horizontal spreading of the net is effected by the two vessels sailing abreast at a certain distance from each other. The use of otterboards is, therefore, not necessary and so the considerable towing resistance of the otterboards is eliminated. Thus, with the two-boat method, relatively small boats can tow relatively large trawls and experience has shown that this is very important in eel fishing if best results are to be obtained.

The first practical tests were carried out in 1964 in the larger North German lakes. In the beginning a relatively small simple net was used (Fig. 1). This gear could be towed by the available 20 hp-boats with a towing speed of up to 3 knots. The results however, were not very satisfactory, but valuable experience was obtained on the handling of the nets and about the most suitable towing speed.

On the basis of these experiences, a large modified trawl was built. This gear was further modified by lengthening the wings by one third. The type of net developed at this time is still used at present in various freshwater fisheries and in further tests being carried out by the Institute (Fig.2). The rig and the mode of operation employed is the same as that used in the Baltic Cutter Fishery (Fig. 3). A leg length of 6 Fd has been selected. The length of the middle legs plays a significant part in the efficiency of operation of this net. By reducing the length of these legs, a higher net opening is provided and by increasing the length of the legs a net opening of smaller height but greater width is obtained and this larger width is of particular advantage when used in fishing for eels. The length of the bridle is an important consideration especially during the shooting and hauling of the net. The bridles should not be too short for the operation of handing over one wing of the net from one boat to the other. Careful attention has also to be paid to the size of the front weights employed as they have to be sufficient to

keep the fishing gear at the bottom. If the weight is not heavy enough the net will rise and this would be a decided disadvantage especially in eel fishing, even though occasionally eels may be caught with trawls in mid-water.

When fishing on soft ground it is recommended that an extra, somewhat thicker rope be fitted in loops to the foot rope of the net. The foot rope weights are mounted on this rope and this protects the net when it touches the ground as it does much to prevent the foot rope cutting into the ground.

When fishing in greater depths of water, it is recommended to use relatively thin wires with a diameter of about 2 – 3 mm as towing warps which can be handled with the aid of a small hand winch (Fig. 4). Otherwise ropes, with a diameter of about 12 mm or more, which can be shot and hauled by hand, are necessary.

The shooting and the hauling of a two-boat bottom trawl is best done in the following manner: First the net is shot from one boat as far as the danleno. Then the boat is turned into the desired towing direction. The second vessel then draws alongside and takes over one bridle and fixes it to the towing warp. The towing warps of both vessels are then shot to a suitable length and at the same time both vessels take position about half the length of the towing warp apart. The length of the towing warps depends, of course, on the depth of water in which the fishing is carried out. At a water depth of only 2 – 3 m about 40 m of warps will be sufficient; at a depth of 10 m about 90 m is necessary and at about 20 m depth approximately 120 m of warp should be short. Otherwise, as observations with a netsonde have shown, the gear will rise from the ground. It is, in any event, better to use a long warp than a short one. A towing speed of 1 to 1–2 knots is suitable for eel fishing with a two boat bottom trawl as it is for other species of fish.

When hauling the gear both vessels stop. With bigger boats it is better if they turn into the direction of the towing warps. These warps are hauled by hand-winchers while the boats proceed at low speed. Smaller boats, on the other hand, can be drawn slowly back to the net while the warps are hauled by hand. Finally the one bridle is detached from the towing warp of one boat and handed over to the other boat, whereupon the net and the catch are hauled on board that boat.

For this type of fishing, only one man per boat is required, which means that large areas can be fished with a two-boat trawl with a crew of two only.

Initially, two-boat trawl were fished in large lakes only. Subsequently they were also employed under much more difficult conditions as for example in artificial lakes. This gear can also be employed in rivers if the current and the traffic are not too strong. The nature of the bottom is of secondary importance as it does not matter whether the ground is hard or soft. Variations in water depths in the course of a haul do not hinder fishing operations with two-boat trawls (Fig. 5). It is, however, important that there are no obstacles in the path of the net, such as large stones or butts of sticks.

The requirements as regards the type of boat employed are not very great. Seaworthy boats only should be used on larger waters; otherwise, all that is necessary is that the boats have sufficient space to handle the gear.

The engine power required depends mainly on the depth of water in which fishing shall take place. The best type is a slow running 20 hp-Diesel motor driving a propeller which is suitable for towing (Fig. 6). This would provide sufficient towing speed at depths down to 30 m, if the net already described, complete with long wings, was used. In shallow waters, not exceeding 10 m, outboard motors of at least 15 hp would be

sufficient (Fig. 7). However, as outboard motors usually have a high revolution per minute, they do not have the towing power of a Diesel motor with the same hp. They are furthermore not as long-lasting as is the Diesel engine.

The yield by the two-boat bottom trawling method has been good in nearly all waters in which fishing has been carried out both in the initial experimental fishing and subsequently in the commercial fishing. The largest eel catches were almost exclusively made during the night. In a large lake in North Germany, 300 to 500 eels were frequently caught in one night alone. The total weight was 60 to 120 kg. The total towing time was usually between four to six hours per night. In addition to eels, 50 to 100 kg of perch and reach were also captured. Even under the difficult conditions of an artificial lake, which necessitated a towing time of approximately nine hours, about 1 300 eels weighing 350 kg were caught and in addition, almost 320 kg of perch and 55 kg of pike-perch were captured. It should, however, be borne in mind that in this artificial lake each haul could, on the average, last only 19 minutes due to the rough ground.

It is remarkable that the two-boat bottom trawl can be used successfully earlier in the year than can any other gear. In a lake in Sleswick-Holstein, on many occasions in the first half of April, several hundred eels per night were caught with the trawl net. It has, however, not yet been possible to use the gear common in eel fishing, like traps and angles, successfully, so early in the year.

From the account given it will be clear that the two-boat bottom trawl is a very profitable system to operate in freshwater for eel and other fish. However, the experience gained over several years has shown that the continuous use of this gear in freshwater is not to be recommended. Too frequent employment of the two-boat bottom trawl will result in a serious reduction in the stock of fish, and in addition, eel and other fish will tend to avoid those areas in which this gear is used. Therefore, the gear in question should only be used at large intervals. Then it should be possible to satisfy large demands by employing the two-bottom trawl for a short time only.

In conclusion it may be mentioned that it has been the experience in Eastern Germany that a combination of the trawl net fishery with electro-fishery can be very successful. Such a combination has not so far been necessary in fishing in Western Germany owing to the efficiency of the type of net used. Because of this fact, tests of this method have only recently been started by the Institute. The results will be published at a later date.

DISCUSSION:

- Deelder - It was essential that unrestricted trawling for eels should be prevented if the eel fisheries were to survive. Trawling had been practised in the Netherlands since 1500. First measures taken to prevent trawling were taken by Emperor Charles V in 1555 and in about 1600 trawling in inland waters was forbidden. In 1932 the Zuiderzee was closed and trawling was permitted in the IJsselmeer. Craft were primarily limited to sailing boats or boats with motors up to 20 hp. There was a week-end closed season and the open season was limited finally to four months per year. Fishermen employed various nefarious means to reduce the effective mesh sizes. Trawling had finally been forbidden in 1970. Trawling was expensive due to the cost of boats; production tended to be low with the result that there are now fewer fishermen and the survivors are no richer. Present IJssel lake production is about 10 kg per ha. elsewhere, with no trawling, production is 20 kg per ha and more. Trawling had an effect on the behaviour of eels. After a trawler has made a haul in a certain region, the fyke net catches were reduced for some time. All evidence pointed to eels being so frightened and otherwise badly affected by trawling that they went off food and sought refuge for long periods. In tagging experiments with market-size eels (using plastic arrow tag) which were caught in fyke nets and liberated after tagging in areas where there was no trawling, some eels were recaptured the same night and about 25 per cent were recaptured in two weeks. When the experiment was repeated with eels caught in trawls, about a month elapsed before a normal number of tagged eels were caught. IJsselmeer eels grow at a rate of 3 cm per year, in Veerse Meer at about 6 cm per year. In view of low growth rate, it is essential that the intensity of fishing be kept down.
- v. Brandt - agreed that in the case of coastal waters and the IJsselmeer Deelder was, no doubt, correct to object to trawling. However, it was necessary in general, to make fishing methods as efficient as possible. In Germany, the fishery owner made a contract with the State and was solely responsible for the fishing. If only one man rents a lake, he should use the most efficient possible method of catching fish. This was legitimate in situations such as obtained in Germany where the fisherman was obliged to undertake the restocking of the waters fished by him to the extent specified by the Fishery Authority.

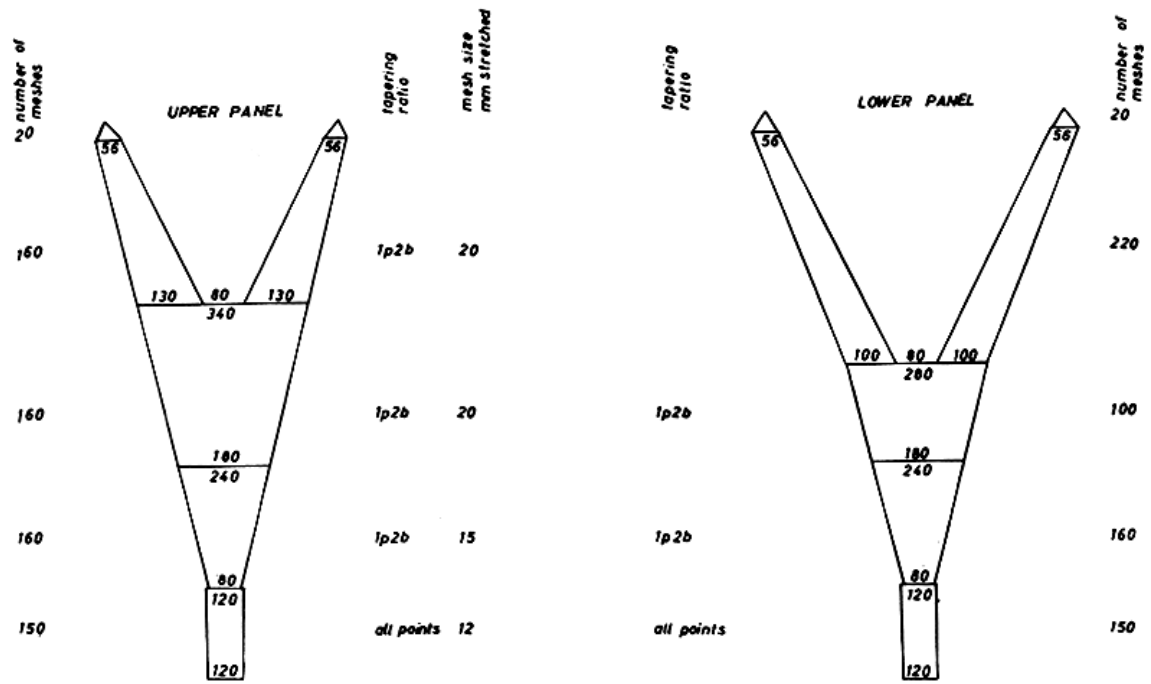


Fig. 1 Structure of a small freshwater two-boat bottom trawl for eel.

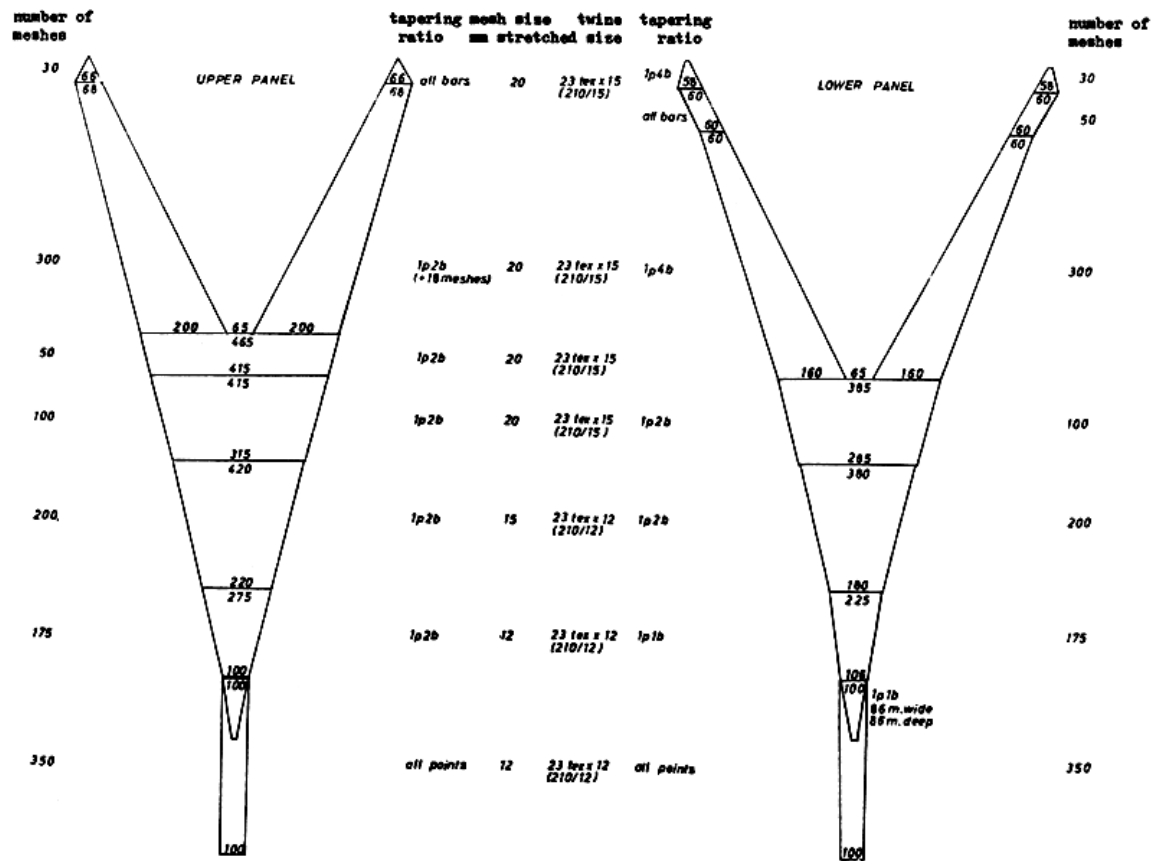


Fig. 2 Two-boat bottom trawl for catching eel in freshwater.

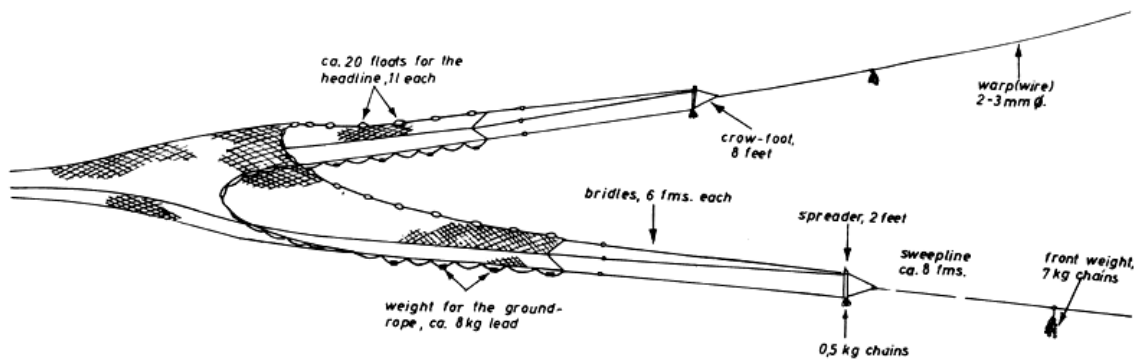


Fig. 3 Schematic representation of the rigging for freshwater two-boat bottom trawls.

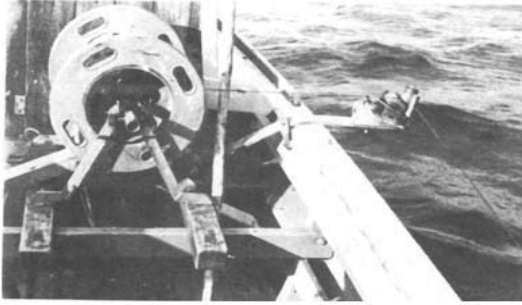


Fig. 4 Haul winch for trawl fishery in freshwater.

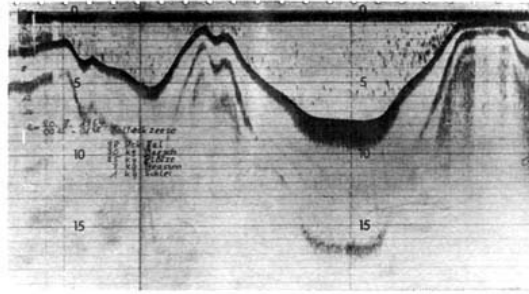


Fig. 5 Echogram of a haul in changing water depths.



Fig. 6 Seaworthy boat with 20 hp Diesel engine for trawl fishery in lakes.



Fig. 7 Openboat driven by 15 hp outboard motor for trawl fishery in small and shallow waters.

APPENDIX 11

A NEW EEL TRAP DEVELOPED IN THE NETHERLANDS

by

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In recent years a new device for catching eels has been developed in the Netherlands, which became remarkably popular in a short period of time.

The instrument may be described best as a baited eelpot: a narrow elongated box, 70 cm long and with a height and width of about 11 cm made from 1 cm thick wooden ballens, nailed together in a simple way. It is fitted with a sliding lid which can be removed in order to put the bait in to get the eels out. Both ends are left open and in this way a rectangular tube is formed. Each opening is fitted with a simple nylon funnel shaped inlet, which offers no resistance to the entry of eels, but prevents escape. Both nylon funnel inlets are kept stretched by a piece of string, connecting one to the other.

The eel boxes are fitted in addition with two iron bars, nailed to the bottom, which ensure that the box sinks to the bottom and remains there. With a piece of cord, of about 1 m, the boxes are attached to a rope 750 m in length, at a distance apart of 25 m. The ends of the main rope are marked with a buoy. The total length of gear of this type used depends upon the number of hands on board, but a crew of three may handle about 300 boxes, for which many kilometres of rope must be used.

Before placing the boxes in the water, a handful of bait is put into each and thereafter the lid is placed in position. The boxes stay in the water overnight and are hauled up again next morning. At the IJsselmeer the bait preferred is smelt. (Osmerus eperlanus L.) and, if available, fish-roe. Preliminary investigations about using artificial food, such as fishmeal, showed that this type of bait was rejected. Other baits, however, such as worms and old cheese are said to be suitable also.

The ability of the box to catch eels depends obviously on the smell of the bait attracting eels to it and upon there being little or no resistance to the eels wishing to enter through the nylon funnel. In addition, as the boxes are tube-like and furthermore are completely dark, they are attractive to the eels. To facilitate still further the entry of eels into these boxes, some fishermen nowadays provide the boxes with two additional openings in the sides of the box so that in all there are four openings (see Fig. 1).

A new box cannot be used straight away. First, it has to be kept in the water for several weeks, obviously to attain the specific smell of the water in which it will be fished. Some fishermen keep live eels for a while in new boxes and are convinced that in this way the attractiveness of the box to eels is speeded up.

Boxes made of waterproof plywood exhibit varying efficiency in the catch of eels. Some make good catches all the time, others do not. Presumably the differences experienced are due to the variations in the kinds of wood used in the manufacture of the plywood, and the water-soluble elements contained in each some of which must be repellent to eels. A study of this subject has recently been started.

It will be evident that the use of these eel box units provides important possibilities for the fishermen, e.g. easy handling with low labour costs. For this reason the long line eel fishery, formerly such an important item in the IJsselmeer eel fishery has been nearly abandoned and replaced by this method.

The catch returns from this box-fishing in the IJsselmeer are rapidly increasing and nowadays are impressive, as is demonstrated by the following table:

Box-eel landings at the IJsselmeer in kg (legal minimum size is 28 cm)	
1965	nil
1966	4 855
1967	32 406
1968	227 340
1969	277 967
1970	449 617 (up to 1 Sept. 1970)

DISCUSSION:

v. Brandt thought that the distance between the valves was too short, and he considered that an eel might tend to escape backwards when his head met the end of the opposite valve and his tail had not yet cleared the valve through which it had entered.

Deelder assumed that the length of the trap could be adjusted to meet local conditions.

Vickers asked Deelder how the trap was baited, and referred to perforated plastic bags as being suitable means of keeping bait intact in a trap.

Deelder said he saw no objection to the use of such bags, but the standard practice in Holland was the use of loose bait in the trap.

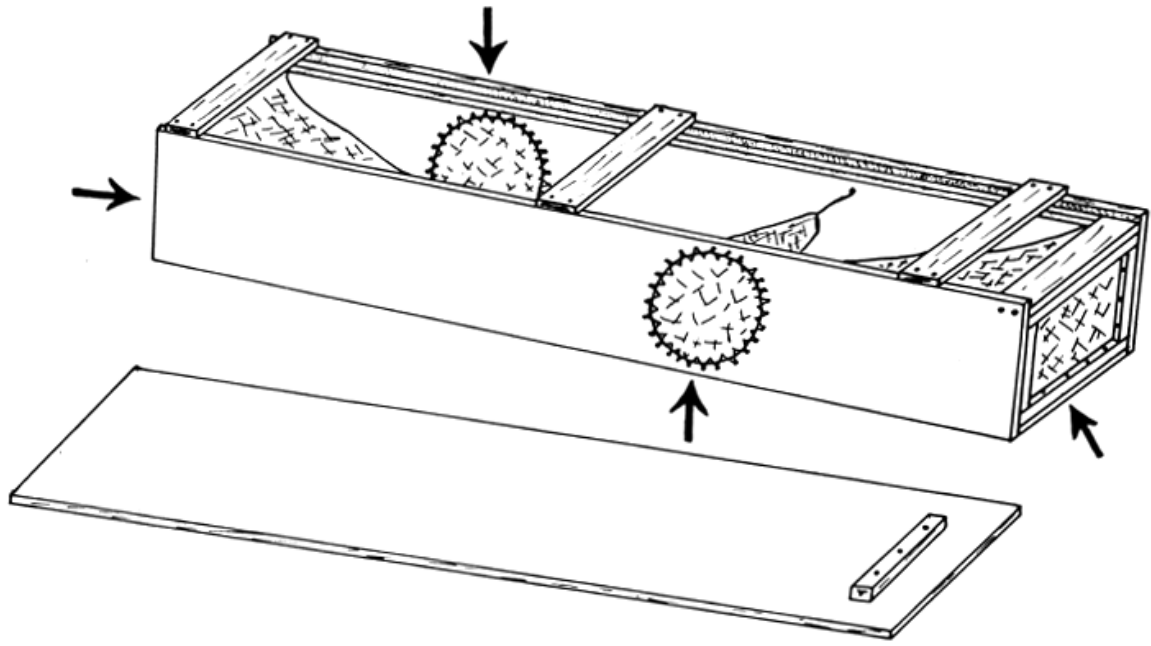


Fig. 1

APPENDIX 12

A DESCRIPTION OF THE DIFFERENT TYPES OF EEL GEAR USED IN DANISH INLAND WATERS

by

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1. INTRODUCTION

Eels are present in practically all types of Danish inland waters: lakes, ponds, marl pits, peat pits, rivers, brooks, canals and ditches. Furthermore they are present in all coastal waters. Silver eels from the Baltic area are heavily exploited during their migration through the Sound and the Belts.

The gears used in inland waters vary much from place to place, being adapted to suit local conditions. All of it can however be traced back to a few basic types.

2. POUND NETS

Pound nets for silver and yellow eel are used on the big commercially managed lakes. In these lakes this gear also serves the function of reducing the competitors for the food of eel, first of all bream, but often also small perch, ruffe and roach. The leaders for these pound nets may be up to 1 000 m and more in length depending on the slope of the bottom, but more usually they are located close to the banks e.g. in continuation of a point or a foreland) and extend only 100–150 m into the lake. Leaders may be supported by floats or mounted on poles. In the smaller bodies of water such as marl pits or peat pits, where commercial eel fishing normally does not take place, such large gear is not employed, neither is it used in running waters.

3. FYKE NETS

Fyke nets occur in two forms: the normal type fyke mounted on poles and the small, movable fykes (e.g. summer fykes). The latter consist of two small fykes facing each other and connected by a leader. They are stretched apart by being anchored by means of two stones or two poles fastened one at each end. A number of units are often combined together to form long chains. The large eel fykes are used by commercial fishermen mainly to catch yellow eels in lakes. The small summer fykes are also used to catch both yellow and silver eels in small water bodies, both by commercial fishermen and also by part-time fishermen and sportsfishermen.

Fykes on poles are used commercially in bigger streams, mainly for silver eel, in which case the entrance is turned upstream. In streams where yellow eels ascend the river from coastal waters in October-November the fykes are turned so that the entrance faces downstream after the silver eel migration has ended. In the spring when these yellow eels descend again (together with some belated silver eels) the fykes are turned again so that the opening faces upstream. Small fykes (or traps), often made of wire netting, are used in small streams to catch silver eels.

4. TRAWL FISHING

Trawl fishing takes place only in large lakes to catch yellow eels, especially in spring when eel prices are sufficiently high to warrant this rather expensive fishing method. Trawling is also undertaken to reduce the number of competitors for the food of eel.

5. BEACH SEINES

Beach seines are used to a small extent, principally in medium or small lakes to catch yellow eels during the summer.

6. LONGLINES

Longlines, like eel trawls and eel seines, are rather labour-consuming gear, are commercially used only to a small extent for the capture of the yellow eel and mainly early in the fishing season. In sport fishing, however, fishing with longlines (mounted with 50–100 hooks) is very commonly used in all kinds of stagnant waters, though sometimes also in bigger streams and canals.

7. ANGLING

Angling with only 1–3 hooks per line, used under the constant supervision of the fishermen, is practised only in sport fishing.

8. BOBBING (German: "Pöddern")

Bobbing is a special way of angling, used by sport fishermen in bigger streams, especially in Jutland. The bob consists of a cotton or nylon line, 1–2 m long, on which earthworms are threaded. The line is then twisted into a ball which is suitably weighted, and is lowered down to the bottom. When the eel bites into the bunch of worms the gear is gently hauled. The teeth of the eel are then caught by the fine threads of the line, so it can be landed into the boat or on to the bank.

9. EEL TRAPS

Eel traps for the capture of descending silver eels are in use in several streams; most often they are incorporated with water mills. They may however be permitted also in the outlet from lakes and smaller water bodies where the fishery proprietor intends to

exploit the eel stock in a rational way (i.e. by reduction of the competitors for the food of the eels and by the liberation of elvers and small eels up to 30 cm).

10. PROHIBITIONS

Eel-spears, eel-forks and scoop-nets are prohibited in Danish inland waters. This also applies to fishing with electricity, poison, explosives or by draining. These prohibitions, however, do not apply to waters which are the property of one fishery proprietor only and without inlet and outlet.

DISCUSSION:

McGrath expressed interest in the practice of reversing the direction of a set of fyke nets to trap the upstream run of yellow eels in autumn.

Larsen - this takes place only in Limfjord and on the west coast.

Deelder - eels in Waddensee live amongst mussels and try to move into fresh water in autumn; they apparently move toward fresh water for hibernation.

Vickers - In River Bann in spring there is a build-up of yellow eels at the downstream entrance of salmon pass.

McGrath - In River Erne at Ballyshannon an elver pass had been built in the cross walls of a salmon pass consisting of a slot filled with large stones through which it was expected elvers would make their way upstream. It was discovered that in addition to elvers trying to make their way upstream there was also a run of larger-sized eels which became stuck in the stones.

O'Leary - In the River Shannon, eels at 60 per lb had been recorded going upstream through a salmon fish pass 16 miles upstream of salt water; their length/weight curve coincides with that of German eels.

McGrath asks for reason for prohibition of spear-fishing.

Larsen - due to pressure from sports fishermen.

McGrath - do pound nets conflict with sport fishing?

Larsen - sport fishing takes secondary place in these fisheries.

O'Leary - are eels in hibernation in spring?

Larsen - activity begins at temperatures from 9° to 10°C.

APPENDIX 13

AN ACCOUNT OF SOME ASPECTS OF THE FISHERY FOR EELS IN SWEDEN

by

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The Swedish eel fishery is mainly an inshore one and it is carried on along all Swedish coasts except the northern part of the east coast.

In order to describe the structure of this fishery, the coast is divided into four sections: the west coast, the Sound (Öresund), the south coast and the east coast (Fig. 1).

On the west coast the eel fishery is not perhaps as important as that on the other coast areas. This is due to the fact that silver eels migrate straight out from this coast and do not pass along it. Consequently this is mainly a yellow eel fishery only (Fig. 2).

The catch has increased during the last few years. The fishermen use small fyke nets and eel pots to catch the eels. The increase in catch is probably due to their using synthetic material in the fyke nets and therefore they can operate more unite than before. Fishing goes on for most of the year except in the winter. There is a peak in the catch in the spring and also one in the autumn.

In the Sound (Öresund) there is both a silver eel fishery and also a yellow eel one. The migrating silver eels are caught with pound nets mostly in October and November. The yellow eel fishery is carried on during the whole year except in January, February and March. The catch in this fishery has increased since the early fifties, mainly due to the fact that the fishermen then begun to use special fyke nets which consist of two small fykes facing each other and with a leader between (Fig. 3). As the bottom of the Sound is more or less level and smooth, they place these units in long chains with 30 to 40 fyke nets in each chain. Two fishermen working together in one boat can operate and tend three to four hundred fyke nets.

The main silver eel fishery is carried on along the south and east coast. As the diagram shows (Fig. 4) the major part of the total eel catch comes from these coastal areas. Although the catch of yellow eel is included also in these statistics, the silver eel catch forms the major part. As the diagram shows, the catch has decreased from 1955 to 1969 on the south coast but on the east coast the catch is about the same. It is the belief of the fishermen that the decrease in catch on the south coast is a consequence of the increase in fishing intensity of the east coast.

The migrating silver eels are caught in large pound nets (Fig. 5). The use of this gear is traditional and the operating method has not changed very much in recent times. The nets are, in the main, the same type but the performance of each may very depending on the topography of the bottom. In areas with a soft bottom the nets are often fixed with poles driven into the bottom. In areas with a hard bottom the nets are supported by floats and are secured with anchors. There is a tendency among the fishermen to go farther and farther out from the coast with their nets. In such an event it is common to change from poles to floats.

The decrease in the number of pound nets from 1958 to 1968, as shown in Figure 6, is explained by the fact that the fishermen replace their old nets by longer and more expensive ones which are more efficient. On the south coast this is quite evident. On the east coast, however, the number has increased, but this is due to the fact that more and more of the units are being used northwards along this coast.

Another development in this fishery is that increasing numbers of progressive fishermen are becoming trained as amateur-divers. This makes it easier for them to locate the big nets in the right place and makes it possible for them to check their gear when necessary.

DISCUSSION:

McGrath - what is the depth of pound net?

Berntsson - up to 10 m.

McGrath - what is the reason for size limits?

Berntsson - the west coast (37 cm) has no silver eels and many males
the east coast (45 cm) has no males
the Sound (31 cm), density of stock in Sound is so high that low minimum is acceptable.

v. Brandt - the longest leader for a German pound net is 600 m. What is the maximum in Sweden?

Berntsson - 300 m.

v. Brandt - described the circular pattern of fish movement following along a leader: which tends to limit the effectiveness of a long leader and necessitates provision of traps at intervals along the leader to ensure fish will not escape capture due to circular pattern of movement out of it.

Vickers - do you have any information on exploitation rate and tag loss?

Berntsson - annual tagging experiment shows a catch of 60 per cent. No tag loss over short period (two months).

Moriarty - what are the tag recoveries after one year?

Berntsson - 1 to 2 per cent up to two year absence.

Deelder - where do recaptures occur?

Berntsson - in region of fishery; none from middle of Baltic.

Larsen - eels tagged in River Murenso were recaptured on coast.

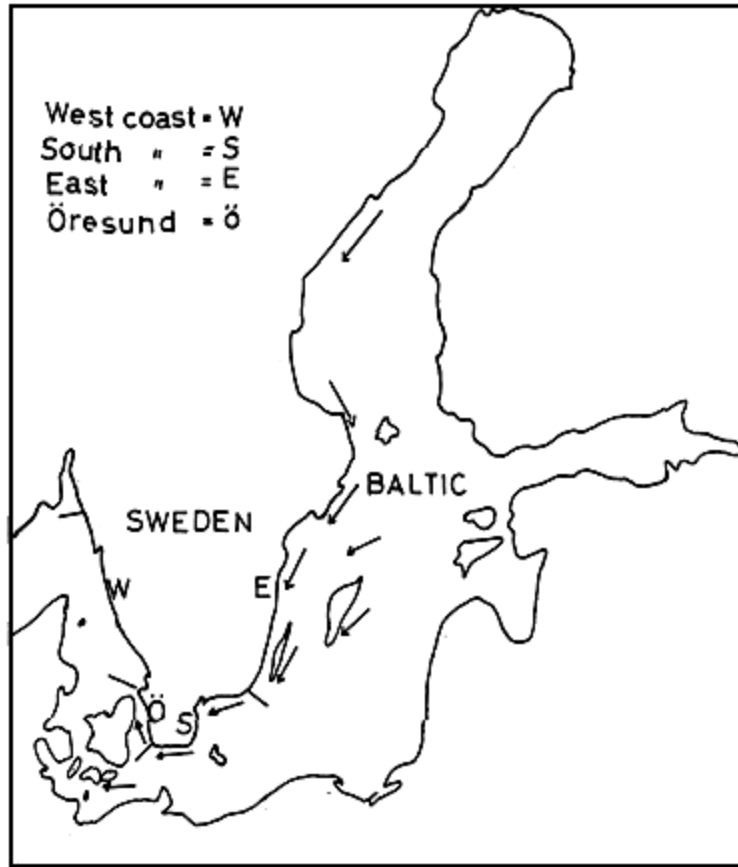


Fig. 1

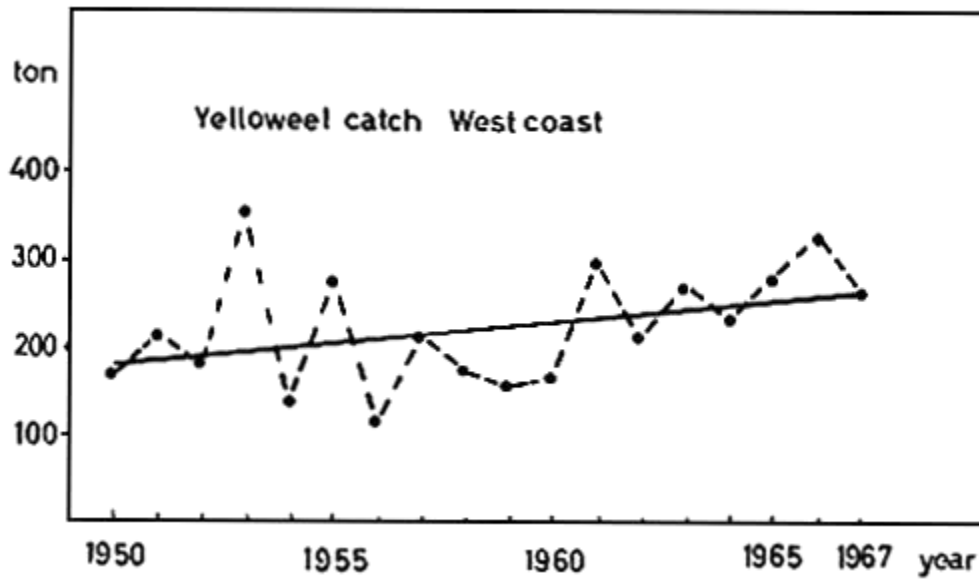


Fig. 2

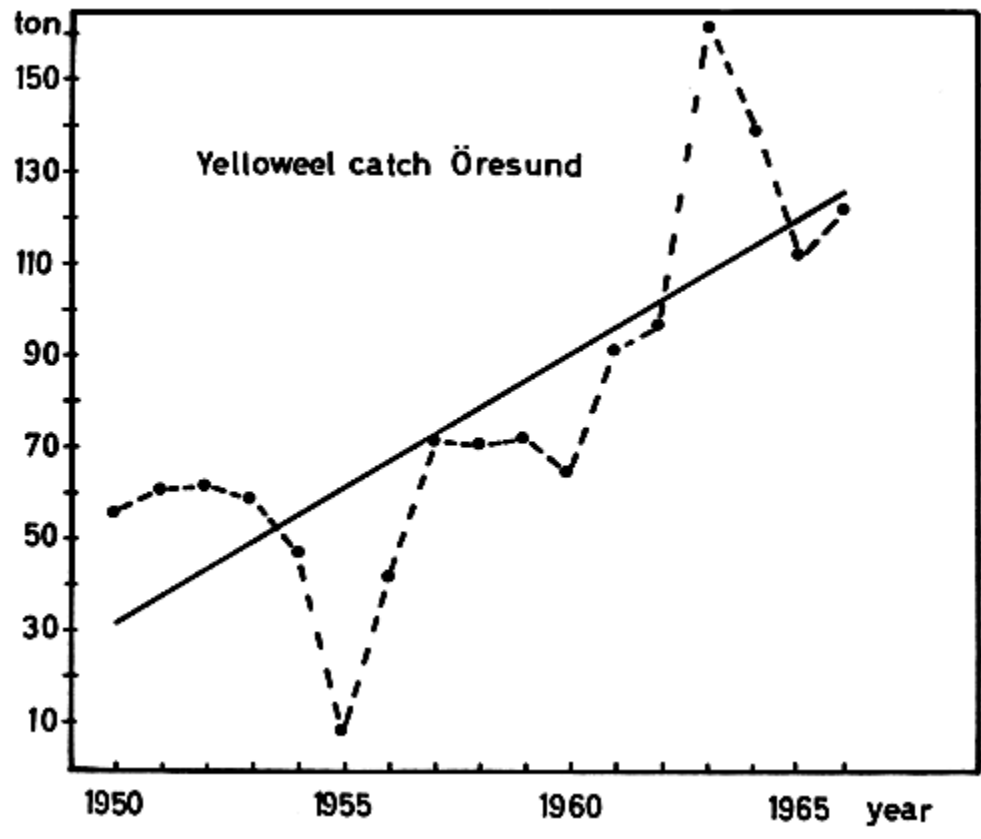


Fig. 3

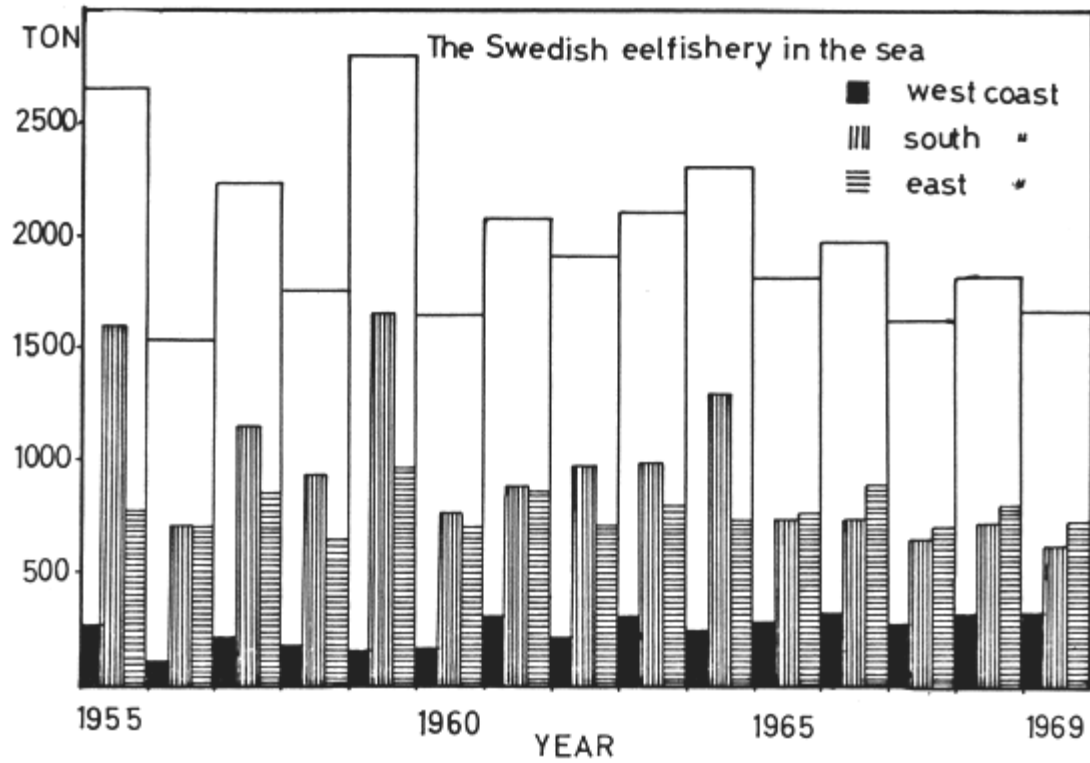


Fig. 4

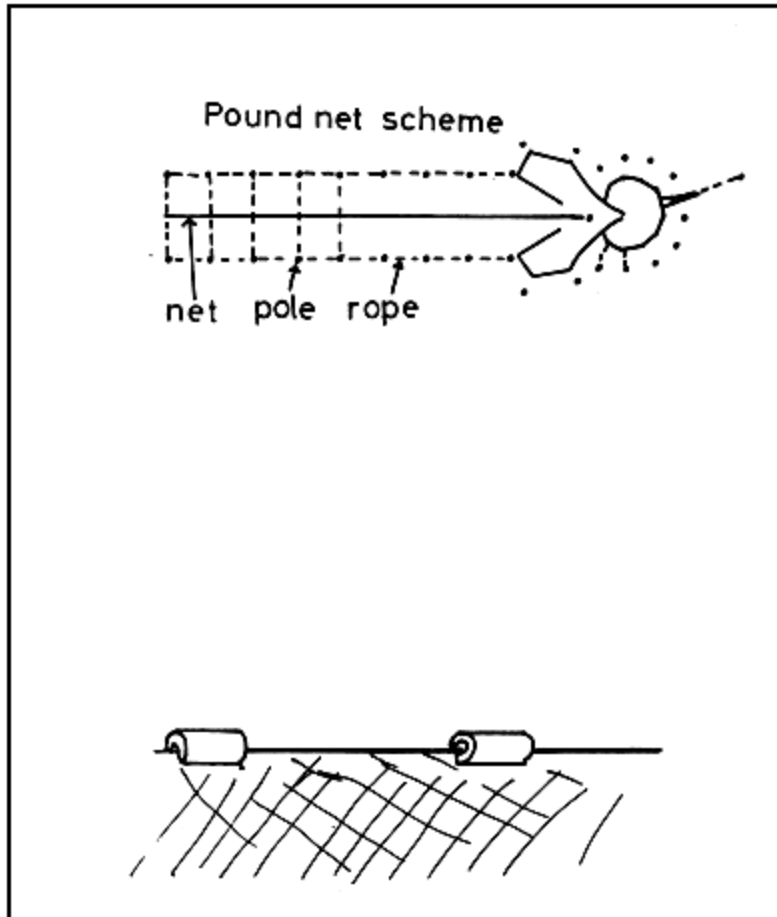


Fig. 5

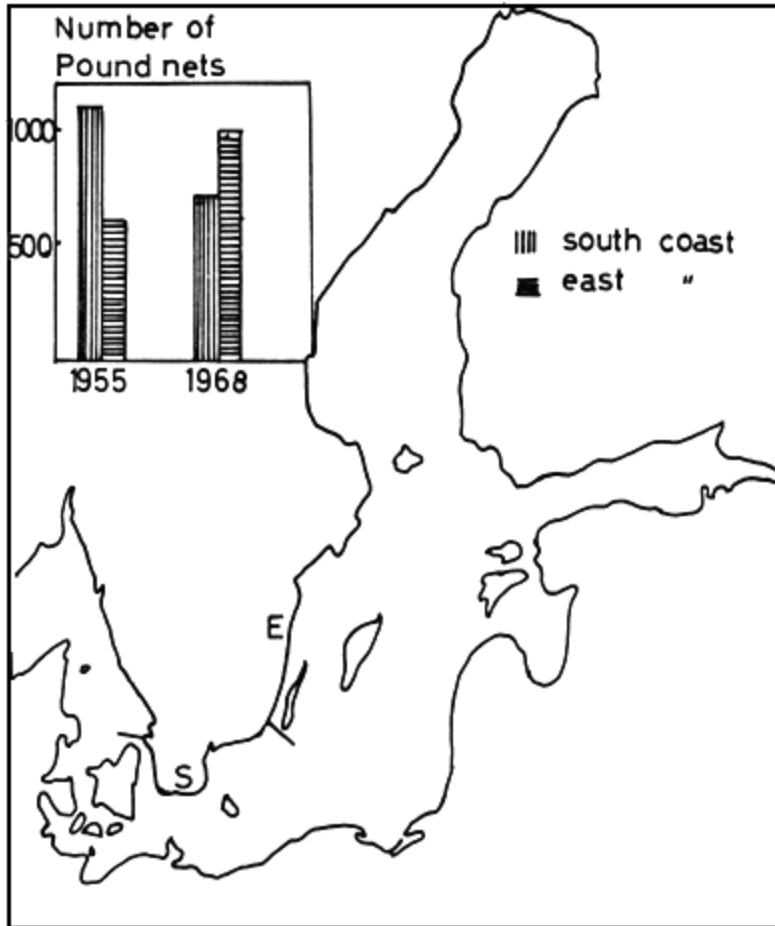


Fig. 6

APPENDIX 14

EEL RESEARCH IN IRELAND IN 1969

by

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Most of the research effort was concentrated on experiments with summer fyke nets. Three zoology students were employed for the field work and the Electricity Supply Board co-operated on the Shannon System. The standard set of eight nets (sixteen traps with eight leaders, arranged in line) was used on the Corrib system. On account of losses and damage to nets, only seven were available for the Shannon but it is unlikely that this made any material difference to the results. When possible fishing took place daily. The figures are based, with one exception, on the total number of days when the nets were fishing, including week-ends and stormy weather when they were not lifted daily. The exception was Lough Mask where persistent rough weather made lifting the net impossible for a fortnight. It was found in this case that the smaller eels escaped and the catch was therefore not typical of normal conditions. The nets used had a mesh size at the codend of 10 mm.

On the Corrib system the River Corrib, the southern part of Lough Corrib, Lough Carra and the eastern side of Lough Mask were studied. On the Shannon the 'Reservoir' between Killaloe and Parteen, Lough Derg and Lough Ree were chosen. The eels were measured, weighed and sexed and otoliths and stomachs were collected. The nature of the flora and fauna where the catches were made was also recorded. The analysis of the stomach contents is still in progress both for 1968 and 1969. Otolith reading for 1968 was completed and some studies were made on the correlation between length and weight of eels from different waters.

Other eel work included a study by electrical fishing and fyke netting of the eels of the River Erriff in Co. Mayo and some observations on the migration of elvers there and on the Owenea, Co. Donegal. Fyke nets were also used at the Galway barrage on the River Corrib to find out whether these nets were liable to interfere with the passage of salmon smolts. This experiment showed that the damage to smolts was negligible. Of 3 600 smolts which passed within 20 feet of the net, two were caught.

The results of the measurements of the eels are given in Figure 1 and Table I. In Table I the figures for 1968 are included for comparison and Figure 2 gives the 1968 distribution.

Table I

Eel catch and fishing effort. (In the last column the figures show the percentage by weight of eels longer than 40 cm)

	Number of eels	Weight of eels (g)	Number of days fishing	Number per net per day	Weight per net per day	Percentage of eels exceeding 40 cm (16 in) in length
<u>1968</u>						
tyL. Corrib N.	185	28 550	44	0.5	61	76.5
L. George	77	8 536	30	0.3	17	47.5
L. Inchiquin	284	51 968	30	1.1	154	70.9
Cootshill Ls.	285	74 901	35	1.0	262	97.7
Killeshandra Ls.	213	53 611	30	0.9	206	92.3
<u>1969</u>						
R. Corrib	33	4 386	3	1.3	182	65.5
L. Corrib S.	389	69 934	18	2.7	485	78.3
L. Mask	77	14 277	8	1.2	223	87.0
L. Carra	71	15 838	13	0.6	152	92.5
Reservoir	57	8 865	7	1.1	180	88.3
L. Derg	269	52 197	23	1.6	324	93.7
L. Ree	12	4 583	10	0.1	65	100.0

In 1968 the poor catches (less than 100 g per net per day) were made in lakes where suitable feeding areas for eels were limited. This explanation does not account for the very small catch in Lough Ree in 1969 where the feeding should be excellent. There is clear evidence in the poor catch and the relatively large size of the eels that the lake is understocked. The figures in the last column of Table I show for each river system an increasing percentage of eels of over 40 cm as the distance from the river mouth increases. This suggests that the total stocks in the upstream lakes are smaller than downstream, resulting from a reduction in the numbers of elvers or young eels which travel that far. Long line fishing probably reduces the stocks further. The Corrib system also shows a steadily decreasing catch in numbers and weight of eels from lower Lough Corrib to Lough Carra (upper Lough Corrib has a poorer stock than any of these points but this is due to the nature of the bed of the lake).

The age distribution of the 1968 eels is shown in Figure 3. This agrees with the conclusions drawn from the length measurements for that year and shows that rapid growth and early maturity are the rule for the rich feeding areas (Cavan lakes and Lough Inchiquin) while slow growth and late maturity occur in regions of poor feeding. Correlation between age and weight has not been calculated in detail yet but the indications are that very few eels of less than nine years of age reach a length of 40 cm (16 in). Calculations of the correlation between lengths and weights of Lough Derg and Lower Lough Corrib eels show that the Corrib eels are heavier. An average 40 cm Corrib eel weighs 225 g, one from Lough Derg weighs 160 g (16-in eels weigh 8 oz and 6 oz respectively).

The results of the 1969 fyke netting confirmed the conclusions of the previous year that there is very little hope of these nets being used on a large scale for commercial fishing. The best catch, from Lower Lough Corrib, would have yielded about £40 per month per eight nets (cost £60). The question of how many nets could be used

in an area of water without over-fishing has yet to be answered. The information available at present suggests that a large investment in fyke netting equipment would at best be very risky. Small-scale netting by a resident fisherman should provide a supplementary income of £50 to £100 a year in a good lake.

The original purpose of the fyke netting experiments was to find out whether there were possibilities of making a substantial increase in the number of yellow eels caught in the country and in the number of people employed in fishing for them. From this point of view the results have been disappointing. It is apparent that the national stocks are low and any greatly increased fishing for yellow, that is immature, eels would serve to reduce them further. The aim of future experimental work will be to determine optimum rates of stocking with elvers to increase the population and catch. Further analysis of the information problem and experimental fishing on the same lines will be continued. The most valuable positive result of the work to date has been the establishment of basic techniques which, applied over a number of years in the future, will yield essential information for rational regulation of the fishery. It will also be possible to assess the effect which eels have on other species of fish, especially on salmon and trout.

The views in this document are based on the data from experiments to date and may well be revised in the light of results from future work.

DISCUSSION:

O'Leary - Would an eel trap not be a more efficient method to capture the eels required rather than the fyke nets employed?

Moriarty - fyke nets were employed as in addition to seeking information about the ageing of eels; information was also being sought about the natural movement of eels. This likewise precluded the use of baited traps. In response to a number of requests Moriarty described his method of mounting otoliths for age determination.

Deelder - used a light beam through a slide-mounted otolith section; the rings on a diagram were plotted by a light sensitive cell: the actual light and shade of each ring on the otolith was plotted; it was possible that the apparatus could be connected to a computer which could be programmed to do the actual counting.

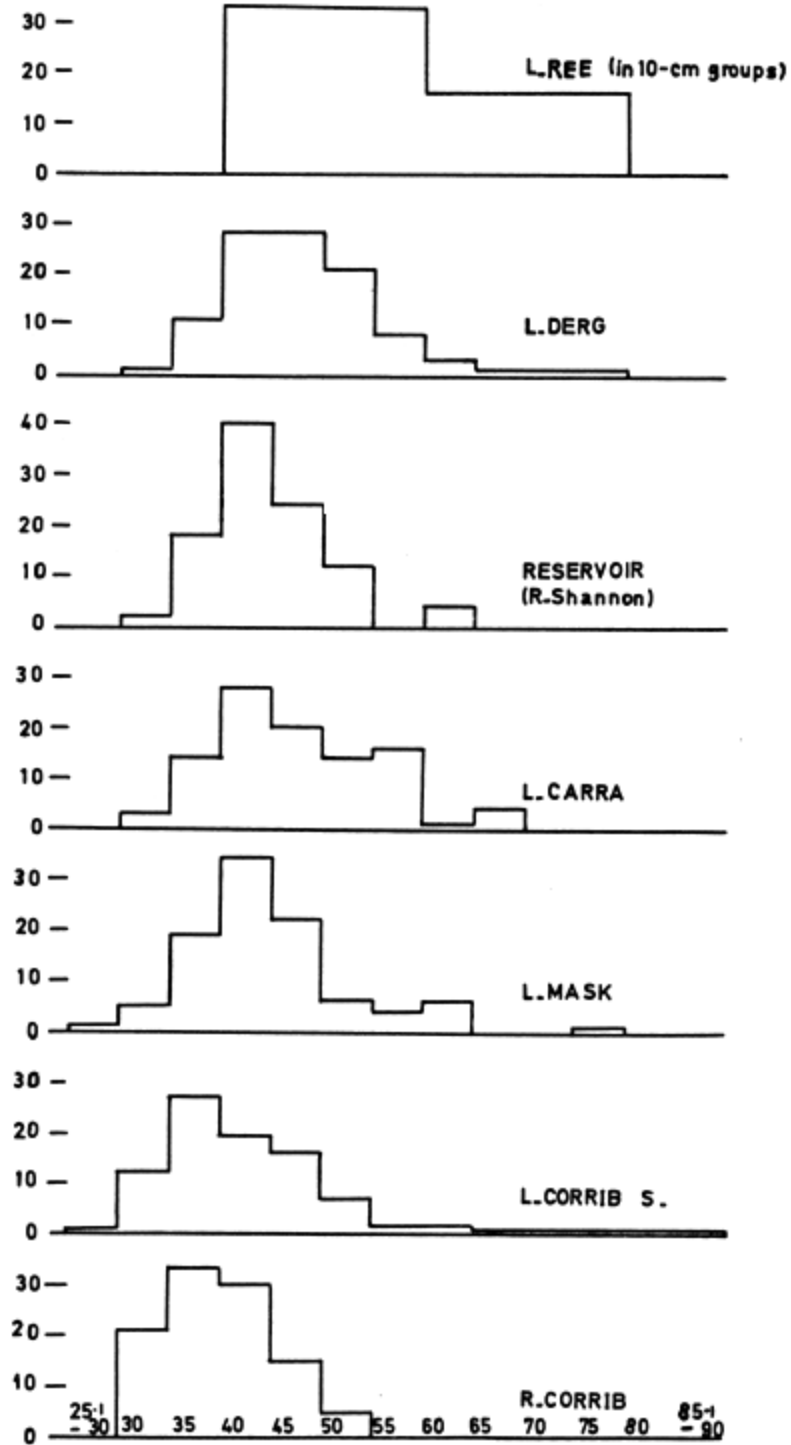


Fig. 1 Percentage length distribution 1969.

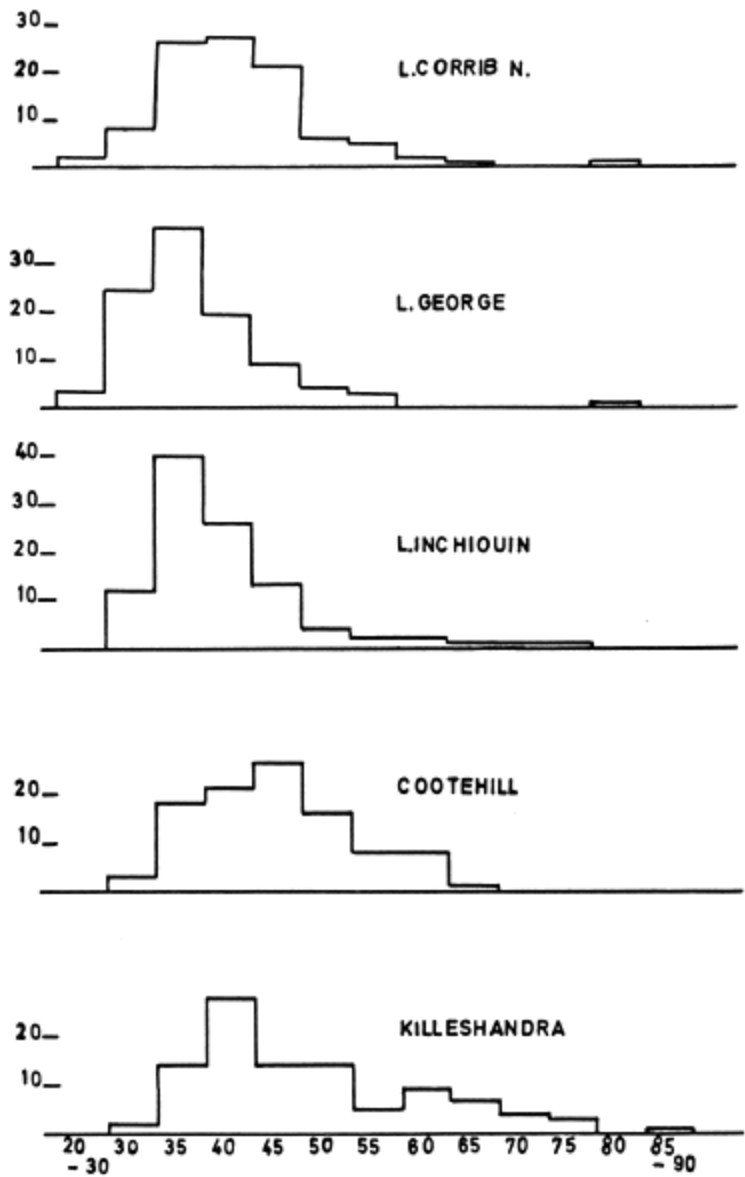


Fig. 2 Percentage length distribution 1968.

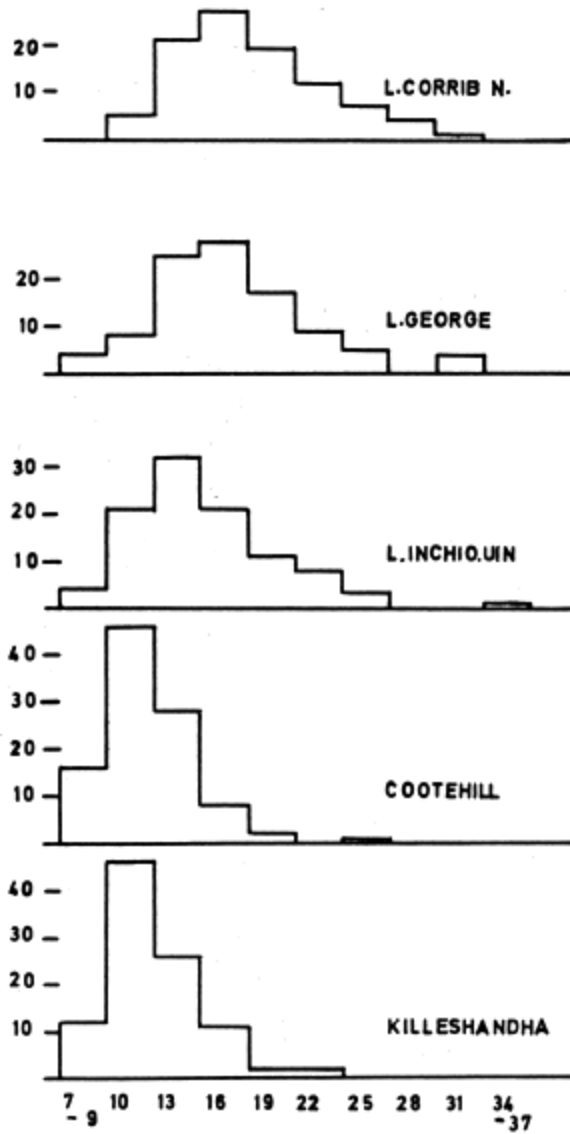


Fig. 3 Percentage age distribution 1968.

APPENDIX 15

THE METHODS AND TECHNIQUES EMPLOYED IN THE DEVELOPMENT OF EEL FISHING IN HUNGARY

by

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As a consequence of the experiments carried out in 1961 and 1962, concerning the introduction of eels into Hungarian natural waters, introductions on a large scale began in 1963. Three of our major lakes were stocked; Lake Balaton, Lake Velence and Lake Ferto. Elvers imported from various countries were used for stocking. Depending on the local circumstances different methods of recapture of silver eels were developed. These methods are improved continuously in the light of experience gained.

The minimum catch size is fixed at 50 cm. Angling is permitted everywhere even during nighttime.

Pertinent data about the above-mentioned lakes are given below.

1. LAKE BALATON

Surface area: 580 km², average depth: 2.5 m. In the event of high water-levels in the lake it is drained through a sluice at the outlet on the channel Sió. The stream flow capacity of this channel is 50 m³/sec. Drainage of the lake usually takes place in early spring and in late autumn.

Table I

Stocking rates	
Year	Elvers (in millions)
1963	4.2
1964	4.0
1965	4.8
1966	3.7
1967	4.0
1968	2.0
1969	2.0
1970	4.5

Catches in tons

Year	fykes	eel-racks	anglers	total
1966	-	-	2.9	2.9
1967	-	-	3.6	3.6
1968	4.4	-	5.1	9.5
1969	3.4	22.2	7.2	32.8
1970. 15 Sept.	5.0	39.5	7.5	52.0

The fykes used belong to the type of big fyke nets. They have three main parts as described in Figure 1. The mesh size is 18–28 mm.

The fykes are set up near the reedy banks with leaders mounted in the reeds. They are fished from April to November. Every 2–4 weeks the nets are taken from the water and dried in order to protect them from algae. These fykes catch not only eels but also other fish. Catches are best when the fykes are located in the path of the prevailing wind.

The disadvantages are: they become covered with algae in a short time; many small pike-perches are caught, and get killed, and because of shipping and of coastal weekend-houses they cannot be used at the best places. Because of the disadvantages outlined above, no further development of this method is planned for Lake Balaton.

The eel-racks of this lake are incorporated in the sluices at the inlet to the Sió, which have two gates. The width of each gate is 4 m, and its maximum discharge capacity is 30 m³/sec. Each gate is fitted with an eel-rack. The eel-rack consists of a bottom fish screen set on steel frames; a catching box; lifting devices with an overhead gantry. The steel frames are hinged so that it is possible to adjust the angle of inclination of the screens to suit the rate of outflow and in the event of ice floes being present in the outflow from the lake to remove the eel-racks altogether from the sluice outlets. Each of the catching tanks has a cubic capacity of 2 m³ which is sufficient to hold 1 ton of fish. The tanks can be lifted and placed directly on trucks by the lifting devices suspended from the overhead gantry which are used also to adjust the racks. Each rack has a spare catching tank which can be installed to replace the one removed.

The eel-racks are fished during periods of draining the lake from early spring - when the ice has melted - to late autumn. Experience has shown that the daily catch is influenced by water-temperature, wind-direction, and the phases of the moon. On the occurrence of a favourable wind (northwest); 5–11°C water-temperature and in the first and last phase of the moon the daily catch is between 1–2 tons. At the time of full moon the daily catch is reduced to 0.1 tons. During summer-draining catches are minimal - 0.01–0.05 tons.

2. LAKE VELENCE

Surface area: 23 km²; average depth: 1 m. Superfluous water is drained through a sluice at the entrance to the channel Dinnyés-Kajtor. The stream flow capacity of the channel is 6.0 m³/sec. Drainage usually takes place in early spring.

Table II

Stocking rates					
Year	Elvers (in millions)				
1963	1.60				
1964	0.06				
1965	0.35				
1966	0.48				
1967	0.52				
1968	0.50				
1969	0.30				
1970	0.40				
Catches					
Year	Small utensils (traps, lines)	Electrified trawling	Eel-channel weir	Anglers	Total
1966	-	-	-	0.9	0.9
1967	1.6	-	-	0.9	2.5
1968	2.4	0.9	-	1.1	4.4
1969	4.5	3.3	-	2.1	9.9
1970 1 Sept.	2.9	4.0	0.3	2.4	9.6

In Lake Velence eels are caught by simple old-fashioned traps; by set lines and with the help of electricity. The length of the lines is between 200–600 m. At 2-m intervals hooks, size 24, are attached to this line by means of 30–40 cm long droppers. Small fish or slices of fish are used as baits. Lines are set during the late afternoon or early in the evening. They are collected again in the morning. The disadvantages of this method are obvious, principally that a lot of small eels and also other fish are caught by it. Eels caught with set lines are usually intended for smoking.

The most economical way of fishing for eels in the lake is by using the electric trawl. This method was imported from the German Democratic Republic, and adapted to suit local use. The trawl is pulled by two boats fitted with 6 hp motors at a speed of 1 km/h. The single-phase direct current convertor, together with a pulse regulator, is fitted into one of the boats. The electric trawl is used from March to October. The current and the impulses used can be regulated and with this means only eels are caught. The experience to date with the use of electric trawls has been so good that we want to introduce electric trawling in all waters stocked with eels.

The eel weir at Lake Velence is built in the channel of Dinnyés-Kajtor. Surplus water is drained through the two openings in the middle of the weir. The traps are beside the openings. With the help of the gate, stop logs and fish screens, various methods of catch can be practised. The traps are directly connected with storage basins so that the eels can swim into them. Because of unfavourable water levels the eel weir has been operated only for short periods.

3. LAKE FERTO

Surface area: 320 km² of which 268 km² belongs to Austria and 52 km² to Hungary. Average depth: 1 m. In the event of high water levels in the lake it is drained

through the main channel of Hanság, its stream flow capacity being 8 m³/sec. Draining usually takes place in the spring if there should be need. In dry years no draining occurs.

Table III

Stocking	
Year	Elvers (in millions)
1967	0.1
1968	0.2
1969	0.3
1970	0.5

Before the year 1967 elvers were stocked in the Austrian part of the lake. Since that time, the Hungarian contribution to the stocking exceeds that by Austria.

Catches (in tons)			
Year	Traps	Eel-rack	Total
1963	0.7	-	0.7
1964	1.6	-	1.6
1965	2.8	-	2.8
1966	0.6	-	0.6
1967	1.4	-	1.4
1968	3.0	-	3.0
1969	4.0	-	4.0
1970	5.6	2.2	7.8

Fishing in this lake is practised by means of old-type traps (mesh size 15–18 mm), and by means of electricity. The major part of the catch of eels is made in the spring. The electric trawl used on Lake Velence was tested here also with good results. A new electric trawl for local use is under construction.

The eel-rack on the main channel of Hanság was finished in the late spring of 1970. It is of the same type as that on Lake Balaton. Initial results have been satisfactory. In addition to the lakes already named various smaller waters such as dead branches of rivers were stocked with eels. In these waters old-type eel traps with small mesh size are employed. Where there is an intake sluice in these waters Swedish portable traps are used also.

DISCUSSION:

Deelder - the efficiency of the eel-rack?

Thuranzsky - assumed to be 100 percent.

Deelder - if so, why use electrical trawls and other devices?

Thuranzsky - sometimes there is no flow at all out of the lake depending on the weather. At such times the market has to be supplied.

McGrath - what was considered to be the desirable stocking rate with young elvers?

Thuranzsky - the most desirable stocking rate for their lakes was 400 elvers 5–6 cm long per ha.

McGrath - what was the orientation of the lake and the position of the outlet in relation to the prevailing wind?

Thuranzsky - the lake is a long narrow one, the prevailing wind is north-west, and the outlet is at the south-east corner of the lake.

O'Leary - wind on Lough Derg in Ireland has a very definite effect on the catch at the eel weir at Killaloe located at outlet at southern end of lake. On a night of strong north wind good catches would be obtained even with low flows.

Deelder - there is a definite relationship between wind direction and catches. This had been commented on and established by various authors.

Vickers - a relationship between wind direction and salmon runs had also been established in Canada.

Moriarty - were the lakes stocked with young elvers fresh from the sea? and if so, it appears that they produce silver eels in 6 years.

Thuranzsky - elvers were purchased from Ireland and France (Mediterranean coast) and they matured to silver eels in 6 years.

McGrath - a unique opportunity existed to study age/weight ratios as first-ever elvers planted in 1963.

Thuranzsky - the average summer temperature of the lake is approximately 26°C and the average weight of the silver eels would be approximately 650 g.

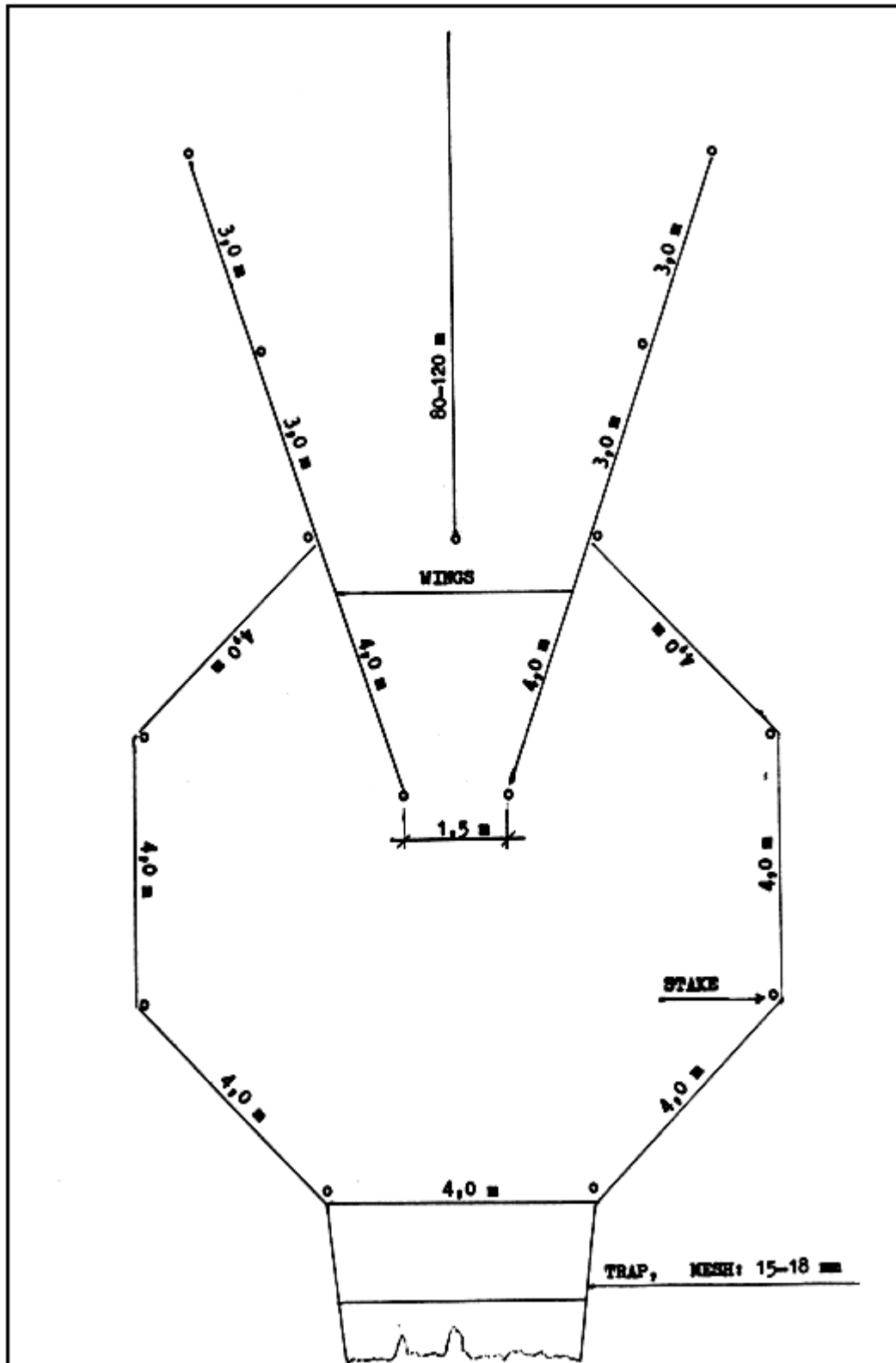


Fig. 1

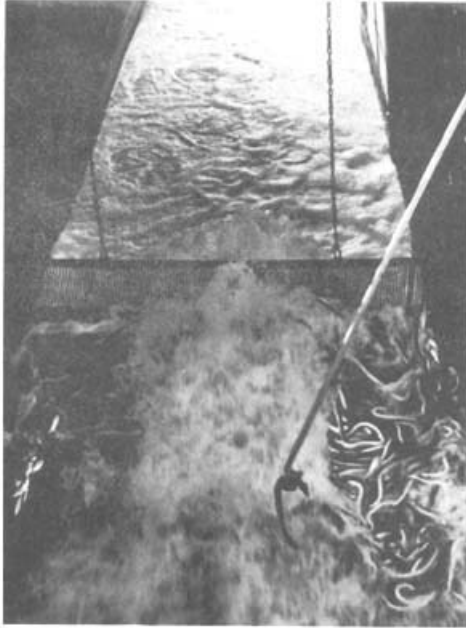
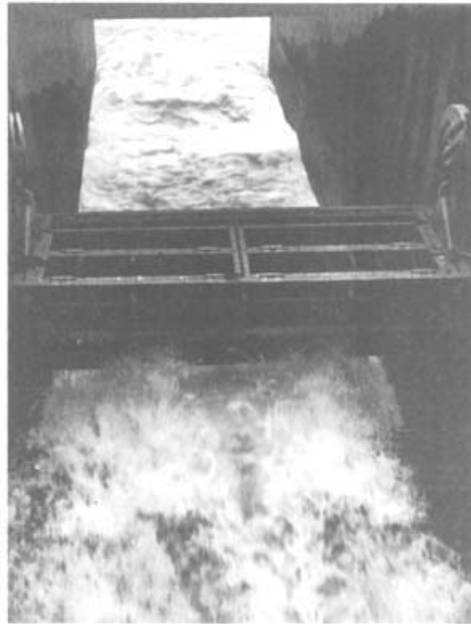


Fig. 2 The eel-rack in operation at Siófok.

Fig. 3 Lifting the tank of the eel-rack at Siófok.



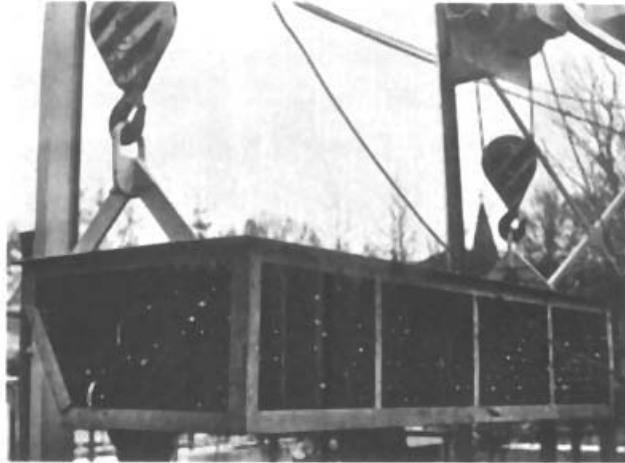


Fig.4 The tank of the eel-rack at Siófok.



Fig. 5 Transportation of the tank of the eel-rack at Siófok.



Fig. 6 Eel channel weir of Velence.

APPENDIX 16

A LOW HEAD ELVER TRAP DEVELOPED FOR USE IN IRISH RIVERS

by

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1. INTRODUCTION	

The Electricity Supply Board are the owners of the entire Eel Fishery on the River Shannon. The catchment area of the Shannon is 1 049 600 hectares and the water surface area of the main lakes and rivers is 35 000 hectares.

During a visit to Ireland in 1966 Mr. Koops of the Fishery Institute Hamburg recommended that the Shannon should be stocked with 20 million to 30 million elvers per year. At that time uncounted elvers passed into the Shannon lakes through elver passes at Ardnacrusha and Parteen Weir. We then decided to trap these elvers and count and transport them to the lakes. We always considered that the natural run was around 10 million but trapping and counting revealed that the run was only 5 million. We were then faced with the problem of finding and transporting the remainder from other sources. There is no system of organised elver catching in Ireland.

Owing to the high rainfall and low river grades in Ireland land suffers considerable flooding. To relieve this situation the Government passed the 1945 Arterial Drainage Act. All the smaller flour mills built in the 1840's became derelict in the 1930's. Consequently as drainage schemes proceeded most Weirs were removed and river gradients flattened. This has made the catching of elvers almost impossible due to the lack of obstructions. Once a drainage scheme is completed it is illegal to put an obstruction in a river without the permission of the Drainage Authority. Such permission is not easily obtained.

2. ELVER TRAP

These circumstances prevailed in the River Feale which has an elver run of up to 15 million and has no lake system and is consequently unsuitable for the production of eels. The necessity for an elver trap which would operate under a head of 5 cm was obvious. Many ideas were tried until ultimately the design shown in Figure 4 was arrived at.

This type of trap has many advantages:

- (a) It can be set at any point where 5 cm of head can be generated over its own length.
- (b) It is portable and can be set by one man in one hour.
- (c) It can be moved upstream as the run of elvers moves upstream.
- (d) It will operate extremely well attached to bridge piers.
- (e) It requires no permanent structure in the river.
- (f) Its cost is low; approx. £25.
- (g) In good runs catches of up to 140 lb. per hour of fresh-run elvers have been achieved.
- (h) The trap will also catch elvers which have spent up to 4–5 years in fresh water. Catches of up to 20 lb per hour of these elvers have been achieved.
- (i) It is possible that the trap may catch older elvers if the size of the groove and pipe were increased.

The trap essentially consists of a nylon brush which comes to and abrupt and at an inclined groove which is cut across the timber on which the brushwork is mounted. Water enters the upstream and of the trap through an adjustable slot and runs over a smooth timber surface. The velocity over this surface is such that elvers cannot proceed. Longitudinal guides help to distribute the water and makes mounting of the trap less critical.

After travelling over the smooth surface the water enters the groove where part of the water flows along the groove and into the pipe. The remainder of the water flows down through the brushwork.

Elvers travelling close to the bank will enter the water flowing out through the brushwork and travel up to the groove where they get into the high velocity stream of water in the groove and are washed into the pipe and down into the holding tank.

We have found from experience that it is an advantage to have approx. 10 cm of smooth board at the downstream and of the brushwork. By moving stones around in the river bed it is possible to make the velocity on the river side of the trap too fast for elvers and thus make them enter the brush. The space between the trap and the bank must be filled with stiff blue clay.

Traps are best made with left and right hand outlets as the smooth side can then be put next to a bridge pier.

Figures 1–3 show one of these traps mounted at a rapid in a small river.

3. SPECIFICATION FOR BRUSHWORK

The bristles stand 88 mm over the base and consist of tufts of 120 bristles of 0.3 mm green nylon. The tufts are at 10 mm centres in staggered rows.

The base is made of hardwood (Iroko) and is tapered from 45 mm at the upstream and to 15 mm at the downstream end.

The tufts of nylon are fixed to the base by lacing with stainless steel wire.

The sides project 120 mm above the base. This will enable the sides to be loaded with weights to provide stability without damaging the brushwork.

The groove is 40 mm wide and 20 mm deep and inclined at an angle of 50°.

The water inlet slot has a maximum opening of 15 mm.

The width of the brushwork is 300 mm. It is hoped to construct brushwork up to 600 mm before the next elver fishing season.

The overall length will vary with the river gradient. Our present length is approximately 1.35 m for very low river gradients. This can be reduced to 0.8 m where the river gradient is steep.

Working details are shown in the attached Figure 4.

It is hoped to add a very faint light to the downstream end of some of these traps next season.

DISCUSSION: No discussion



Fig. 1 Elver trap positioned at water edge along river bank

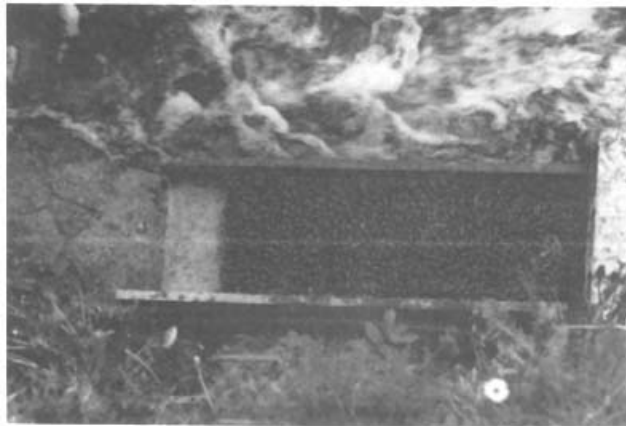


Fig. 2 Trap detail: showing position and bristles

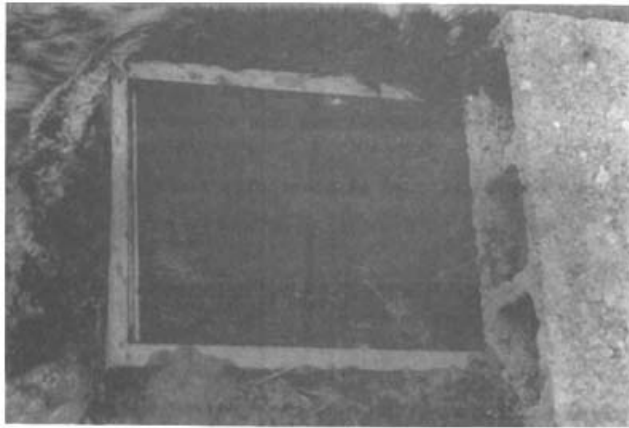


Fig. 3 Trap detail: showing inlet and slot

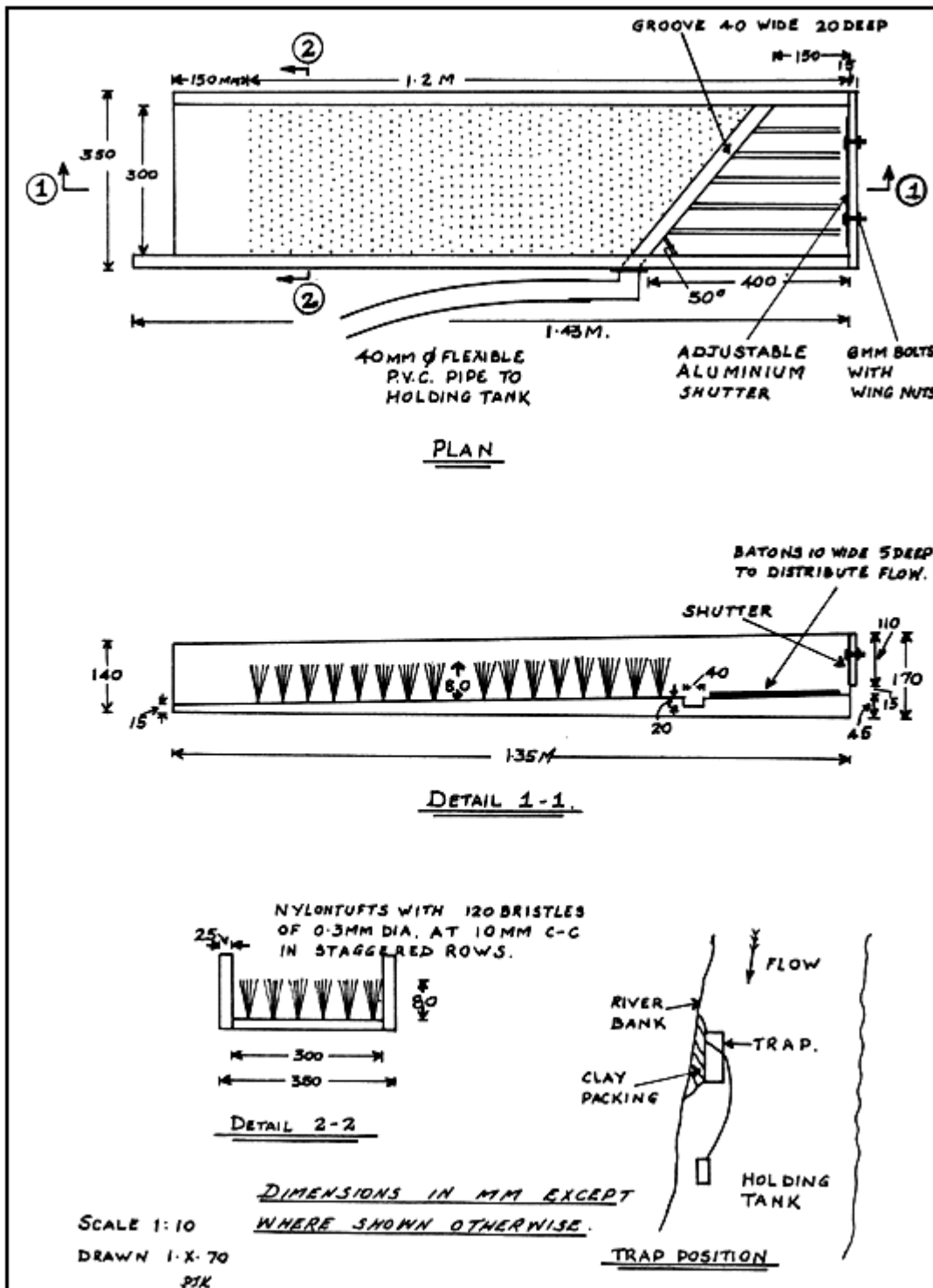


Fig. 4 Elver trap

APPENDIX 17

AN ACCOUNT OF SOME EXPERIMENTS IN FISHING WITH EEL NETS IN IRELAND

by

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The Electricity Supply Board (E.S.B.) is the owner of the entire fishing rights of the River Shannon above Limerick. The Shannon Hydro Electric Scheme caused considerable interference with all fisheries on the river. Up to the mid-1960's the restoration and development of the salmon fishery occupied the principal interest of the E.S.B. Very little attention was paid to the eel fishery.

In 1958 a new salmon and elver pass was completed at Ardnacrusha Power Station. This was the first determined effort to pass elvers into the Shannon Lakes. Many of these elvers had spent 4–6 years in the tidal section of the river below the Power Station.

During this period the E.S.B. operated an eel weir at Killaloe Bridge. This weir was of an old-fashioned design and consisted of 36 nets, each approximately 2.30 m wide and 3.36 m deep. The catch for this weir is shown in Table I and II. An examination of these tables reveal that there was a considerable increase in the catch from the year 1965–1966 onward. It was thought that this increase might have been due to the larger size elvers which had passed through the Ardnacrusha Fish Pass since 1958.

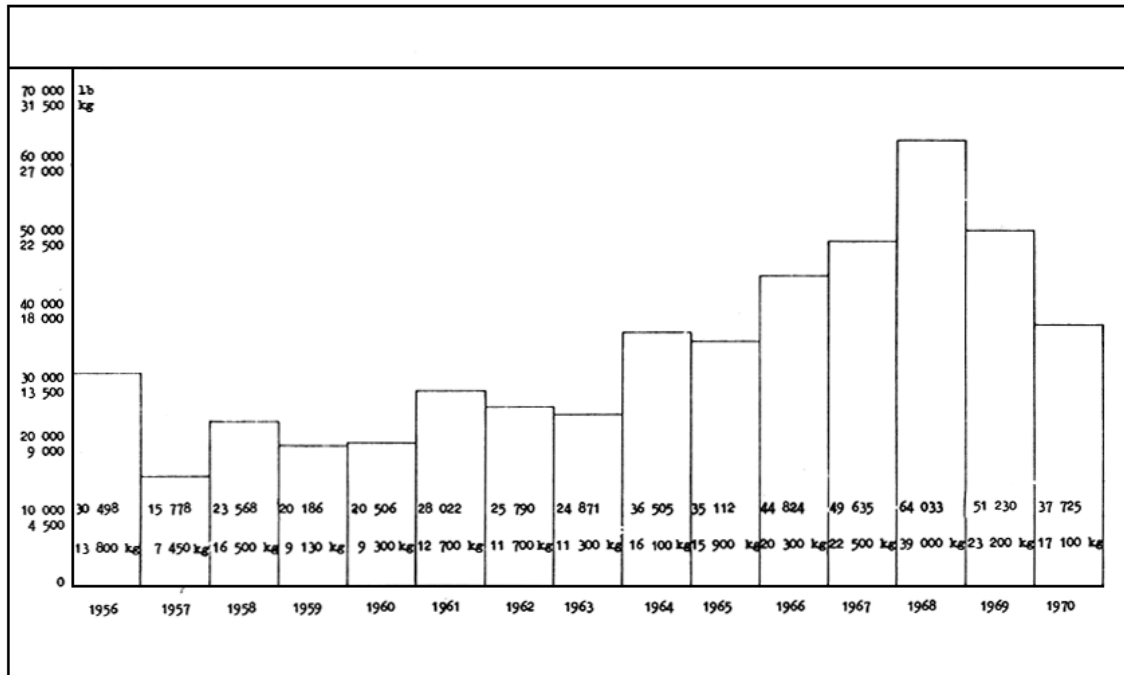
Table I

YEAR	CATCH	
	lb	kg
1955 – 1956	30 498	13 800
1956 – 1957	15 778	7 450
1957 – 1958	23 568	16 500
1958 – 1959	20 168	9 130
1959 – 1960	20 506	9 300
1960 – 1961	28 022	12 700
1961 – 1962	25 790	11 700
1962 – 1963	24 871	11 300
1963 – 1964	36 505	16 100
1964 – 1965	35 112	15 900
1965 – 1966	44 824	20 300
1966 – 1967	49 634	22 500
1967 – 1968	64 033	39 000
1968 – 1969	51 230	23 200
1969 – 1970	37 725	17 100

It appeared therefore in 1966 that there was considerable room for improvement in the Shannon eel fishery. The E.S.B. then consulted the Institute for Coastal and Freshwater fishery of the Federal Research Board for Fisheries in Hamburg on how best to improve the eel fishery. Herr Koops visited the Shannon and quickly reached the following conclusions:

- (a) The efficiency of the eel weir at Killaloe was very low.
- (b) The elver stocks in the Shannon were far too low.
- (c) Fishermen fishing for immature eels should be compensated and prohibited from fishing.

Table II



TOTAL EEL CATCH AT KILLALOE WEIR (SHOWN IN TABLE I)

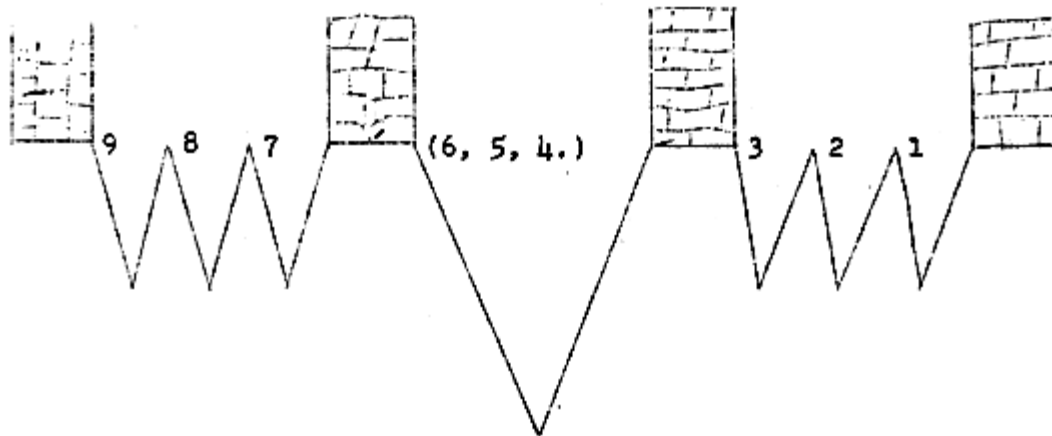
The E.S.B. adopted Herr Koops' suggestions and proceeded on all three recommendations.

Item (a) led to certain experiments with new types of nets.

In the diagrams attached are details of the various nets tried. The standard Killaloe eel net has been in operation for many years and the design remained unchanged except for the change in material from cotton to nylon. The net is very short which made lifting the mouth necessary when fishing the tail. This allowed eels to escape while the net was being fished. During a good run of eels it might be necessary to lift the net 5 or 6 times in the course of the night's fishing operations.

Each arch of the bridge has three standard nets. It was therefore decided to try a large net with a long tail covering the gap formerly covered by three standard nets.

The experimental net (Hamen) was chosen for the first set of experiments and it was put into one of the best fishing opes of the bridge to replace standard nets Nos. 4, 5 and 6 as shown in sketch.



The large net was fished without lifting the mouth.

Fishing started on 21 August 1968 and on 15 October 1968 the efficiency of the nets was assessed by the catches made which were as follows:

Nets 9, 8, 7
1 268 lb

Nets 6, 5, 4
119 lb

Nets 3, 2, 1
1 884 lb

The normal catch ratio for these nets would have been:

60 : 80 : 100

It was obvious now that there was something drastically wrong with the design of the new net. We then tried fishing one of the original standard nets inside the large net for two nights and the catches were as follows:

352 lb

120 lb

506 lb

The small net caught the 120 lb. There were no eels caught in the large net. The large net was then removed and replaced by three standard nets and the catches to 30 December 1968 were as follows:

5 533 lb

5 944 lb

12 168 lb

The small net fishing inside the big net proved that eels entered the mouth of the large net. They must have escaped through the 55 mm meshes. An examination of the 119 lb of eel caught did not indicate that the net was selective in the size caught. After 30 December 1968 the valves of the large net were tried in different positions but this did not improve the catching performance.

For the year 1969/1970 a new net as shown and described "Experimental Net B.G." was tried. As will be seen from Table I the total catch for that year was low due to the fact that the winter flood did not come during the normal eel fishing season. It was, therefore, never necessary to lift the standard nets at night. We, therefore, did not have an opportunity to fully evaluate this net. Bearing this in mind it appears that this net offers some promise of increased efficiency. The net was fished throughout the 1969/1970 season and the catches were as follows:

Nets 9, 8, 7
3 414 lb

Nets 6, 5, 4
7 185 lb

Nets 3, 2, 1
9 490 lb

It is proposed to continue fishing this net for the 1970/71 season and reassess the value of large versus small nets at the end of the season.

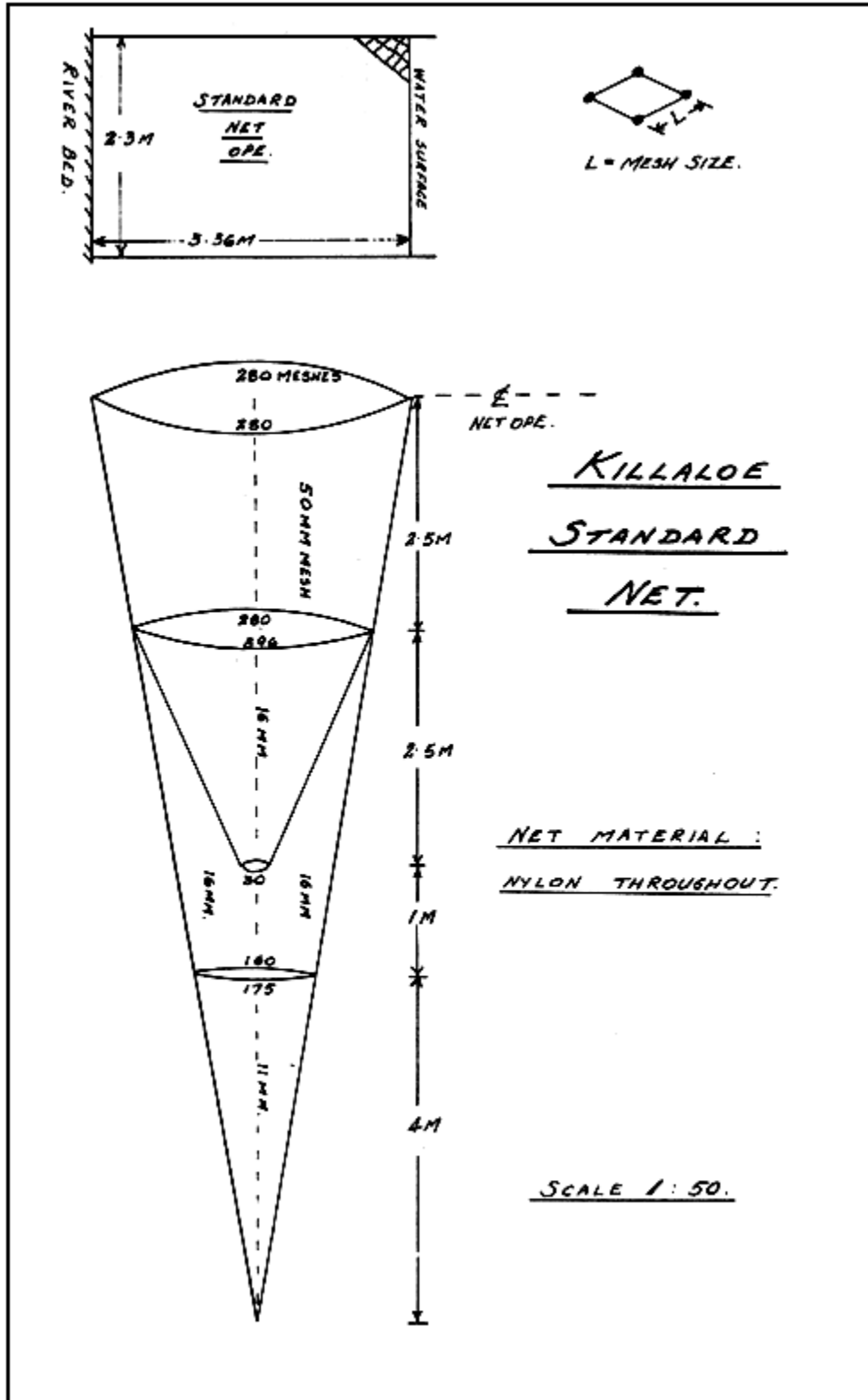
DISCUSSION:

O'Leary - Killaloe nets are believed to capture 16 to 40 percent of the run.

McGrath asked for views on why large net failed.

Koops - eels may be able to detect small mesh. Presumably the 55 mm was too large and something between 55 mm and 16 mm should do. Escapement may be due to habit of eels in resting before entering the net, others might escape under net. Clear water might explain the tendency of Shannon eels to keep to the bottom.

O'Leary believed that silt in front of net might discourage entry.



Eel Fishery Development - Net details and velocity curves at Killaloe Weir, Ireland Fig. 1a Killaloe standard net

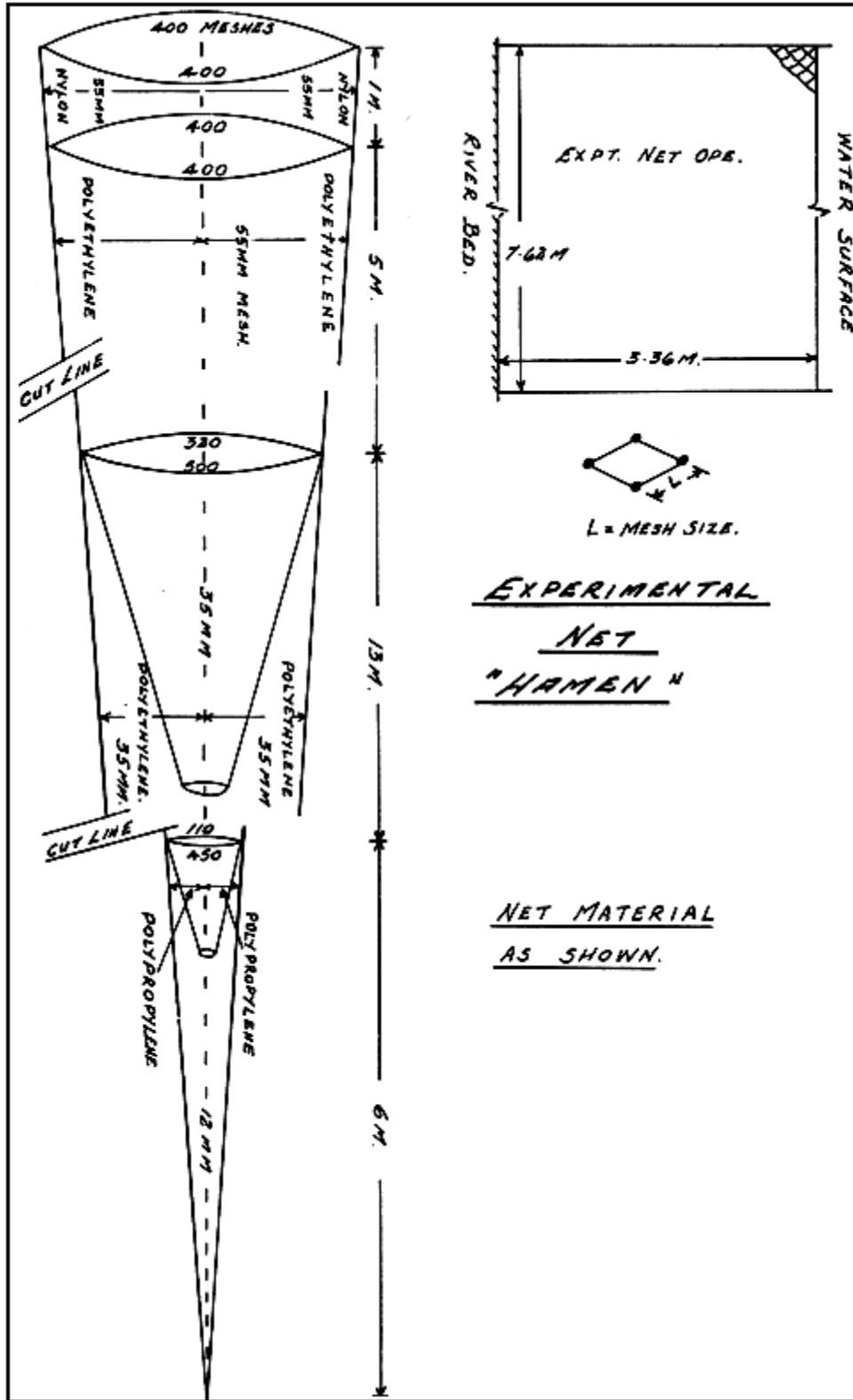


Fig. 1b Experimental net "Hamen"

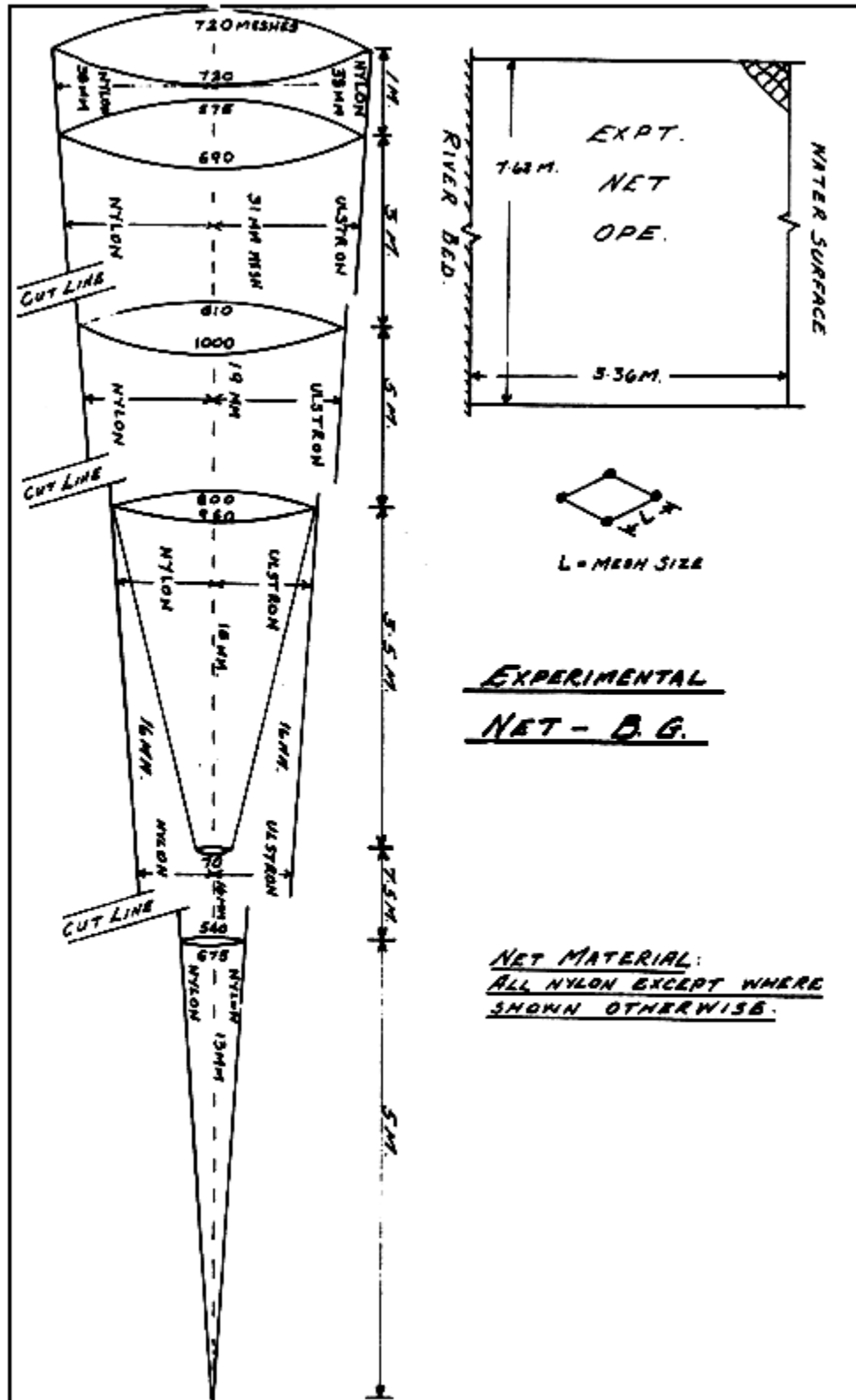


Fig. 1c Experimental net - B.G.

VELOCITY MEASUREMENTS AT KILLALOE BRIDGE

TAKEN 30-1-69 ALONG \perp EXPT. NET OPE.

DISCHARGE THROUGH BRIDGE 440 M³/SEC.

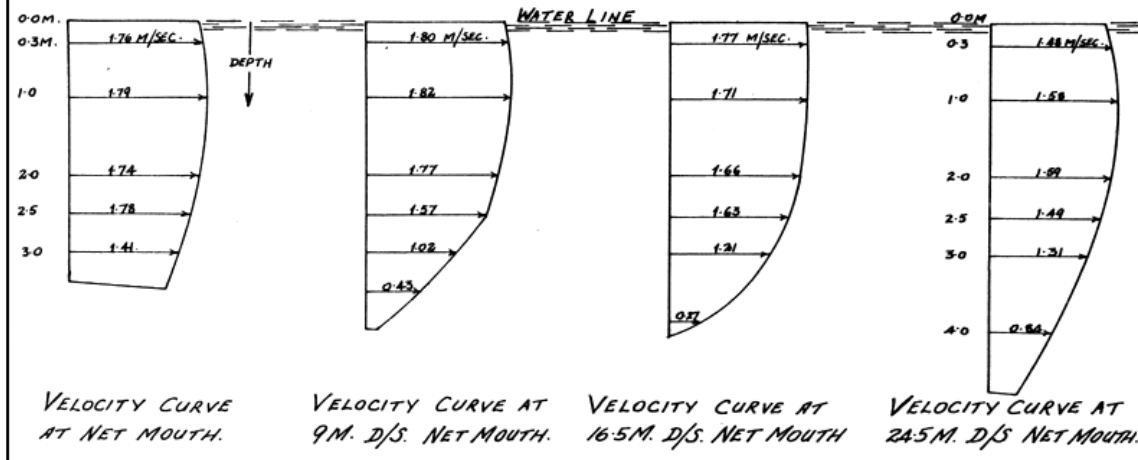


Fig. 1d Velocity measurements

APPENDIX 18

EEL FISHING IN IRELAND

by

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Eel (Anguilla anguilla) fishing in Ireland is based, in the main, on the capture of the silver eels while migrating to the sea in the Autumn and early Winter of each year and, to a lesser extent, on the capture of yellow eels in lakes.

Eel fishing is not carried out as intensively in Ireland as it is in many other countries. There are 144 522 hectares of fresh water under the administration of the Department of Agriculture and Fisheries, Dublin, but not all the eel stocks in these are exploited and those that are exploited are not intensively so. The location of the principal eel fishing operations is shown in Figure 1.

In the 20-year period from 1963 to 1968, the annual catch of eels reported has ranged from as low as 65 metric tons in 1950 to a maximum of 176 metric tons in 1965. The actual variation in catch from year to year is illustrated in Figure 2.

While there are grounds for believing that the figures for total catch reported for each year are not accurate, nevertheless, all indications point to the discrepancy between the figures quoted and the true figures being not such as would cause any drastic change in the graph as plotted.

There are a number of explanations for the comparatively low level of eel production. It is not possible to exclude the possibility that the production of eels in Irish waters is less than in other countries. However, there are a number of contributory factors which tend to result in a low level of exploitation of the eel stocks available. Among these is the difficulty of conducting eel fishing operations by conventional methods in the flow conditions obtaining in typical Irish rivers. The run-off of the rivers is subject to great variations and very rapid changes can occur in the volume of flow in the river over a short period of time. This is particularly so at the time of year when silver eels are migrating to the sea.

In addition, most Irish rivers carry a considerable load of debris such as leaves from trees and weeds under such river flow conditions. These can very quickly block the conventional eel fishing devices and entail the expenditure of considerable effort to keep the eel nets and traps clear of accumulations of debris. This is essential particularly in the larger installations, to prevent the installations being blocked and washed away or alternatively, resulting in the flooding of adjoining lands.

Another important factor is that eel fishing activities in many places must be subordinate to the requirements of game fishing for salmon and trout, which provide an important source of revenue to the country from tourist anglers. Considerable attention is paid to safeguarding the requirements of the salmon and trout and the sport fishing activities based on their capture, and so eel fishing operations are subject to a number of restrictions in the interest of the game fish.

Considerations such as these militate against more intensive fishing for eels, especially in the large lakes where it is feared the employment of the large type fyke net with leader extending from the shore line would interfere with the movement of boats engaged in sport fishing. In addition, there is also apprehension in angling circles that these types of nets would capture large numbers of salmon and trout which, otherwise, would be available for anglers.

In recent years, experiments have been conducted with the so-called "Summer" fyke nets to ascertain whether these could be employed in Irish water without conflict with the other fishery interests. These experiments are proceeding and it is too soon yet to say what the final decision will be; however, early indications are that they are unlikely to harm other fish stocks. These nets are also being used to provide specimens for age determination and for the acquisition of information about feeding habits.

Among the methods which have been employed over the years for the capture of eels are:

- (i) hand-line including "bobbing"
- (ii) spear
- (iii) long lines
- (iv) eel baskets
- (v) eel grid traps
- (vi) eel weirs

Of these, long lines, eel grid traps and eel weirs are the most productive methods.

Long Lines

The practice followed in Ireland is very much the same as that employed in other countries and therefore particular mention of this method is not necessary in this report.

Eel Grid Traps

A typical installation of this kind is illustrated in Figure 3. The eels are sieved out of the river flow by the grid arrangements from which the only escape is either upstream back against the river flow or into a sunken trough from which a pipe leads to a tank from which the eels are unable to escape because it is fitted with a non-return valve.

The vertical grid on the downstream face of a number of these installations is hinged to the supporting cross beam so that in the event of the grating becoming clogged with debris, it will be forced open by the weight of the impounded water behind and thus allow it to escape, and thereby prevent the flooding of adjoining land or the destruction of the eel fishing installations.

Eel Weirs

The arrangement of a typical installation of this type is shown in Figures 4 and 5. These drawings are based on structures which are in operation. In this particular case, the foundation on which the structure rests is of rock, so that the supporting framework is not as strong as is required in other installations where weaker foundation conditions obtain.

In one installation of this type, comprising a row of 11 conical nets, a catch of 16 metric tons of eels in a fishing season has been possible. In another installation, in which provision has been made for 50 conical nets, a catch of 30 metric tons in a fishing season is possible.

Two typical eel nets which have been employed in Ireland in structures such as these, are made up as follows:

Eight ft of 280 meshes round, each 4 in, then tapering over a distance of 12 ft at 1¼ in mesh to 160 mesh round, each 7/8 in, and continuing for a further 12 ft. A valve 8 ft long, made up of 1¼ in mesh commences at the start of the taper in the main net and itself tapers to 30 mesh round, at 1¼ in, in a distance of 8 ft.

Another net arrangement is made of 265 mesh round, at 4 in mesh, extending for a distance of 6 ft 8 in, and then tapering at 1¼ in mesh to 180 mesh round. A valve likewise is fitted inside the taper which is also made up of 1¼ in mesh but tapering to 30 mesh round size.

Another more rudimentary type of eel net installation is shown in Figure 6.

There has been an increased interest in the development of eel fisheries in Ireland in recent years. Many individuals have built small eel fishing installations of the types described above.

The Electricity Supply Board of Ireland in particular has embarked on a major programme of development of the eel fisheries in the River Shannon, which is the largest river in Ireland. When this river was harnessed by the construction of a hydro-electric station to produce electricity, the entire fishing rights in the river system above a certain boundary line were vested in the Company by the State and it was charged with the responsibility of developing the fisheries in the waters entrusted to its care. Among the many steps taken by the Electricity Supply Board in discharge of this responsibility, has been the development of the eel fisheries in the river system. The Board has embarked on a programme of restocking the lakes in this system with elvers. These elvers have been captured in the lower reaches of the River Shannon as well as in other river systems (by permission of the Fishery Authority on an experimental basis) where eel fishing is not carried out and the elvers have been transported to the lakes and upper reaches of the River Shannon.

An ingenious elver trapping device has been devised by a member of the Board's Engineering staff, Mr. D. O'Leary. Details of this installation will be supplied in a separate paper to be presented to this Consultation and it is sufficient to make mention only of the development in this paper.

The storage of eels is not practised to a great extent in Ireland as most of the catch is exported as soon after capture as possible. The most important market for Irish eels at the present time is that at Billingsgate in London where eels can arrive alive usually within 24 hours of capture. Some provision is made for the storage of eels for a short period of time but, in general, these arrangements consist of wooden crates built on the river bed adjoining the place of capture or floating and attached to anchors. Provisions are made for the flow of water through the tanks so that the eels will be kept in a healthy condition. Special precautions have to be taken to ensure that the eels will not escape from the tanks and, in particular, that they will not damage themselves in endeavouring to force their way through openings in the tanks. It has been the experience that any opening greater than ¼ in diam. will encourage the eel to try and force its way out and usually the eels damage themselves, especially at the tail, and so die.

In recent years there has been a growing interest in the processing of eels before dispatch, particularly the hot-smoking of eels. A document was prepared to inform processors in Ireland on suitable methods of smoking eels. It is a record of the methods

demonstrated by Mr. J. van Pel, a member of the technical staff of the Institute of Fishery Products, T.N.O. IJmuiden, The Netherlands, whose services were made available in 1962 by the courtesy of the Institute and its Director, Ir. J. van Mameren^{1/}.

However, the Irish public is not as interested in the consumption of smoked eel as are people in other countries and the majority of eels captured still continue to be exported live or deep frozen to other countries where the importers, for obvious reasons, prefer to purchase the eels and smoke them than to import the processed fish.

In an effort to overcome the problem posed by the clogging of eel traps and eel nets with leaves and other debris, efforts in recent years have been directed to the developing methods of eel fishing less likely to be affected by the presence of floating debris in the rivers. One line of investigation being followed is the employment of electricity to divert eels from the main river channel to a smaller and more easily maintained eel trap at one side. This work has not been successful as yet in the field, despite encouraging results obtained in laboratory experiments. The difficulty being experienced arises from the velocity of flow obtaining in the main river at the sites where the barriers are erected. Due to this velocity of flow, eels which are affected by the electric field and their swimming ability thereby impaired, tend to be drawn through the electric field by the river flow rather than diverted to one side.

Some details of the results obtained in investigations of the use of electricity for the capture of eels are contained in EIFAC OP3 "Application of Electricity to Freshwater Fishery Management and Development in Ireland" by C.J. McGrath et al. and FI 68/SC 1 – 3; 1 – 4 - "The use of electricity in the Exploitation of Eel Stocks" by P.J. Sharkey (see Appendix 24).

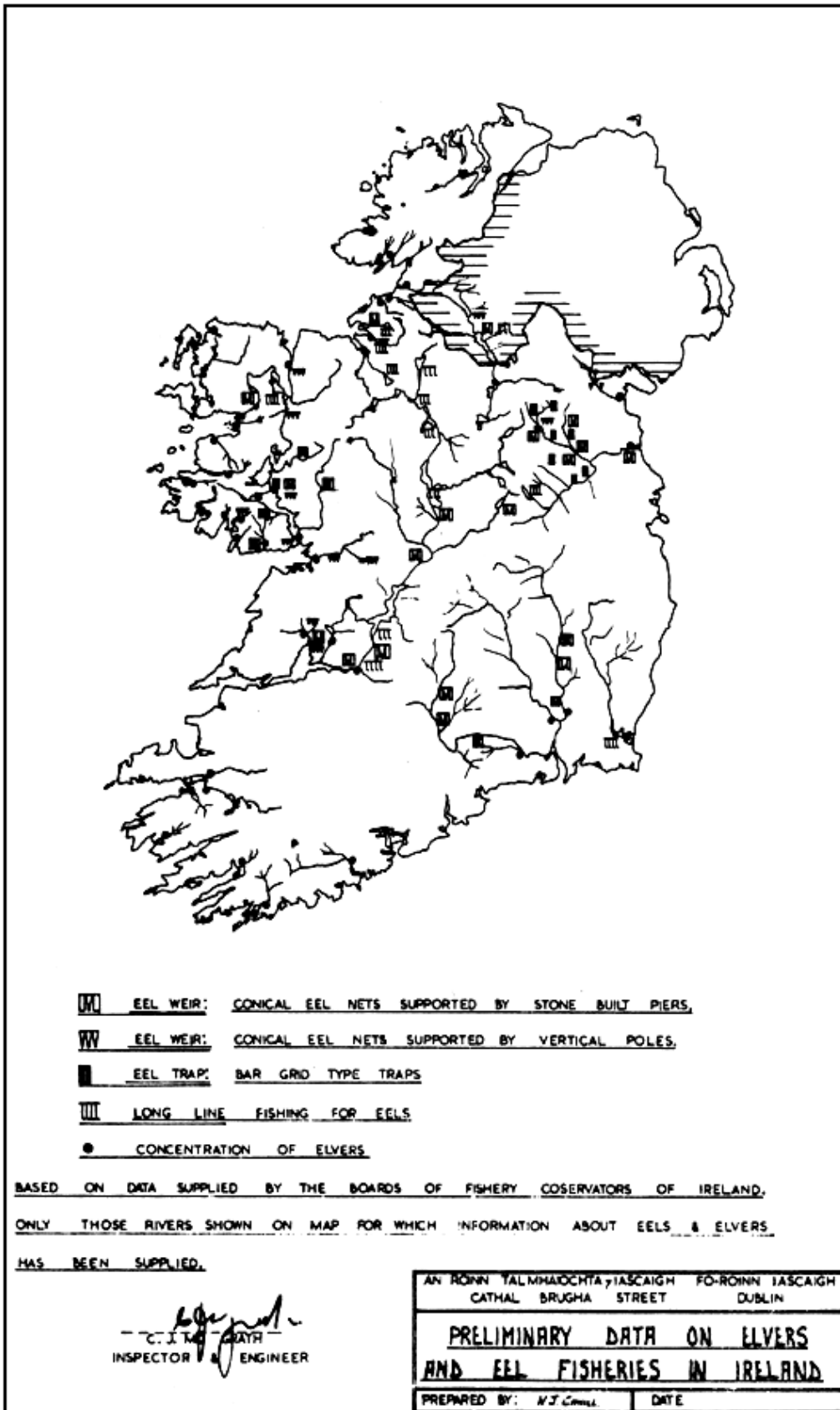


Fig. 1 Preliminary data on elvers and eel fisheries in Ireland

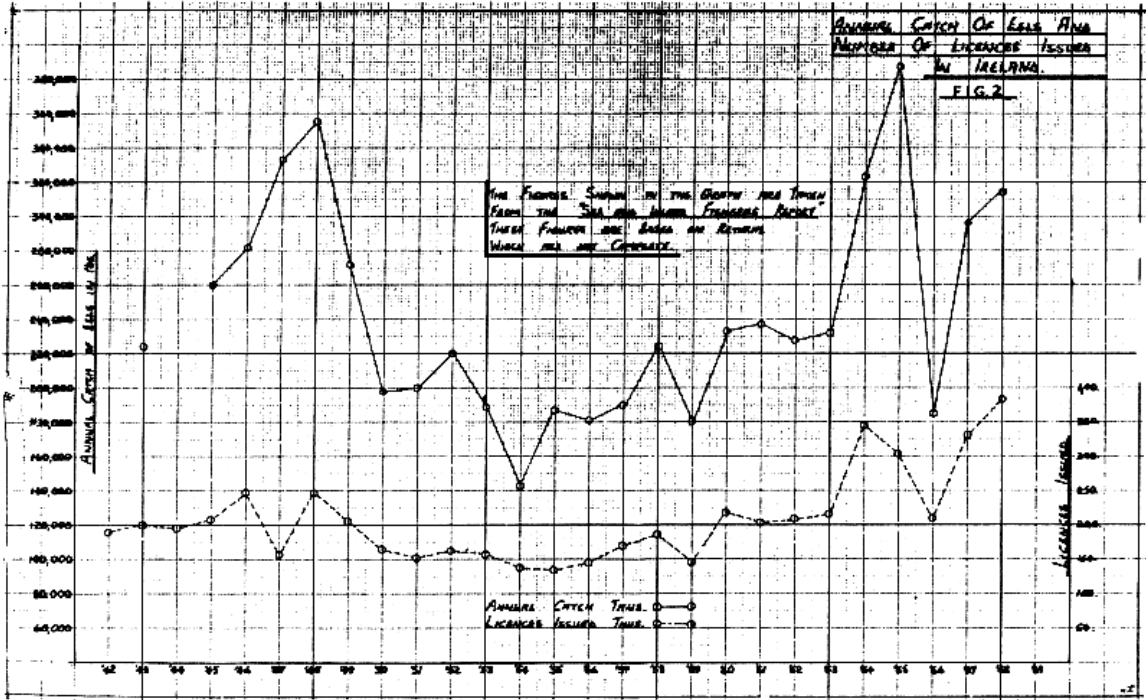


Fig. 2 Annual catch of eels and number of licences issued in Ireland.

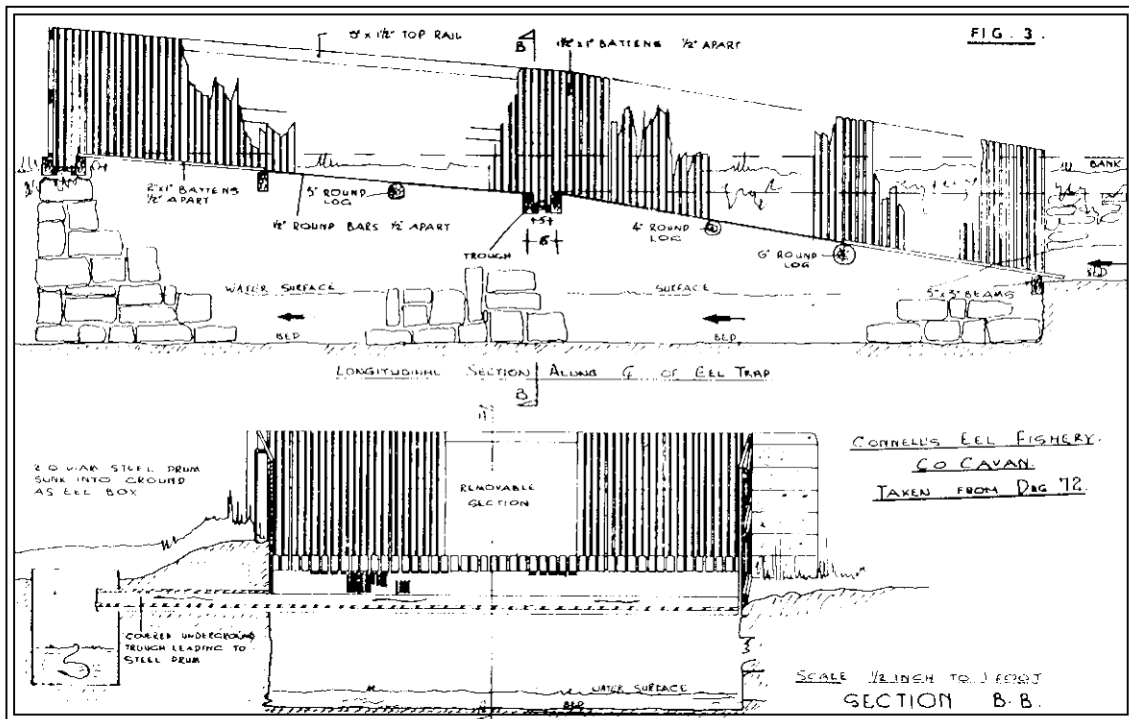


Fig. 3 Connell's eel fishery. Co. Cavan

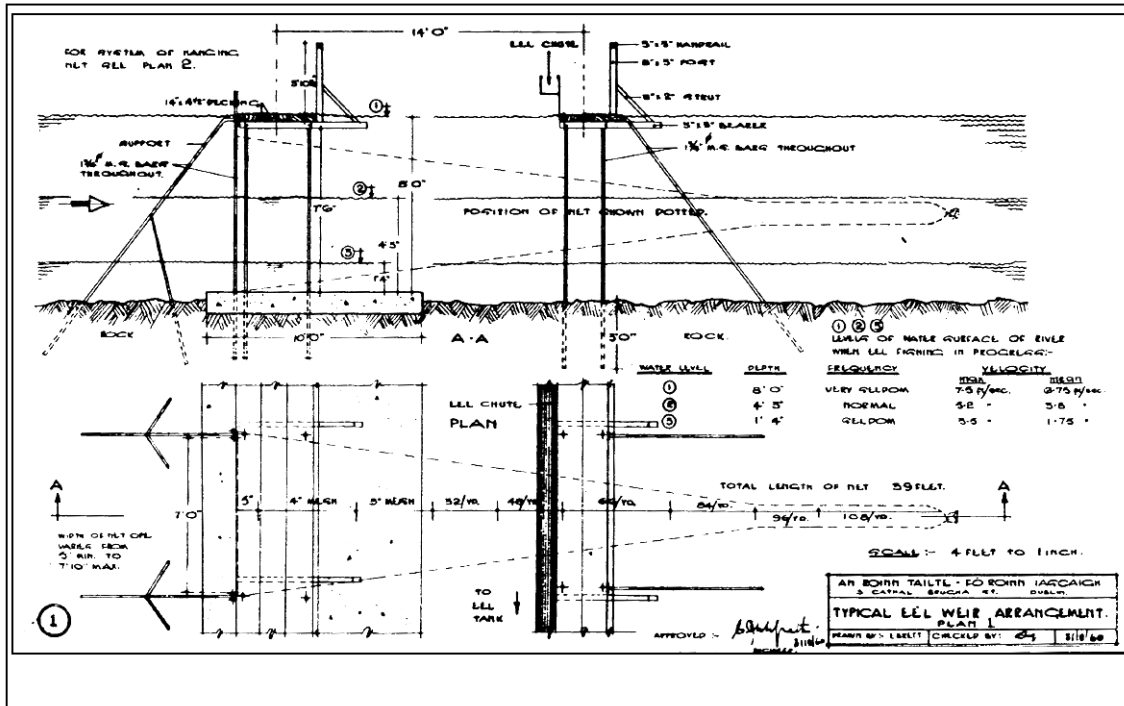


Fig. 4 Typical eel weir arrangement. Plan 1.

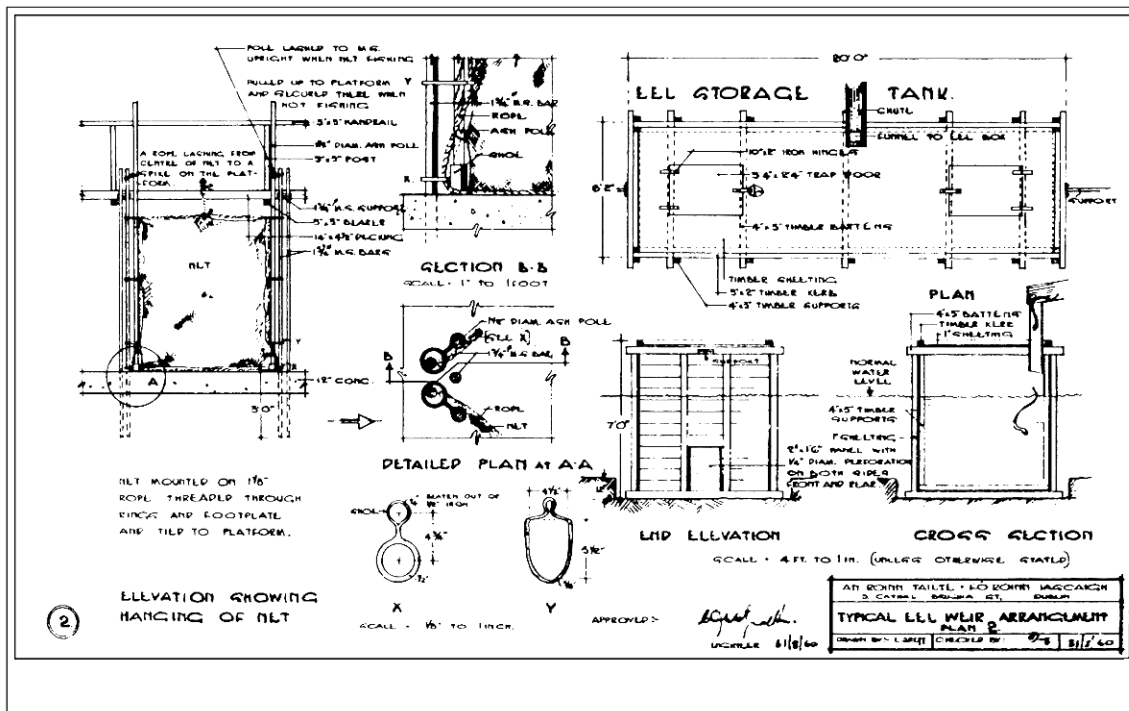


Fig. 5 Typical eel weir arrangement. Plan 2.

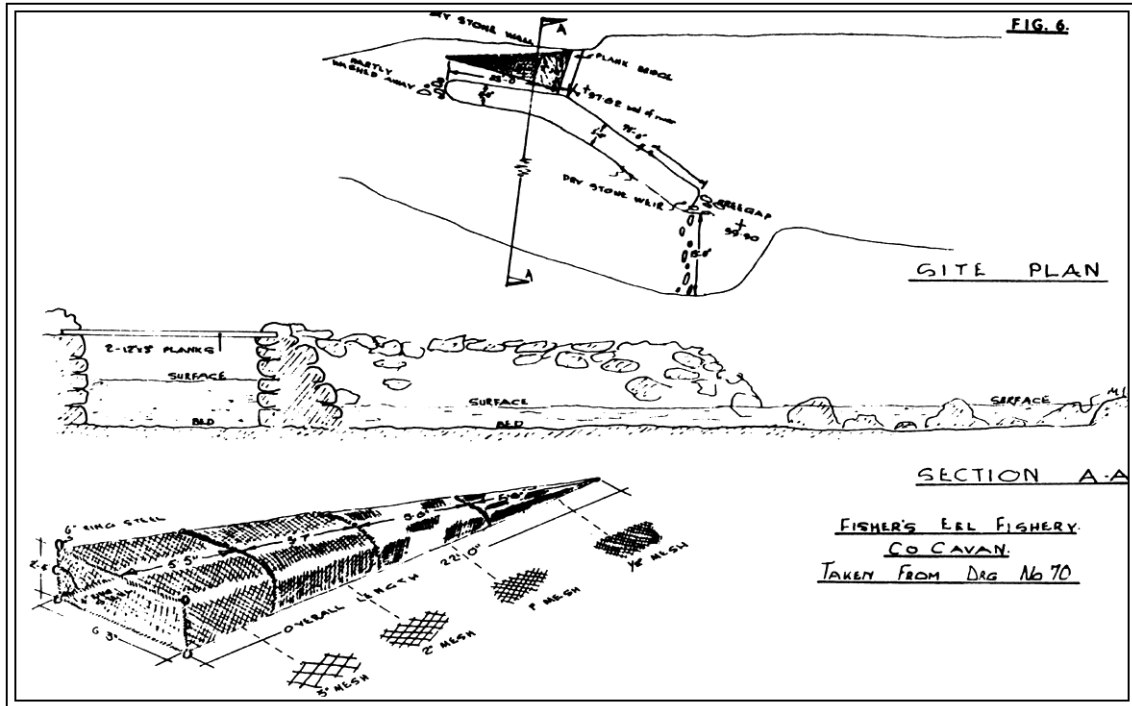


Fig. 6 Fisher's eel fishery. Co. Cavan.

¹¹ Copies can be obtained from the author of this paper

APPENDIX 19

A REPORT ON EXTENDED TESTS OF A MACHINE FOR CLASSICAL ELECTRIC FISHING

(with emphasis on eel)

by

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1. TECHNICAL CHARACTERISTICS	

The machine consists of the petrol engine driven a.c. generator, type PAB2-1/230, 2 kVA, 230 V, and of the rectifying unit. It is capable of fishing in waters up to 1.5 m deep with conductivities ranging from 50 to 800 S/cm. This range covers almost all inland waters in Poland, excluding, however, some littoral ones which are very conductive and some extremely pure in mountains.

The rectifying unit provides also some additional safety measures against electric shock.

Rectification is performed by means of full wave bridge rectifier (semiconductor diodes) fitted with capacitive filter.

Additional safety measures are implemented by:

- (a) adapting the unit to be connected to the platform with a safety switch, which switches on only when the electrofisherman stands on it;
- (b) outfitting the unit with a special circuit for automatic switch-over from working (220–280 V) to extra-low voltage (12 V) in the event of an electrode

being above the water surface and from extra-low (12 V) to working voltage (220–280 V) when both electrodes are immersed into water.

Another good point of the above automatic circuit is that it constitutes a reliable and very accurate protection of the rectifying unit, and also the generator, against overload and the effects of short-circuits. Therefore, it protects the machine from damage and from being too quickly worn away. Electric fuses, type Bi and BA are, owing to this, unnecessary. In fact they could not have given an equivalent protection. They are quite good in case of short-circuits, but one cannot rely on them in case of overload. Their characteristics are too much dispersed. Besides, it is well-known that when a fuse blows too often, then the operation team is tempted to by-pass it or replace it with a bigger one.

2. ESTIMATION OF THE MACHINE'S PERFORMANCE

Tests under practical conditions have been carried out since spring 1968 till summer 1970. The machine (Fig. 1) worked for 679 hours. This is ample for a firm assessment of the machine's performance. Let us point out that the amortisation time was taken to be 1 000 hours.

The tests took place on the State Fish Farms "Lysin" and "Gardno" (Table I), with 81.3 percent of fishing time and 79 percent of fish caught on the lake Gardno itself.

Table I

List of lakes on which the fishing tests were carried out

Fish Farm	Lake	Surface area in ha
"Lysin"	1. Folusz	69.0
	2. Orchowo	90.0
	3. Gasowskie	100.0
	4. Popielewo	350.0
	5. Rogowskie	353.0
	6. Zninskie Duze	450.0
	7. Rzecs	15.6
	8. Koldrap	92.3
	9. Biskupin	116.6
	10. Wenecja	131.7
	11. Wylatowo	140.2
	12. Oćwieka	142.7
	13. Znińskie Male	150.0
	14. Chomiaze Ksieza	159.6
"Gardno"	15 Gardno	2 530.0
	16. Modlo	165.0
	17. Dolgie Duze	148.0
	18. Czarny Mlyn (staw)	10.0

The fishing technique is illustrated on Figure 2. There were three people in the fishing team. One handled the active electrode (anode), another the dip net, and third the boat. All these people were ordinary fishermen.

The results are presented in Table II, separately for spring, summer and autumn.

Table II

Results of fishing tests with the petrol engine driven s.c. generator, type PAB2-1/230, fitted with the rectifying unit for the period of spring 1968 to spring 1970

Specification	Fishing season			Total
	spring	summer	autumn	
Duration of fishing in hours	307.5	107.5	264.0	679.0
Fish caught in kg	9 414	1 581	7 787	18 782
eel in it, in kg	5 067	959	583	6 609
eel in it, in %	53.8	60.7	7.5	35.2
Value of fish in zł	356 667	49 173	157 671	563 512
eel in it, in zł	291 175	41 156	32 883	356 214
eel in it, in %	82	84	21	65
Mean value of 1 kg of fish in zł	37.9	31.1	20.2	30.0
Fishing performance in kg/h	30.6	14.7	29.5	27.7
eel in it, in kg/h	16.5	8.9	2.2	9.7
Value of fish caught in one hour in zł/h	1 159	457	597	829
eel in it, in zł/h	946	382	124	537
Operation costs in zł/h	416	205	247	315
Net profit, in zł/h	743	251	349	512

Operation costs were calculated as follows:

(i) (a) Amortisation time	1 000 h	
(b) Mean value of fish caught during one hour	829.90 zł	
(c) Total value of fish caught	829 900 zł	
(ii) (a) Price of the machine (petrol driven a.c. generator - 22 000 zł; rectifying unit - 26 000 zł)	48 000 zł	
(b) Working costs		
- fishing team and service (30 percent of the value of of the fish)	248 970 zł	
- repairs	4 500 zł	
- spare parts	3 000 zł	
- accessories	3 000 zł	
- 10 running examinations	2 000 zł	
- petrol and lubricants	8 000 zł	
	Total cost	317 470 zł
	Cost per one hour	317.50 zł
	Net profit per one hour	512.40 zł

Generally speaking, the results given in Table II indicate that the earning capacity of the machine was very high.

2.1 Fishing Performance

Fishing performance is understood here as the result of fishing in kg per hour.

According to Table II, the mean fishing performance was 30.6 kg/h in spring, 14.7 kg/h in summer and 29.5 kg/h in autumn. Therefore in spring and autumn it was almost the same, whereas in summer about one half.

2.2 Value of Fish Caught in one Hour

This value appeared to be the biggest for spring. It was 1 159 zł (Table II). For autumn it was about half, i.e. 597 zł, for summer even less than that, i.e. 457 zł.

While the fishing performance in summer when compared with autumn was half, the value of fish caught in one hour was in summer only 24 percent less than in autumn. It resulted from different species compositions for those two seasons.

2.3 Species Composition

High value of fish caught per one hour fishing time during spring is produced partly by a good fishing performance and partly by the fact that eel constituted a considerable part of the whole catch. It can be seen from Table III that in spring catches, eel constituted 53.8 percent in respect of weight and 82.0 percent in respect of value.

Very near to this was the situation in summer. Hence a relatively high value of fish caught in one hour with the fishing performance being rather low (Table II).

There was only a small number of eels in autumn. It was in respect of weight - 7.5 percent, in respect of value - 21.0 percent. This fact produced a low value of fish caught in one hour fishing time, with the fishing performance being high, almost as high as in spring.

As far as eel is concerned the best fishing performance appeared in spring - 16.5 kg/h, smaller in summer - 8.9 kg/h, the worst in autumn - 2.2 kg/h.

Pike was most numerous in autumn, i.e. 43 percent in respect of weight and 39.6 percent in respect of value (Table III).

There was a relatively small percentage of second class fish. In spring and summer it was about 12 percent, whereas in autumn 19.6 percent.

The percentages of other fish species are given in Table III.

2.4 Earning Capability

The machine turned out to be most profitable when used during spring. In this season the net profit was 743.7 zł/h (Table II). In autumn it was 349.5 zł/h, in summer - 251.7 zł/h. Mean value of this profit for the total time of tests was 512.4 zł/h.

2.5 Reliability

It is essential for such a machine to be reliable. In fact the one in question stood the test in this respect. It failed only once during 679 hours of work. The repairs cost 700 zł for the rectifying unit and 100 zł for the petrol engine driven a.c. generator.

The operational costs were therefore even lower than those estimated for calculation of the net profit.

Table III

Percentages of various fish species in fishing tests

Species	Spring		Summer		Autumn		Total	
	in respect of weight	in respect of value	in respect of weight	in respect of value	in respect of weight	in respect of value	in respect of weight	in respect of value
eel	53.8	82.0	60.7	84.0	7.5	21.0	35.2	65.0
pike	25.3	12.5	18.7	11.0	43.0	39.6	32.0	19.9
tench	5.9	3.0	4.6	2.6	5.0	4.9	5.4	3.5
carp	0.7	0.5	-	-	23.8	29.8	10.2	8.7
other fine food fish	2.3	0.5	3.9	1.0	1.1	0.6	1.9	0.6
Total	88.0	98.5	87.9	98.6	80.4	95.9	84.7	97.7
second class fish	12.0	1.5	12.1	1.4	19.6	4.1	15.3	2.3

3. REMARKS ON SOME PRACTICAL OPERATION TECHNIQUES

The special circuit to ensure automatic switch-over from high voltage working to extra-low voltage, requires that the cathode length be adjusted in such a way that the current does not exceed 10 A. The bigger the water conductivity the shorter should be the cathode. The cathode is made of bare electric wire immersed into water.

The experience gained up to the present enables us to say that:

- (a) with water conductivities of 500–700 S/cm the cathode should be about 0.4 – 1.0 m long;
- (b) with water conductivities of 300 – 500 S/cm the cathode should be 1.0 – 2.0 m long;
- (c) with water conductivities of about 100 – 200 S/cm the cathode should be 2.0 – 3.0 m long.

Sometimes it happens that the cathode must be shortened even to 10 cm.

Having too long a cathode, e.g. 3 m in water of 700 S/cm, would result in the machine being over-loaded. The automatic circuit does not switch on the working voltage or switch it off, if it has already been on. The machine is not allowed to work. By this fact the operation team is informed that, because of the overload, the cathode should be shortened. On the other hand one must remember that with too short cathode in pure water, the generator is not fully loaded. This fact reduces its fishing power. Therefore, with too long cathode in highly conductive water the machine could not work and with too short cathode in pure water it would be less effective. For each water conductivity there is a proper cathode length which ensures that the fishing abilities of the machine are fully used.

In view of this it is desirable to know what the water conductivity actually is. If it is not known, one should start to fish with a short cathode and then lengthen it - if fishing results are poor - up to the length with which the machine is fully loaded. One can lengthen the cathode simply by tying some more wire to it.

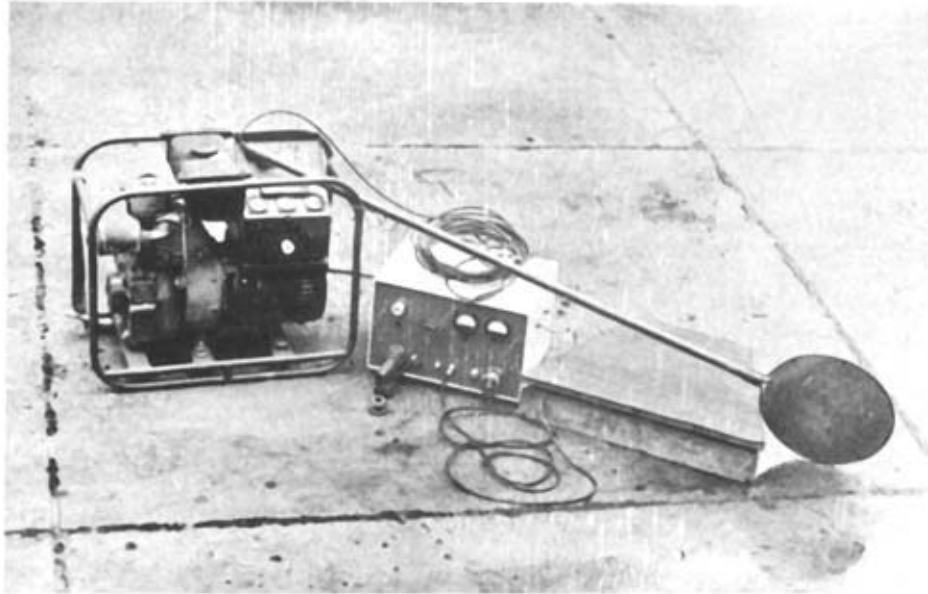


Fig. 1 Machine for classical electric fishing consisting of a petrol engine driven a.c. generator, rectifying unit safety platform and electrodes.



Fig. 2 Electrical fishing - operation technique.

APPENDIX 20

THE APPLICATION OF ELECTRICITY TO THE FISHING OF EELS BY MEANS OF TRAWLS

by

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The idea of catching eels in lakes by means of an electrified trawl was introduced to Poland from the Democratic Republic of Germany.

The prototype of the Polish trawl was constructed in 1967 in the Laboratory of Fishing Techniques (Inland Fisheries Institute in Olsztyn-Kortowo), which cooperated in this project with the Department of Rural Electrification (Poznań College of Technology). Tests under practical conditions were carried out in the summer of 1967 at the State Fish Farm "Gizycko". The results obtained were good.

The so-called "classical" arrangement for electrical fishing, which is composed of an a.c. generator (driven by a petrol engine) and a rectifying unit, can be successful when fishing along the margins of the lakes, which are usually grown over (reeds, etc.). On the other hand, this electrified trawl makes it possible to catch eel in other parts of the lake.

Net portions of the trawl are formed in the shape of a sack with short wings (Fig. 1). The horizontal opening is about 8 m. Top and bottom lines are about 2 m apart and are fitted with electrodes. The electrical energy is supplied from the petrol-driven a.c. generator, 2 kVA, 230 V, 8,7 A (type PAB2-1/230), via a step down transformer and insulated electrical conductors fastened to one of the towing lines. No rectifiers or impulse units are used. The trawl is towed by two boats at the rate of about 1.5 km/h. The best boats for this purpose are those with Diesel engines, 5 hp each, fitted additionally with special belt transmission for board propulsion. In this case two people can operate the whole arrangement.

The length of the towing lines and the distance the boats are apart when towing depends on the depth of water. This relationship is given in Table I.

Table I

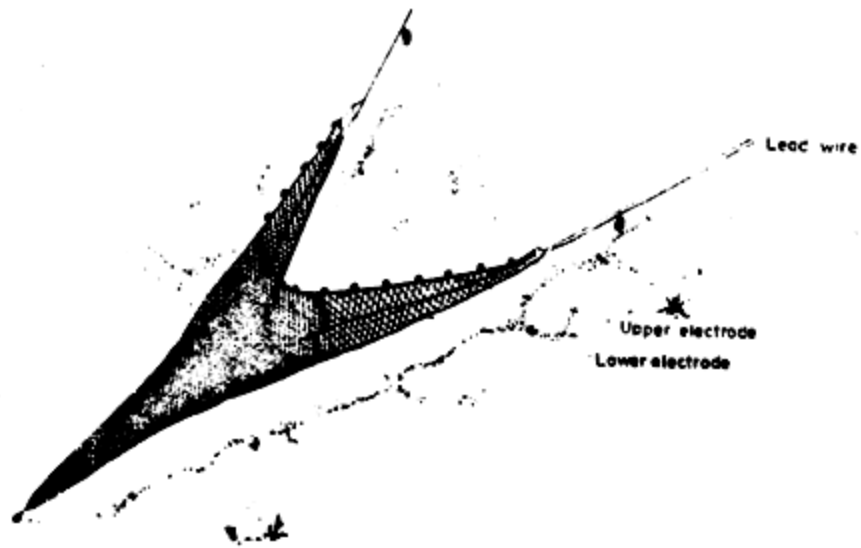
Water depth in m	Length of towing lines in m	Distance the boats are apart, in m
3	30	40
5	40	50
7	50	60
10	65	80
15	90	100
20	115	130

The electric field, built up in the plane of the trawl net mouth, paralyses the movements of any eel which is in its path. An escape becomes very difficult and the eel falls back into the sack located about 15 – 20 m away from the net mouth. Voltage gradients there are very low. This permits a quick recovery of the eel which is therefore in good condition, and reaches the market alive.

Fishing performance per one hour of towing depends on the population of eels in the area. The best result, so far, of 38 kg of eels per hour has been reached on the lake Gardno which is located very near to the Baltic sea coast. Its main characteristics are: surface area 2 468 ha, maximum depth 2.6 m, average depth 1.3 m, water conductivity 300 – 500 S/cm. If one takes into account that during the period of one hour a surface area of about 1 hectare can be fished, then the above result must be regarded as a good one.

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APPENDIX 21

RECENT DEVELOPMENTS IN THE APPLICATION OF ELECTRICITY TO THE FISHING OF EELS BY MEANS OF SEINE NETS

by

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1. INTRODUCTION	

Fishing in lakes by means of the conventional seine nets can be very profitable despite the fact that the efficiency of the whole process is rather low, i.e. of the order of 0.34 – 0.7 (the latter figure, cited by one author only, is probably too optimistic). This efficiency is understood as being the ratio of the number of fish actually caught to the total number of fish encircled by the net.

More effective seine nets therefore are very desirable, in view of the trend towards further intensification of fishery management of lakes.

It is generally believed that by the use of electricity one will be able to improve upon the results being achieved by the use of the net itself. It will be remembered that this was the case with the electrified trawl for eel.

With seine nets the problem is that the encircled fish escape in large numbers during the last phase of fishing, when the wings are being drawn together, and the concentration of fish is becoming too great.

Experiments under laboratory conditions showed that fish could not be highly concentrated when one of the partitions in the tank was the electric field in water. Fish tried to escape through this field despite this being very unpleasant, painful or even fatal.

2. THE CONVENTIONAL SEINE NET ASSISTED BY THE ELECTRIFIED NET PARTITION

Preliminary tests have been carried out with the electrified net partition, 30 m long, placed in between the wings of the seine net. An alternating current of 50 Hz was switched on when there was still 400 m of wings to be drawn (Fig. 1). The results were 700 – 1 500 kg of fish per one operation. Fishermen were pleased with the effect of the electric field. A number of fish were, however, strongly shocked and - as it takes two hours to draw the wings 400 m long - all the fish were exposed to the danger of electric current for such a long time. This is undesirable. The experiment showed also that the electrification of the wings of the seine nets would produce similar menace for fish.

3. THE ELECTRIC SEINE NET

The following ideas and requirements had been laid as the foundation of the project:

- (a) It is no good to electrify seine nets in their present form. The seine itself should be modified for the purpose of electrification.
- (b) The area covered by the electric seine net should be as big as in the case of the middle-size conventional one (10 – 20 ha).
- (c) Fish should fall into the net bags (from which they are not able to escape) during the whole process of drawing and not only in the last phase, after being concentrated by wings, as is the case with the conventional seine net.
- (d) The electric field in water should be produced at the mouth of the net. By immobilizing the fish, the escape is prevented. In this way the number of fish falling into the net bags during the whole process of drawing should be substantially increased.
- (e) Fish should be under the influence of the electric current for as short a time as possible. In order to ensure this, the end and side of net bags must be placed 15 – 20 m away from the electric field.

The proposed electric seine net is illustrated in Figure 2.

3.1. Structure

It consists of a number of net bags attached to the frontal part of the seine net and of rather short wings. The length of the frontal part is about 100 – 150 m. The wings are 50 – 75 m long. The net bags are fitted with special devices ("hearts") which make it impossible for fish to escape. The length of the net bags is 25 – 30 m. Electrodes are installed only in the frontal part and are energised by the petrol-driven engine a.c. generator, 2 kVA, 230 V, 8,7 A type PAB2-1/230 or two of them in parallel, if necessary. This apparatus has been already used in Poland in the so-called "classical" arrangement for electric fishing and as the source of electrical energy for the electric trawl for eel.

3.2. Fishing Method

It is assumed that the net will be hauled (Fig. 2) by two 5 hp engines mounted on two anchored boats. The haul will cover a distance of 1 –2 km. With the width of the frontal part being 100 m the area fished by the net will be 10 – 20 ha. The pulling power of a 5 hp motor is about 600 kg. Thus a resistance of the net of up to 1000 – 1200 kg could be catered for. The previous experience with nets of this size showed that it should

not be as high as this. The drawing rate is expected to be about 1 – 2 km/h. Four to five people will be enough to operate the whole gear.

3.3 Main Applications

It is assumed that the electric seine nets will appear in two versions, differing one from another in mesh sizes and some parameters of the electric field in water. One of the versions will be for catching eel, another for catching carp, both to be used in lakes intensively stocked with these species.

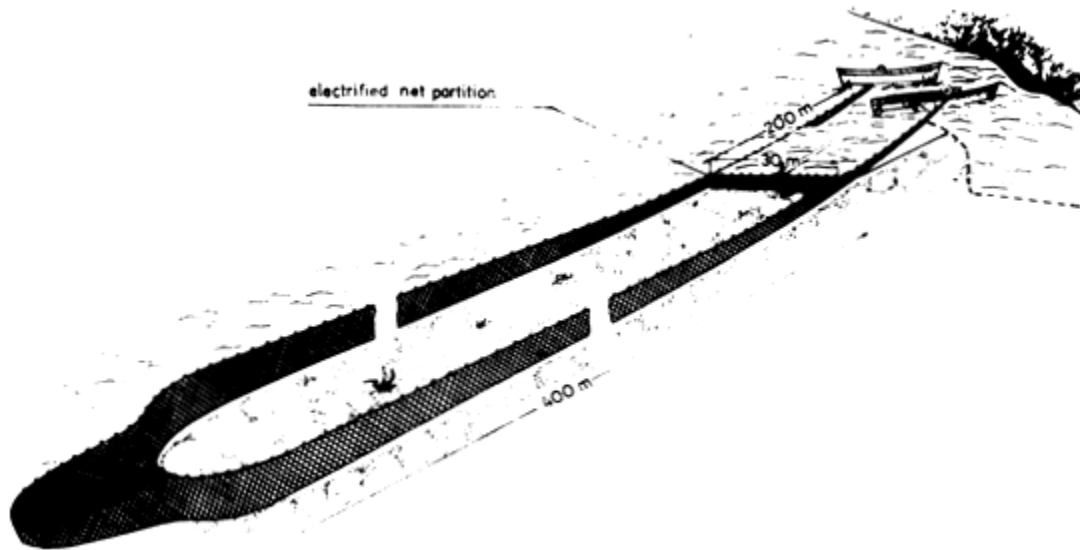
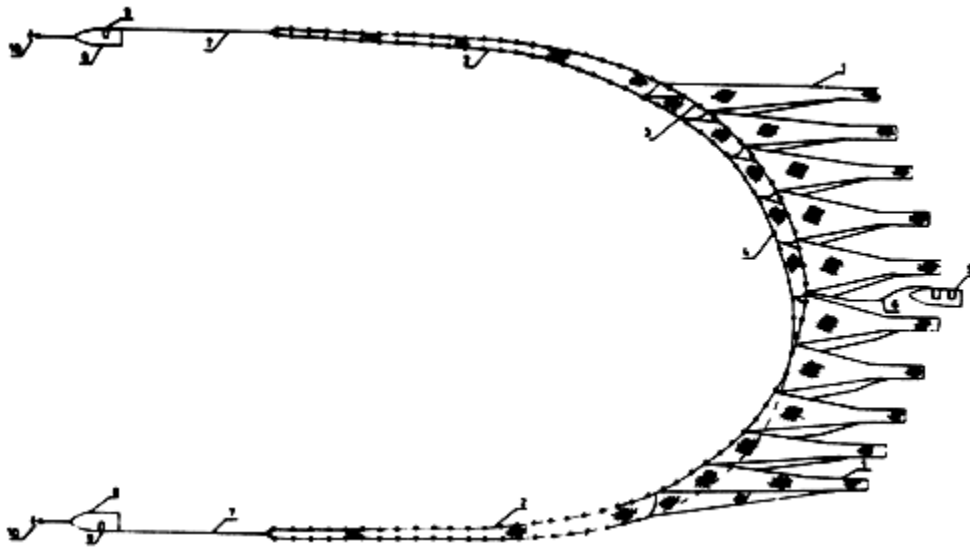


Fig. 1 The conventional seine net with the electrified net partition (in between the wings).



- | | |
|-------------------------------------|-----------------------------|
| 1 Bags (in a number of 10) | 6. Electric supply wires |
| 2 Wings | 7. Towing lines |
| 3 Upper electrode (upon bag's side) | 8. Boats of the seine |
| 4 Lower electrode (upon bag's side) | 9. Mechanical seine haulers |
| 5 Boat with a c. generator | 10. Anchors |

Fig. 2 Electric seine net.

APPENDIX 22

EEL FISHING IN GREECE

by

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In Greece, eels are common in most rivers, estuaries, lakes, ponds and in the sea. The colour of the eel varies with the habitat, for example: in clean waters it is green and the belly is white, but in dirty waters it is brown, yellow or dark.

There are three types of eel in Greece:

- (a) Anquilla mediorostris (called in Greek Katharóchelo),
- (b) Anquilla acutirostris (called in Greek Soovlomýtaró), and
- (c) Anquilla latirostris (called in Greek Kavátsa or Gavátsa).

These differ in body, colour, etc.

The eel grows to a maximum length of 140 cm and a weight of 10 kg; but the average size and weight is 40–100 cm and 2–6 kg.

These eels spend a considerable time feeding and growing in freshwater where the diet is composed entirely of bottom living animals chiefly: molluscs, insect larvae, small fish, crustaceans, etc. After 5 to 7 years they begin migrating to the sea in thousands in dark moonless nights during flood flows after heavy rainfall in the period from October to January.

Spawning takes place in the Sargasso Sea in spring and early summer. From eggs, they become young larvae-leptocephali and from these they metamorphose to transparent eel shaped "glass-eel" with a length of 2–3 cm and as such they arrive on the European coast after two to three years. In Greece the period of arrival on the coast is from November to mid-May. At that time the waters are black with young eels.

The fishermen catch them with a special net and transport them to some rivers where they grow.

1. EEL FISHING AREAS IN GREECE WITH ANNUAL PRODUCTION

The Greek fishermen catch eels from autumn to winter, in some rivers, estuaries, ponds and in the sea. The principal areas in Greece where eel fishing is carried on and the annual production of each in kilogrammes are as follows:

(a) Patraikos:	20 000 kg
Prokopos, Papas, Korychi, Agoolinitsa, Mooría:	200 000 kg
(Agoolinitsa and Mooría are not producing eels since 1969 as these areas have been drained for agricultural production)	
Messolonghi:	30 000 – 40 000 kg
Petalas	5 000 kg
Vonitsa	10 000 kg

(b) Amvrakikos (Logaru, Tsookalio, Preveza, Agrilos, Palametro, Niochori, etc.):	400 000 kg
(c) Kerkyra (Corfu) and Sagiada (Alexandrcopolis, Keramoti, Komotini, Booru):	15 000 kg
Thermissia, Ioannina, Trichonis, Lyssimachia, etc:	5 000 kg

The total annual production of eels in Greece is about 600 000 kg of which only about 10 percent is for home consumption, the balance is exported live either by special vessels (cap. 50–100 t) or lorries (8 to 10 t) to Italy, Netherlands and Germany. The time of maximum production is November and December.

2. METHODS OF FISHING EELS IN GREECE

In Greece the gear employed to catch eels is usually one of the following:

- (i) Volkos, Daooli: cylindrical and conical nets - fyke nets (Fig. 1)
- (ii) Piiros Ichthyotrophion: fish weirs or fish fences - labyrinths
- (iii) Long lines: by hooks in the nighttime.
- (iv) Kamaci or Kamaki: forks, spears with 5–7 prongs with barbs (Fig. 1 (b))
- (v) Baskets of various kinds fished in the bays and in rivers.

DISCUSSION: No discussion

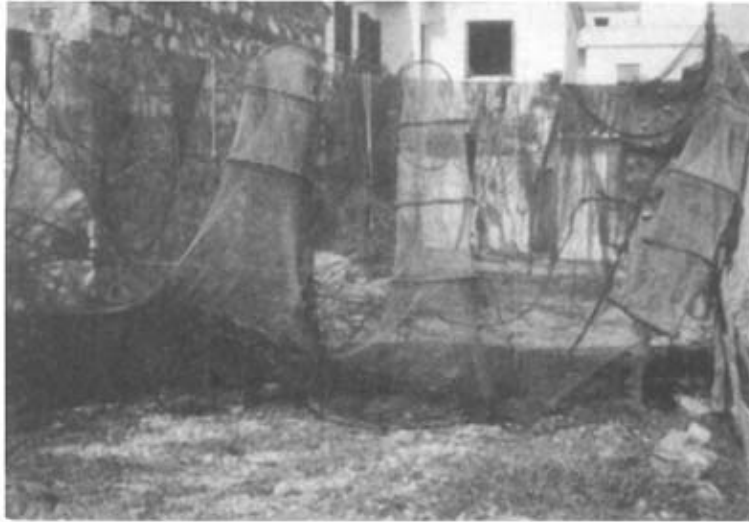
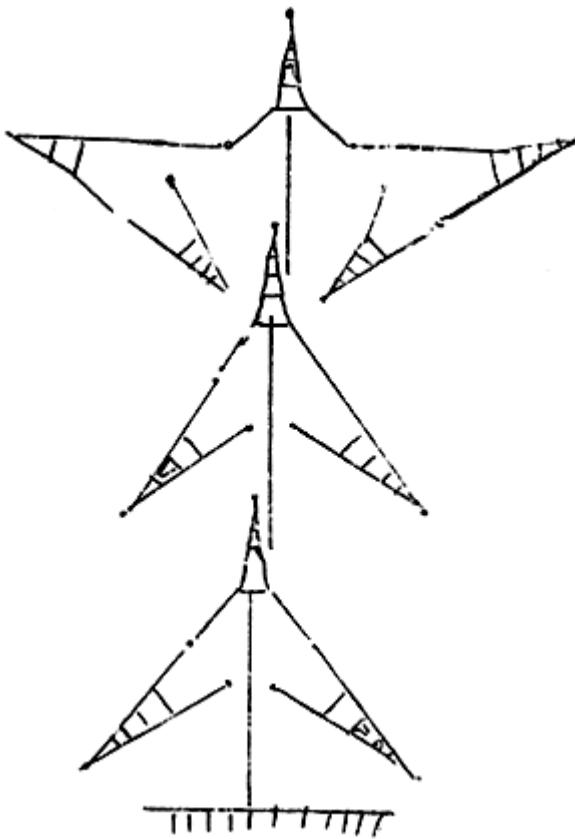
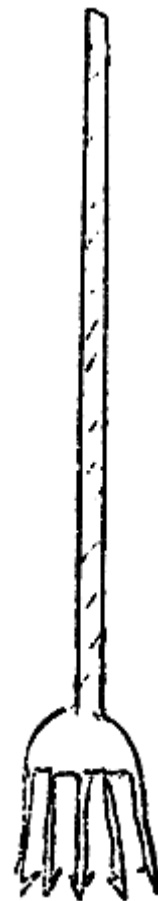


Fig. 1 "Volkos"



(a) "Volkos"



(b) "Kamaci"

APPENDIX 23

EEL INVESTIGATIONS IN LOUGH NEAGH, NORTHERN IRELAND (Summary)

by

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There are approximately 300 fishermen using 150 boats fishing for eels in Lough Neagh (surface area: 388.5 km²) on a seasonal basis. The traditional method of fishing yellow eels is by use of long lines with up to 1 200 hooks per line baited with small fish (usually perch, Perca fluviatilis, or stickleback, Gasterosteus), worm and “plug” (pieces of Coregonus lavaretus). Experimental fishing has demonstrated that “plug” bait gives the best all-round size of eel.

In 1960 some fishermen commenced trawling using one-boat otter trawls and by 1964 this method, although illegal, was well established on the lake. The Ministry of Agriculture for Northern Ireland carried out an evaluation of the effect of trawling on the stocks in 1965 and 1966. The results confirmed that the method should not be legalised. However to give alternative methods, long lining experimental fishing with fyke nets was investigated. Each net had a leader with a length of 8 m and depth of 45 cm fitted with traps at each end. It was calculated that 25 such nets would give a catch of legal-sized eels (i.e. greater than 42 cm) comparable to a long line with 1 200 hooks.

As the fyke nets were not legalized, trawling continued with varying intensity. This resulted in overfishing and the catches are now declining rapidly as are those in eel weirs for the capture of silver eels located on the River Bann which discharges the water from Lough Neagh to the sea.

APPENDIX 24

THE USE OF ELECTRICITY IN THE EXPLOITATION OF EEL STOCKS^{1/}

by

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1. INTRODUCTION	

In recent years the Department of Agriculture and Fisheries in Ireland has embarked on a programme of investigations of how electricity can be employed for the management, development and exploitation of inland fisheries. This work is being carried out by the writer under the direction of Mr. C.J. McGrath, Fisheries Engineer, assisted by Mr. D.F. Murphy, Assistant Engineer.

A field laboratory has been fitted out at the Department's Salmon Hatchery at Glenties, Co. Donegal, and here applied research into the subject is conducted under actual working conditions. In that part of the work dealing directly with eel fisheries, or although concerned with other work found to be applicable in part to eel fishing as well, some results of practical interest to those concerned with the exploitation of eels were obtained, and the following account deals with these.

The particular activities in question were as follows:

- Electro-fishing of migrating silver eels in daylight
- Electro-fishing of yellow eels in daylight
- The fishing of migrating silver eels by conventional horizontal grid trap suitably modified to avail of the use of electricity

- Laboratory and field experiments on the use of electricity for the blocking and guiding of eels
- Fishing of migrating silver eels by fyke net assisted by an array of electrodes suitably positioned and energized
- Control of migrating silver eels by the use of floodlights
- The trapping of migrating elvers with the aid of electricity.

2. ELECTRO-FISHING OF MIGRATING SILVER EELS IN DAYLIGHT

During the development work on an electric eel barrier, which will be described later in this document, a battery-operated electro-fisher with an output of 350 V was used to monitor the migration of silver eels in a generally fast flowing river system and to collect specimens for experimental work. Good catches were made, as the following sampling results indicate:

5 lb in 45 minutes (6.6 lb per hour)
 8 lb in 40 minutes (12.0 lb per hour)
 5 lb in 45 minutes (6.6 lb per hour).

However, the electro-fisher in use initially had a fixed frequency square wave form pulsed D.C. output at between 25–30 p.p.s. and it was observed that some eels were being missed because they became rigidly tetanized in their hiding places, from which they floated out after the fishermen had passed by. A solid state electro-fisher, with an output of 350 V, which was under development at the time and in which the pulse repetition frequency could be varied from 10 to 150 pulses per second, was, therefore, tried with improved results, as described hereunder, which could not be explained entirely by the experience gained in previous operations in selecting productive and avoiding unproductive stretches of water:

30 lb in 120 minutes (15 lb per hour)
 16 lb in 60 minutes (16 lb per hour)

With this machine, best results were obtained at a p.r.f. of 10 per second. The lower frequency, combined with the triangular wave form pulsed D.C. output possible with this machine rather than square wave form pulse of the previous machine tried, produced less tetanus, presumably because of the shorter exposure time. With this energizing, the eels more frequently broke out from their cover while still in range of the landing net and were easy to capture.

A further improvement was achieved by using a shovel-shaped electrode equipped to act as a landing net. This arrangement had been suggested originally by Dr. D. Piggins of the Salmon Research Trust of Ireland for the capture and recovery of small salmonids in streams with gravel bottoms and had been developed by the writer for that purpose. The frame is made from ½ in diameter aluminium bars and is roughly triangular in shape with each side measuring about 16 in. The handle is attached at the mid-point of one side. This shape of net greatly facilitated the lifting of the eels, especially from among the stones and gravel, and under boulders on the bottom of river channels.

This experience would suggest that, if approved by the fishery authority, in suitable river systems migrating silver eels could be caught in daylight by the above method in commercial quantities. The fishing times per catch quoted above include the time spent moving equipment and men from place to place along the river banks. Initially, a four-man team was employed, but later the team was reduced to two: one man fished with the battery and pulser mounted on a carrying frame on his back, while the helper remained on the bank carrying a narrow-necked collecting tank into which he

put the captured eels. The fishing technique employed was for the man with the electro-fisher to wade in the stream, fishing under overhanging banks and under large rocks and any other dark area where migrating eels would tend to conceal themselves during daylight hours. When drawn from the cover, the eels were caught in the landing net and thrown onto the bank of the river where the helper collected them and put them into his collecting tank. This man wore a glove with a rough-textured or sand finish which facilitated the handling of the eels.

The experience gained in this operation suggested that there was little to fear that this fishing operation would interfere with stocks of salmonids. Young salmon and trout were encountered in large numbers in this fishing, but they were very rarely knocked out because of the low p.r.f. and short pulses.

3. ELECTRO-FISHING OF YELLOW EELS IN DAYLIGHT

In many of the smaller, less productive streams in Ireland, there are present quite large numbers of small yellow eels (3 in to 6 in in length) which could perhaps be removed and employed for the intensive stocking of the larger and more productive lakes and river systems. A technique has been devised which makes electro-fishing operations for these fish much more productive than they might otherwise be. Cotton wool waste is soaked in pilchard oil and placed in small sacks. Stones are also placed in the sacks to prevent their being moved by the river current, and they are then placed in pools or else are tied to the roots of trees along river banks adjoining stretches of deep flowing water. The eels are quickly attracted to these baits, and electro-fishing can commence with good results within a few hours of their being placed in position. The baits have been found to remain effective for a period of two weeks, and each location can be fished with profit daily; even in some cases, twice daily throughout this period. The electro-fisher equipment employed for the capture of silver eels can be used for this purpose also, except that a finer mesh landing net must be employed together with a faster rate of pulses per second of the order of 40–50.

4. THE FISHING OF MIGRATING SILVER EELS BY CONVENTIONAL HORIZONTAL GRID TRAP SUITABLY MODIFIED TO AVAIL OF THE USE OF ELECTRICITY

A horizontal grid trap of the conventional pattern which had been constructed across a river channel for the capture of downstream migrating smolts was employed to recapture silver eels that were being used in experiments to test the effectiveness of an electric barrier in deflecting eels. This barrier had been erected across the river channel upstream of the grid trap, and the silver eels which had been captured previously for this purpose were released upstream of the barrier and when they moved downstream their reactions to it were studied at various energizing levels. It was found that although the eels were caught in the flume forming part of the trap and discharged by it into the holding tanks provided at each bank of the river for this purpose they, nevertheless, disappeared overnight unless removed from the tanks to a more secure place of detention. It was surmised that they made their way back up the flume and escaped over the sides. Some eels also had been seen to escape across the top of the flume when they first entered it while it was surcharged with water. To prevent this happening, the trap was electrified in a very simple manner by fastening 7/22 bare copper wire along each side of the flume at mid-water level and continuing this into and around the inside of the holding tanks. This was then energized at 25 V A.C. R.M.S. 50 ops. Thereafter, when eels were released onto the grids of the trap and were swept into the flumes they curled up and were swept into the trap boxes. Eels were retained successfully in these

electrified boxes for two weeks. The energizing was then switched off, and the following day the eels were no longer to be seen.

It was noted that during the hours of daylight the eels made no attempt to escape from the holding tanks even after the power had been switched off.

5. LABORATORY AND FIELD EXPERIMENTS ON THE USE OF ELECTRICITY FOR THE BLOCKING AND GUIDING OF EELS

Laboratory experiments were carried out in an 8 ft 4 in-long tank, 2 ft wide, made up of transparent acrylic panels. This was filled with water to a depth of 1½ ft. Electrodes consisting of lengths of 2 in diameter galvanized iron tubes were suspended across the width of the tank and half-way along its length, each tube being 2 ft apart from its neighbour.

Ten silver eels of various sizes, from 10 in to 27 in, were placed in the tank and allowed to acclimatize over a period of two weeks. The tests were then run as follows: one end of the tank was illuminated with a 100 kw floodlamp (white light). The eels were allowed to settle in the dark end of the tank of their own volition. This retreat to the dark end usually took approximately 15 minutes to complete. The barrier electrodes in the tank were then energized at 24 V D.C. from two 12 V accumulators in series. The spotlight was then turned to illuminate the tank and where the eels had congregated. The movement out of the illuminated zone toward the dark end would then commence in a few minutes. As soon as the eels encountered the barrier field, they withdrew very sharply. They made repeated and determined attempts to get through however. These attempts would be sustained for hours at a time, individual eels taking turns to attempt a break through. The general movement of the eels was slow and leisurely, but the attempts on the barrier were sudden and determined, usually made by one individual at a time after a patient searching of the fringe of the barrier field. After each attempt the eels withdrew with a convulsive reverse swimming action and retreated as far as possible from the field. With the spotlight off, the eels made no determined attempts on the barrier and apparently only encountered the field by accident.

Following the tank experiment, work was begun on installing an eel diversion barrier in a river. A suspension cable was slung across the river at an angle of about 30° to the flow, and, from this 2 in diameter galvanized tubular electrodes were suspended at 2 ft intervals. However, the barrier was not completed in time for the eel migration, and tests had to be confined to liberating hand-caught silver eels above the completed section of the barrier. A 30 ft section was energized at 24 V D.C. from batteries, and 10 eels were released some 20 ft upstream. Of the 10, three were lost sight of, two lead along the barrier to a trap at the downstream end, and five lead upstream along the barrier and escaped around the unfinished end. Arrangements were made to extend the barrier across the full width of the river channel, and field experiments will be continued during the migration of eels next winter.

6. FISHING OF MIGRATING SILVER EELS BY FYKE NET ASSISTED BY AN ARRAY OF ELECTRODES SUITABLY POSITIONED AND ENERGIZED

An exploratory trial of the feasibility of guiding migrating silver eels by electricity in a major river channel was made a number of years ago on the River Shannon by the writer on behalf of the Electricity Supply Board of Ireland. At Killaloe, a commercial eel weir is operated just down-stream of a multiarch road bridge. Below each arch there are three fyke nets, designated from left to right as A, B and C. Experience over the years had shown that, at the arch selected for trials, net C caught nearly as many eels as A

and B together. The success of the experimental guiding of the eels would be indicated by the extent to which the catch pattern could be changed. The electrode arrangement was designed to divert eels to net B.

The depth of water at the site was 10 ft, and three 10-ft lengths of copper bus-bar were used as electrodes, one strapped vertically to each side of the arch at the upstream end, and one standing vertically just upstream of the centre of the mouth of net B. The array was energized with 110 V full-wave rectified D.C. from a unit powered by 50 cps mains supply (i.e. 100 half-sine pulses per second, each having a duration of 10 milliseconds).

The arrangement was fished during the hours of darkness on two consecutive nights. There were five fishing periods, each of two hours' duration per night, with power on and off every second period. The catches in the five power-off periods were as follows:

Net A - 119 lb Net B - 161 lb Net C - 260 lb (This conformed with the normal catch pattern).

In the five power-on periods the catches were as follows:

Net A - 70 lb Net B - 238 lb Net C - 68 lb

Further trials were made to determine whether better results could be obtained with higher energizing voltages. Energizing voltages of 200, 250 and 280 were tried, and the guiding effect was found to fall off as the voltage increased, until at 280 V it was negligible.

This adverse reaction of fish to stimuli exceeding certain limiting values compared with favourable reactions below these figures has been experienced in other investigations carried out since these trials were made. This limiting value has been found to vary from site to site and quite clearly is influenced by the particular conditions obtaining at each site. The usual experience is that when the limiting figure is exceeded the effect of the stimulus on the fish is not to induce the fish to react more strongly but rather to inhibit it from reacting at all and, by causing the fish to become disorientated, it is incapable of avoiding the zone of stimulus but instead is carried involuntarily by the water current deeper into the hostile environment of the stimulus.

7. CONTROL OF MIGRATING SILVER EELS BY THE USE OF FLOODLIGHTS

As a result of the marked avoidance reaction to light shown by the silver eels in the tank experiments, it was decided to test this effect in the natural river. Accordingly, two 500 W floodlights (white light) were arranged under one arch of a road bridge which is situated just above the site of a horizontal grid trap. The lights were adjusted to illuminate one half of the river for some 20 yards above the bridge. The adjustment was such to give a fairly sharply defined line of demarcation between the light and dark areas. The downstream migrants were thus presented with a choice of a bright or dark bridge arch. The arrangement of the grid traps and boxes below the bridge is such that it is possible to ascertain which arch was favoured by the migrants.

The complete arrangement was in working order by mid-November 1967, but it would appear that the eel migration had occurred earlier during some three weeks over very heavy floods. However, large numbers of salmonids were taken in the trap corresponding to the illuminated arch, which would suggest that this method may be of some assistance in trapping salmon smolts. Trials will be made during the next smolt migration as well as during the eel migration. It is appreciated that the use of this method

is limited to waters of shallow depth, free from discolouration, not usually associated with conditions obtaining during silver eel migrations.

8. THE TRAPPING OF MIGRATING ELVERS WITH THE AID OF ELECTRICITY

Reference was made in Section 4 to electrifying the flume of a grid trap to prevent eels escaping after capture. This arrangement was in operation when elvers were migrating upstream and during periods of high tail water level at the horizontal grid trap they were able to get into the flume. Those that entered the energized part of the flume were washed down into the trap box serving that portion of the flume, with those entering an unenergized part were not affected. From this box they could be removed easily by dip netting. This method of trapping elvers will, therefore, be of interest to people collecting them for examination or transplanting.

¹Submitted at the Fifth Session of EIFAC as FI/EIFAC 68/SC I-4

APPENDIX 25

EELS IN THE MUNSTER BLACKWATER RIVER, IRELAND^{1/}

by

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Dublin, Ireland

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1. INTRODUCTION	

Eels are plentiful in all of the lakes, estuaries and rivers in Ireland with the exception of a few small, land-locked lakes. Commercial capture of eels is affected by nets and traps for migrating silver eels and by long line for the feeding yellow eels. Wicker traps, baited with small fish, have been used on a small scale and until recently spear-fishing was carried out in the south-east of the country. Summer fyke nets have been used experimentally since 1961 in certain river estuaries.

Virtually nothing is known of the size and age composition of the stocks of eels in the Republic of Ireland. The present paper gives the results of the first of a series of investigations on the biology of the eel population being undertaken by the author. The Blackwater was chosen as a river estuary with a completely unexploited stock of eels.

2. EXPERIMENT

Samples of yellow eels were collected in the estuary of the River Blackwater, County Waterford, in 1965 and to a lesser extent in 1966. The tidal portion of this river is approximately 25 km in length and varies in width from 40 m to 800 m. The stretch selected for study was 5.6 km in length and extended from 4 km to 9.6 km downstream of the top of the estuary. Its width at high tide varied from 125 to 400 m. The bed of the estuary for the most part had a thick covering of mud. There were a few sandy areas but fishing on them gave poor results, and they were avoided as far as possible.

The gear used was a string of summer fyke nets, having an opening hoop of 54 cm diameter. In the first season (June to September 1965) each end of the string was attached to a stake and the nets were stretched across the current. In the second season (May 1966) the nets were attached to anchors and set parallel to the current. The nets used in 1965 had a mesh size (stretched) of 2.1 cm at the codend and those used in 1966, 1.7 cm. Each string consisted of from two to six pairs of nets with single leaders.

3. RESULTS

The catches per net are set out below:

	Mesh size	Number of eels/net/day	Weight of eels/net/day
1965 (June to September)	2.1 cm	2.14	317 g
1966 (May)	1.7 cm	2.28	283

The lengths and weights of the eels captured on a basis of 5 cm length groups are given in Tables I and II. Otoliths of 106 eels taken in 1966 were read. They were examined immersed in creosote but not ground. Considerable difficulty was encountered in making the readings, and the results given in Table III are set out on a two-yearly basis with a view to minimising the errors. The stomach contents of 168 specimens were examined, of which 44 (26 percent) were empty. The occurrence of the most important food items (those present in more than 10 percent of the stomachs) is set out in Table IV. Examination of the gonads of 38 of the specimens taken in 1965 revealed that 28 were female, 3 male and 7 could not be determined. The females ranged in length from 34 to 67 cm, the males 31 to 33 cm and the unknowns 33 to 37 cm.

Table I
Length Distribution of Blackwater Eels

Length (cm)	1965		1966	
	Number	Percent	Number	Percent
21-25	3	0.1	23	7.0
26-30	111	5.8	94	28.6
31-35	432	22.8	106	32.3
36-40	345	18.1	28	9.0
41-45	382	20.1	28	9.0
46-50	264	13.9	14	4.2
51-55	151	7.9	13	3.9
56-60	92	4.8	8	2.4
61-65	61	3.2	4	1.2
66-70	50	2.6	3	0.9
71-75	4	0.2	2	0.6
76-80	4	0.2	1	0.3
81-85	-	-	1	0.3

Table II
Weight Distribution of Blackwater Eels

Length	1965		1966	
	Weight (g) Total	Mean	Total	Mean
21–25	117	39	693	30
26–30	5 161	46	3 843	40
31–35	28 300	65	6 838	64
36–40	32 527	94	2 761	98
41–45	51 066	133	4 149	148
46–50	50 795	192	3 098	221
51–55	40 317	267	3 492	268
56–60	32 899	357	2 986	373
61–65	28 050	459	2 016	504
66–70	28 774	575	2 200	733
71–75	2 905	686	1 669	834
76–80	3 704	926	892	892
81–85	-	-	1 110	1 110
Total	304 615		35 747	

Table III
Length and Age of Blackwater Eels (1966)

Age Group	Number	Mean	Lengths (cm)		Mode
			Minimum	Maximum	
5 and 6	21	31.0	24	39	26
7 and 8	42	30.6	24	39	31
9 and 10	27	41.2	31	78	45
11 and 12	9	44.9	38	60	-
13 and 14	4	40.2	52	68	-
15 and 16	2	73.5	65	82	-
17	1	71.0	-	-	-

Table IV
Food of Blackwater Eels

	<u>Present in</u>	<u>Percentage</u>
Amphipoda (<i>Gammarus</i> sp.)	59	47
Fish	21	17
Mysidacea (<i>Praunus</i> sp.)	20	16
Insects	14	11

The fishery is not commercially exploited, and in the virtual absence of large predatory fish which might eat the well grown eels it may be assumed that the fall in numbers of eels captured above the 31–35 cm groups results from the spawning migration. The proportion of eels smaller than these depended on the mesh size. In 1965, using the 2.1 cm mesh, 5.9 percent of the total catch were less than 31 cm; in 1966 with 1.7 cm mesh, these made up 35.6 percent. The mean weights of the small eels were substantially lower when the small mesh was used.

It appears from the examination of the gonads that male eels in the fishery do not exceed 37 cm in length. The length distribution figures show a decrease in the numbers of eels in the 36–40 cm group but similar numbers in that and the 41–45 cm group. This can be explained by the migration of a large proportion of male eels before they reach a length of 40 cm. The next abrupt drop in numbers comes after the 50 cm length by which size many of the females have left. Larger eels show a steady decline in numbers. The age determinations indicate that the majority of eels migrate at seven or eight years old. The rate of growth is very uneven and shows great variation amongst individuals.

Ten of the stomachs contained unidentifiable material. In some cases this may have been remains of offal from a bacon factory upstream, but otherwise the diet of the eels in the area consisted of living animals. Of the 21 stomachs containing fish flounder, Pleuronectes flesus occurred in five, eels in two, and the others were too much digested for identification. The insects in most cases were larvae of Trichoptera and Ephemeroptera.

^{1/} Submitted at the Fifth Session of EIFAC as FI/EIFAC 68/SC I-3

APPENDIX 26

STUDY TOUR ITINERARY

14 OCTOBER 1970

The eel fishery operated by Master Fisherman W. Dobberschütz on the River Weser was inspected and discussed with him. There was a demonstration of the method of setting and fishing plastic eel basket traps set in series in line with the river flow at selected localities along the river channel.

Different methods of mounting and fishing stow nets were examined; first of all, by means of stakes driven into the river bed; secondly, mounted on double beams suspended at each side from a boat anchored in the stream of the river, and finally swimming free in the river current. This net is anchored at one side to the bank and maintained in station in the stretched open position by means of an otter board arrangement attached to it by a rope and so angled to the current to maintain a constant pull away from the bank on which the anchor is placed. The otter board could be adjusted to swim out from the bank or to swim into it by pulling a rope to alter the inclination of the rudder attached to it relative to the direction of the river current in which it was located: in this way, the net could be brought to the bank and emptied of eels and afterwards returned to its fishing position.

A launch was kindly placed at the disposal of the delegates by the Hoya River Authority by means of which it was possible to pass along the river and view the various fishing activities in comfort. Mr. Olbricht, Governmental Adviser of the Hoya River Authority received the delegates and accompanied them on their tour of inspection. Mr. Bokeloah, President of the Fishermen's Association of Nienburg also honoured the delegates by his presence.

The Schokker type stow net fishing arrangement operated by Master Fisherman Brauer at Landesbergen was also inspected and its method of operation discussed with the owner.

15 OCTOBER 1970

The eel fishery operated on the Steinhude Lake was inspected.

There was a very interesting demonstration of pair trawling for eels by means of two boats fitted with outboard engines.

Two methods of fishing for eels by means of electricity were demonstrated. A simple but effective method devised and employed by the local fishermen making use of a bank of cadmium batteries connected "in series" was contrasted with a very sophisticated electronic device designed by Dr. Halsband.

A visit was paid to the eel smoking establishment of the firm of Schweer and Kuckuk and great interest was expressed by the delegates in the preparation of the eel for smoking and in the actual smoking process.

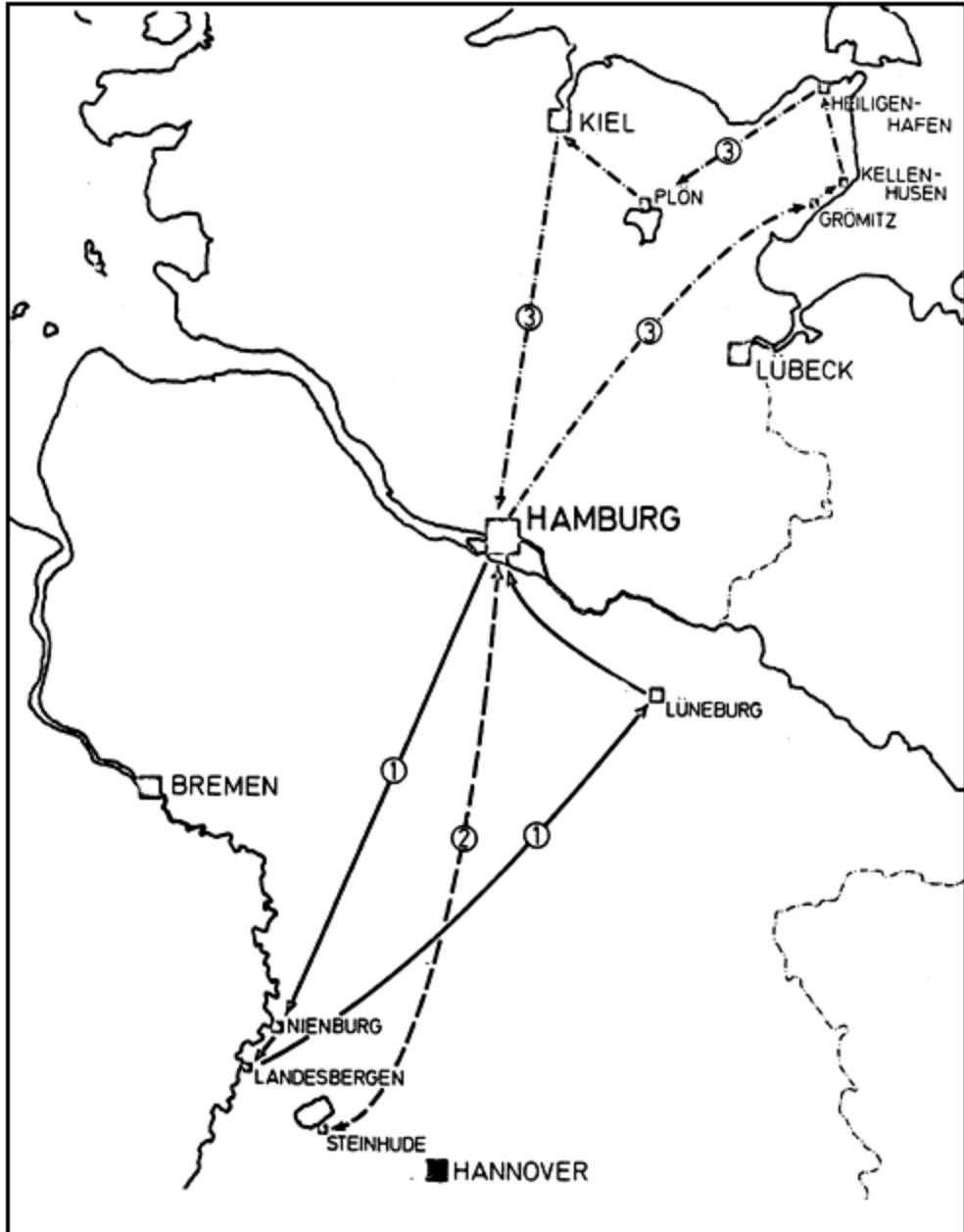
16 OCTOBER 1970

The large Pound Nets erected in the Baltic Sea off the coast near the harbour of Grömitz and operated by Master Fisherman Willy Wichmann were visited by means of a boat placed at the disposal of the delegates and much interest was shown in the demonstration of the method of fishing these nets by Mr. Wichmann.

The eel fishery operated by Master Fisherman Wilcken on Lake Plön was inspected and so also was the horizontal grid type eel weir at the outlet of the lake at Ascheberg.

A very interesting and informative account of the operating procedure for these fisheries was given by the owner. He also demonstrated the methods employed by him in the preparation, storage and distribution of eels prepared in various ways for consumption by the public. Great interest was displayed in the attractive retail establishment in which the products of the fishery were sold to the public.

At the conclusion of the study tours the delegates were pleased to have the opportunity of meeting in Kiel and exchanging views on fishery matters with Dr. Pape, Governmental Director of the Ministry of Agriculture of Schleswig Holstein, Mr. H. Kutsch, Governmental Gear Adviser of the Fishery Division of the Chamber of Agriculture, Kiel and Dr. Thurow, Head of the Kiel Station of the Institut für Küsten- und Binnenfischerei.



Tour Itinerary

APPENDIX 27

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Minique Fisheries Ltd.
Middle West Pubnico
Nova Scotia

APPENDIX 28

List of Manufacturers and Eel Fishery Owners who provided Gear for Display at the Consultation

Manufacturers

Messrs. Hermann Enger & Co.
Netzfabrikation GmbH
Bremerhaven 29

Carsten-Börger-Str. 5
(Post Box 262)

Messrs. Itzehoe Netzfabrik A.G.
Itzehoe/Holstein

Brunnenstr. 2-10
(Post Box 248)

Messrs. Friedrich Studkenbröcker
Inh. Prödel & Dr. Zöhrer
Lockhausen über Herford

Messrs. Rudolf Vogt
Netzweberei, Mech. Flechtere
Itzehoe/Holstein

Lindenstr. 41
(Post Box 362)

Eel Fishery Owners

W. Dobberschütz
Nienburg/Weser

Weserwall 14

Laskowski
Ascheberg bei Plön

Plöner Chaussee 40

An important and interesting feature of the Consultation was the impressive display of various kinds of eel traps and other eel fishing gear which had been mounted in the foyer of the main Conference hall. This display of apparatus was provided by the exhibitors and eel fishermen whose names are listed above and their help and cooperation in making this very informative display possible was much appreciated and remarked upon by the delegates.

Papers Issued In this series

- EIFAC/T1** Water quality criteria for European freshwater fish. Report on finely divided solids and inland fisheries (1964).
- EIFAC/T2** Fish Diseases. Technical Notes submitted to EIFAC Third Session by Messrs. J. Heyl, H. Mann, C.J. Rasmussen, and A. van der Struik (Austria, 1964).
- EIFAC/T3** Feeding in Trout and Salmon Culture. Papers submitted to a Symposium, EIFAC Fourth Session (Belgrade, 1966).
- EIFAC/T4** Water quality criteria for European freshwater fish. Report on extreme pH values and inland fisheries (1968).
- EIFAC/T5** Organization of inland fisheries administration in Europe, by Jean-Louis Gaudet (Rome, 1968).
- EIFAC/T6** Water quality criteria for European freshwater fish. Report on water temperature and inland fisheries based mainly on Slavonic Literature (1968).
- EIFAC/T7** Economic evaluation of inland sport fishing, by Ingemar Norling (Sweden, 1968).
- EIFAC/T8** Water Quality Criteria for European Freshwater Fish. List of literature on the effect of water temperature on fish (1969).
- EIFAC/T9** New Developments in Carp and Trout Nutrition. Papers submitted to a Symposium, EIFAC Fifth Session (Rome, 1968).
- EIFAC/T10** Comparative Study of Laws and Regulations Governing the International Traffic in Live Fish and Fish Eggs, by F.B. Zenny, FAO Legislation Branch (Rome, 1969).
- EIFAC/T11** Water quality criteria for European freshwater fish. Report on Ammonia and Inland Fisheries (1970).
- EIFAC/T12** Salmon and trout feeds and feeding (1971).
- EIFAC/T13** Elements of the theory of age determination of fish according to scales. The problem of validity (1971).
- EIFAC/T14** EIFAC Consultation on Eel Fishing Gear and Techniques (Rome, 1971).

Documents publiés dans la présente série

- EIFAC/T1** Critères de qualité des eaux pour les poissons d'eau douce européens. Rapport sur les solides finement divisés et les pêches Intérieures (1964).
- EIFAC/T2** Maladies des poissons. Notes présentées à la troisième session de la CECPI par J. Heyl, H. Mann, C.J. Rasmussen et A. van der Struik (Autriche, 1964).
- EIFAC/T3** Alimentation dans l'élevage de la truite et du saumon. Communications présentées à un symposium, quatrième session de la CECPI (Belgrade, 1966).
- EIFAC/T4** Critères de qualité des eaux pour les poissons d'eau

- douce européens. Rapport sur les valeurs extrêmes du pH et les pêches intérieures (1968).
- EIFAC/T5** Organisation de l'administration des pêches intérieures en Europe, par Jean-Louis Gaudet (Rome, 1968).
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