Perspectives on Reference Literature for Underwater Acoustics (1983)

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PERSPECTIVES ON REFERENCE LITERATURE FOR UNDERWATER ACOUSTICS

Committee on Navy Scientific
and Engineering Literature

NAVAL STUDIES BOARD

Commission on Physical Sciences,
Mathematics, and Resources
National Research Council

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

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CONTENTS

1 INTRODUCTION AND BACKGROUND

Since the close of World War II, the U.S. Navy and other government agencies have sponsored a great deal of research and development relating to underwater acoustics and sonar. The primary form of documentation for the results of this work has been the scientific or technical report. Such reports typically have limited initial distribution and, after a lapse of time, are often difficult to identify or retrieve. This is true in spite of the government's extensive efforts to provide repositories for all such documents. The result of this arrangement is that the efficiency and effectiveness of continuing research and development suffer in these ways:

- Excessive time is spent in searching the literature (if such searching is even done).
- There is unnecessary duplication of work (that is, too much reinvention).
- Subsequent work is not as good as it might be because proper use is not made of prior work.

Furthermore, typically (and for good reason) reports are not written with the conciseness of journal articles and books. This results in significant storage problems and adds to the burden of sifting through material to obtain those elements that have enduring value. Another point is that, initially, many of the reports in the field of underwater acoustics carry a military security classification. Unfortunately, much of the material remains classified long after such a restriction serves any real purpose, and classification only impedes the identification and transfer of such material. A final point is that a vast store of valuable information that resides in the minds of a group of researchers who have been active for many years (many of them since World War II) is, unfortunately, now being lost because of retirement or death. It is important not to lose this irreplaceable store of knowledge and experience.

A considerable body of underwater acoustics information has found its way into archival journals and books, but there is a basis for believing that this is not the case for a major fraction of the total relevant literature. A recent survey indicated that 65 percent of the articles read by scientists are less than one year old and 85 percent are less than three years old.* It is estimated

*King, Donald W., and Nancy K. Roderer "Communications in Physics - The Use of Journals," Physics Today, October 1982, pp. 43-47.

that most articles more than ten years old are no longer read, even though many of them are still of unique value. This is not the case for books, which seem to have a life of at least several decades; the survey employed in this report bears out this conclusion.

The value of books may be summarized as follows:

- They increase efficiency of R&D by making needed information readily available in a concise, distilled, and organized form. They are easy to consult and, if well written, easy to use.
- They summarize what is known, thus indicating what need not be repeated. They often serve to identify directly or indirectly what is not known and therefore what yet needs to be done. Books may identify the place to start research.

In recognition of this situation, the U.S. Navy asked the Naval Studies Board (NSB) of the National Research Council to survey the community concerned and to identify needs for summary books and/or other actions that would improve the efficiency and quality of the Navy's R&D program. The NSB established the Committee on Navy Scientific and Engineering Literature to study the problem and respond to the Navy's request. The general assignment was broad in that it encompassed all areas of science and technology of importance to the Navy, but the initial phase (like this report) was restricted to the field of underwater acoustics and sonar engineering.

The first step of the Committee was to develop a bibliography of books that already exist on the subject of underwater acoustics. A list of approximately 125 titles was the result, most of them published in the post-World War II period and most of them written in English or available in English translations (many of the titles are now out of print). Even though these titles constitute a sizable library, it was clear that the coverage of the field is not uniform; significant gaps seem to exist. Naturally, many of the books do not include or reflect the most recent developments.

The Committee felt that it was essential to obtain the views of a sample of the R&D community in regard to the adequacy of existing books and the need for new ones. To obtain this information, a survey form was developed and sent to 76 activities in government research centers, university research centers, and industrial groups. It was suggested that each activity ask 10 percent of its staff working in the field of underwater acoustics to complete the survey form.

The cooperation of the activities and the response of the individuals were gratifying. The results of the

survey are discussed in the following section of this report, and summaries of the data are included as appendixes. These data form a crucial part of this study, and the Committee has made extensive use of the information in developing its recommendations and reaching its conclusions.

2 THE SURVEY

THE RESPONSE

A copy of the survey form, the list of underwater acoustics books, and the cover letter are included as Appendix A. This packet was sent to 76 activities. Responses were received from 38 activities, with a total of 263 individual responses (see Appendix B). The Committee considers this a good response rate and estimates that it may represent a valid sample of the scientists and engineers actively engaged in conducting R&D in underwater acoustics for the U.S. Navy.

In general there appears to be an acceptable balance among the respondents. Years of experience in the field ranged from less than 1 year to 40 years, with a median of 14 years. The spread is good, indicating that we have information not only from those with extensive experience but also from those new to the field (see Appendix C). Almost half of the respondents hold the Ph.D. degree, and we feel that this probably is not representative. Those doing basic research and exploratory development may be overrepresented while those doing hardware design may be underrepresented. In regard to fields of interest (see Appendix D), all areas are represented, with the largest groups being in signal processing and ocean acoustics. In regard to systems, anti-submarine warfare (ASW) is more heavily represented than, for example, minehunting; this is to be expected and is appropriate.

The Committee appreciates the amount of effort that was expended in completing the survey forms. Full completion of a form was not a trivial task. The degree of detail provided was highly varied, but the following numbers may be of interest.

Respondents who indicated levels of interest only	14
Respondents who cited references	238
Respondents who added references	148
Respondents who added reports	42
Respondents who recommended new books (or topics)	98

These numbers indicate that while a few spent little time responding to the form, many must have spent many hours in providing additional listings and in identifying needed books. Several took the time to write detailed letters that were especially useful. Some activities clearly had an organized and coordinated effort. Several examined the original booklist with great care and provided the Committee with corrections and clarifications. In brief, the response to the survey by the activities and individuals was impressive. The Committee interprets this

to mean that the community sees this as a worthwhile project and supports it.

BOOK CITATIONS

The number of times that a particular book (from the original list of 148 titles) was cited for each of the 48 subtopic areas is tabulated in Appendix E, together with a summary of the total times that each of the books was cited (for all 48 topics). A detailed examination of these tabulations is tedious but can be very informative. At this point we will take the space to discuss only a few of the topics and books, but the data will be referred to in subsequent sections of the report.

One point is clear: some books were cited frequently, while many were scarcely cited at all. In part, this distribution is a result of the fields of interest of the respondents, but it also indicates something about which books have been found to be most useful.

Table 1 lists 14 books that were cited more than 100 times. This cutoff point is entirely arbitrary, and one should be careful not to give undue weight to this particular list. However, it serves to make several points.

TABLE 1 Most Cited Books (Books Cited More Than 100 Times)

Rank	List Number	Author	Number of Citations
1	138/139	Urick (Principles)	706
2	99	NDRC (Division 6 Summary Reports)	207
3	141	Van Trees (Part I)	137
4	143	Van Trees (Part III)	127
5	111	Ross	122
6	70	J. W. Horton	118
7	76	Kinsler and Frey	117
8	101	Officer	115
9	31	Brekhovskikh (Waves)	114
10	140	Urick (Propagation)	114
11	142	Van Trees (Part II)	109
12	77	Kinsler, Frey, Coppens, and Sanders	106
13	145	Winder and Loda and/or Whalen	104
14	27	Bobber	103

The popularity of Urick's Principles of Underwater Sound is truly impressive; there was no close competition

in this survey.* Urick was cited 1 or more times by 176 respondents for a total of 706 times. The median number of citations per person was 2 but one person cited it 40 times. However, more than 80 respondents did not cite it at all (a number of these included no book citations for any topic).

We believe that this extreme comparative popularity is due to several factors:

1. It is a general book and covers, in various depths, most of the areas of underwater acoustics. It was cited for 45 of the 48 subtopics.
2. It is a useful, practical, well-written book. It summarizes a vast amount of information. It uses the language of the underwater acoustics community and is easy to use. Graphs are heavily employed.
3. It can be used by a wide range of R&D personnel: students, newcomers, experienced people, researchers, designers. It has something for everyone.
4. The bibliographies for each chapter are very useful.
5. There is no other book like it in the field of underwater acoustics. It has filled and is filling a need.

The frequent citation of Urick also tells us something about the lack of books. For many of the subtopics Urick was frequently the only reference cited. In part, this is because there are no specialized books for those topics. Urick wrote a general-coverage book. Perhaps the quality of the R&D program would be improved if specialized books (those that treat in depth topics that Urick covers in a chapter) were readily available. This aspect is further discussed in subsequent sections.

The fact that Urick's was the most cited book will come as no surprise to most of the underwater sound community, although the magnitude of the margin might. However, the fact that second place was achieved by the NDRC Division 6 World War II Summary Reports prompts some comments. These 23 volumes were listed as one item (Number 99 in the original list). It would have been more informative if we

*In hindsight, we recognize that the first and second editions of this book should have been listed as one line-item in the booklist since the two editions are very similar. Many respondents listed both for the same subtopic. In order not to give undue weight in our tally, we have combined Numbers 138 and 139 but did not give a double count when both editions were cited by the same person for the same subtopic. Regardless of the method of counting, Urick's book was the most cited by a wide margin.

had given each volume a separate number. Some respondents indicated which volume was being cited but most did not; therefore, we have lumped all citations into a single number. The important point is that these very old documents are still considered useful by a number of workers. This is even more noteworthy when one considers that the original distribution of the reports was very limited and that most of the volumes were classified for at least the first decade after publication. Volume 7, Principles and Applications of Underwater Sound, and Volume 8, Physics of Sound in the Sea, have been reprinted twice (first by the Committee on Undersea Warfare, National Academy of Sciences-National Research Council in 1951 and later by the Naval Material Command in 1968). These two volumes did receive fairly general distribution, are to be found on the bookshelves of most of the R&D workers, and were the most cited volumes when volume citations were included. While it is recognized that much still-useful information is in these documents, there is much that is now woefully out of date. The Committee believes that this can be interpreted to mean that a need exists for some new summary documents.

A large number of respondents indicated signal processing as a primary field of interest, and this is reflected in the number of citations for books on that subject. Most signal-processing books are broader than just underwater acoustics applications and were not included in the original book list. The three volumes by Van Trees all received high numbers of citations. Unfortunately, the same item number (Number 145) was given by error to Whalen, Detection of Signals in Noise, and to Winder and Loda, Introdution to Acoustical Space-Time Information Processing, making it impossible to separate the citations, since both are signal processing books. Strictly speaking, Winder and Loda should not have been included in our list because it was published as a report rather than a book. It was included because it was recognized as a popular publication. Regardless, signal processing is a popular and important (and very broad) topic.

The continuing popularity of J. W. Horton's Fundamentals of Sonar (of World War II origin) is interesting in that the book has long been out of print and much of the material would be considered out of date. For a number of years it was one of the very few general (and generally available) books on sonar. Kinsler and Frey, Fundamentals of Acoustics (and the recently revised edition by Kinsler, Frey, Coppens, and Sanders), is a long-popular book on general acoustics. There are many general books on the fundamentals of acoustics--many old and a few new--but this one, together with a few others, seems to match well with the needs of the underwater acoustics community.

The other five books in Table 1 are examples of more specialized works that are (or are becoming) classics for their topics. Propagation and noise are popular and important topics and are represented on the list. Bobber's Underwater Electroacoustics-Measurements is one of a kind on its subject. A common characteristic of these books is that they are practical and clearly written. They can be understood and used. They do what good books should do--they collect, distill, and organize a body of knowledge.

Several of the most cited books were published by the Navy (or the Government Printing Office). One often tends to think that this mode of publication is not as effective as publication by commercial houses, but this may not be true. A final point is that most of the authors of these books were supported by the U.S. Navy (directly or indirectly), and the contents of the books were derived in large part from Navy-sponsored work. The USSR also made a contribution.

The Committee draws two important conclusions from this part of the survey.

1. While a large number of books deal with underwater acoustics specifically, there are a number of subareas in which no good summary books exist.
2. There are a number of examples in which the people working in an area are not aware of the existence of books that would be useful to them. The mere publication of a bibliography of existing books, categorized by topic, can serve a useful purpose. A number of respondents have commented on the value of the booklist and recommended that it be published in a revised and expanded form.

BOOKS ADDED TO THE ORIGINAL LIST

On the original book list of 148 titles, approximately 80 percent were specifically concerned with underwater acoustics. The respondents cited 290 other books that they found to be useful references and suggested that these titles be included in the bibliography. This expanded list is included as Appendix F.

As might be expected, most of the added titles are for books that are not specific to underwater acoustics. Table 2 tabulates the number of added titles in some rather arbitrary categories. The largest number is in the broad field of signal processing. The categories of pattern recognition, displays, and artificial intelligence might well be included under signal processing. The next largest group includes general books on acoustics and waves.

TABLE 2 Books Added to List, by Topic

Topic	Number of Titles
Signal processing (general, statistical methods, includes some radar books)	71
General acoustics and waves in general	55
Radio and radar	35
Vibration (general, mostly solids)	20
Oceanography	16
Transducers	13
Underwater sound (general, propagation, sonar)	12
Mathematics	9
Pattern recognition and displays (could be signal processing)	8
Radiation, diffraction, scattering (general)	7
Optics	6
Seismics	5
Noise (mostly airborne)	5
Human factors	5
Fluid mechanics	5
Operations research	4
Artificial intelligence (could be signal processing)	3
Nonlinear acoustics	2
Physics	2
Acoustical materials	1
Animal sonar	1
Acoustical holography	1
Miscellaneous	5

A large number of radio/radar books were added (and many of the signal processing books are in fact written primarily for the radio/radar community), which deserves some comment. The radar community is a large one and has made rapid progress since the beginning of World War II (its origin dates to the early 1920s, but the subject was highly classified until the end of World War II). Radar work during World War II was summarized in the now classic and famous Radiation Laboratories Series, comprising 28 volumes, which was published unclassified by McGraw-Hill and was later issued in a paperback reprint edition. These books had a profound influence on the development of radar in the United States and the rest of the world. In the period since World War II a large number of unclassified radar books have been written and published. The library card catalog file at a large state university lists 148 book titles under radar and only 12 under sonar. Books in

Print lists 83 titles under radar and only 11 under sonar. The Committee believes that some of the progress in radar can be attributed to the communication of technical information via published books.

The heavy citation of radar books indicates that the sonar community is aware of radar science and technology and makes good use of the published material. This is especially true in the areas of signal processing and arrays. One may argue that parallel books are not needed in the sonar area since the radar books exist. However, that is only true to a degree. There are major differences in the two types of systems, and an added burden is placed on the sonar researcher if he has to make the necessary translations (units, nomenclature, etc.).

A final point is that even when these additional titles are added to the original list and the augmented list is correlated with the list of 48 subtopics on the survey form, some of those subtopics are not well covered.

SCIENTIFIC AND TECHNICAL REPORTS

A detailed review of the individual responses makes it abundantly clear that the R&D community depends heavily on two sources for information: (1) reports and (2) journal articles (unclassified and classified).

The Committee made no attempt to survey the community for a tabulation of important journal articles, but such a survey might be of considerable value. The Committee does stress that the archival journals (e.g., The Journal of the Acoustical Society of America, Acustica, Journal of Sound and Vibration, Russian Acoustics, U.S. Navy Journal of Underwater Acoustics, and others) form an indispensable resource for information. Publication in these journals should be encouraged and supported.

Individuals were asked to list those scientific and technical reports of a tutorial or summary nature that they felt were of special value. They were also asked to flag those reports that they believed could and should be developed into book form with only modest effort. Some 140 such reports were listed and are tabulated (with some screening) in Appendix G. Some of these reports were named by several different respondents, an indication of their special value.

The Committee makes three comments on this portion of the survey.

1. Reports are an important source of information and are the primary sources in many areas. Yet the same reports are not cited all that often. One questions whether the existence of the reports is widely known.

2. The publication of a list of important reports, especially those of a tutorial/summary/survey nature, would be a service to the community.

3. It is believed that a list of only 140 reports must be only a small fraction of the total of such reports that should be in this category. The development of a much more complete list would involve considerable effort, but we believe it is justified. One approach would be to identify one individual at each major activity and request that he/she review all of the publications by that activity and compile the list. This could be a follow-on task to the current work of the Committee.

BOOKS IN PREPARATION

Only 14 books in preparation were identified; they are listed in Appendix H. Several seem to be written and nearing publication, while others are in the indefinite category. Although the total number of these books is not large, some would appear suitable for filling some of the obvious gaps; these are discussed in Section 3. There may be other books in preparation, but the authors may be reluctant to go on record with any disclosure. Perhaps this report with its survey results may encourage an increase in the book-writing activity.

BOOKS RECOMMENDED FOR REPRINTING

Many of the books on the original list, as well as on the expanded list, are out of print. (It should be noted that book dealers frequently still stock books that the publishers list as out of print.) Individuals were requested to flag those books that they felt were of such value as to justify reprinting. The response to this request was not heavy nor was there any significant indication of multiple requests for reprinting any specific book (see Appendix J). In explanation it may be that many of the out-of-print books still reside in the libraries of R&D activities.

It should be noted that The Acoustical Society of America (ASA) has a program to reprint in paperback form and sell at modest costs certain classic books in acoustics. In each instance the original publisher and the author (or heirs) have assigned their rights to the ASA. Several of the books on the survey list have been reprinted in this program (and are so listed). The ASA is providing a useful service and appears to be breaking even financially. This might be a suitable avenue to take should there be a decision to reprint any books.

3 RECOMMENDATIONS

GENERAL

A detailed examination of the individual survey responses indicates that there is a need for some new books in the field of underwater acoustics and sonar. Some 210 suggestions were made for new books (some very specific and others general) by 98 individuals. An analysis of the list of existing books supports this conclusion. It is appealing to say that the community needs an updated version of the "Red Books" (NDRC Division 6 Undersea Warfare Summary Reports), but it is not a very feasible concept to implement. The 23 volumes of the series covered only a 5-year period of research and development. To summarize the work of the past 37 years (and the level of effort has been higher than it was during the World War II period) would be a monumental task and even if done would produce a great many books that would have very limited value or use. Also, a number of books have been written in the post-World War II period, and these do not need to be duplicated.

The approach taken by the Committee was to examine the subject of underwater acoustics, divided into 48 subtopics, and correlate the existing books with those subtopics, in order to determine whether and where gaps existed. For help in making decisions, the Committee has used (1) the results of the survey, (2) the augmented booklist, and (3) the judgment of the individual Committee members.

In our recommendations we have tried to emphasize useful and practical books, those that if available would be heavily used by many members of the community and that would significantly raise the efficiency and quality of the R&D program. A common theme in the survey responses was "practical books."

The Committee has assumed that the audience for the new books is the professional staff (scientists and engineers) in R&D programs. The same documents should also be useful to students, teachers, and R&D managers. In general, the treatment should be at the college senior/first-year graduate school level. The aim should be that the books contain sufficiently detailed information so that it would not be necessary for the reader (worker) to refer to the host of primary materials (reports and journal papers). This is not meant to imply that the author need not provide a full set of references.

SPECIFIC RECOMMENDATIONS FOR NEW BOOKS

Appendix I tabulates the number of individual recommendations for several broad categories. Table 3 lists fifteen books that the Committee recommends be either written or compiled. Each of these topics will be discussed in brief detail.

TABLE 3 Recommended New Books

First priority	
Transducers: theory, design, and construction	New book
Arrays and beamforming	New book
Sonar systems design	New book
Sonar applications and systems	New book
Physics of underwater sound	New book
Second priority	
Sea tests: planning, design, operation, and analysis	New book
Oceanography for underwater acousticians	New book
Computer-aided detection/classification; artificial intelligence; man-machine interfaces; interactive displays	New book
Shallow water acoustics	Compendium
Arctic acoustics	Compendium
Radiated noise	Compendium
Third priority	
Catalog of Navy and commercial sonar equipment	Compendium
Patent abstracts	Compendium
Bibliographies, glossaries, dictionaries	Compendium
Definitive history of underwater sound and sonar	New book

Transducers: Theory, Design, and Construction

More survey respondents recommended a definitive book on transducers than for any other topic. This is also the view of the Committee. Such a book should include the theory necessary to understand the operation of transducers and should provide a basis for logical design. The book should be thorough on practical design procedures and should include numerous examples. In regard to construc-

tion it should include "cookbook"-type information on materials and fabrication techniques. The coverage should include both reciprocal and nonreciprocal transducers and should cover the frequency range from a few hertz to the lower megahertz region. Operation over the full ocean water column depth should be covered. Element interaction is an important topic, as is equivalent-circuit techniques. The book needs to cover transducers for sonar systems and for research purposes.

The Committee does not believe that a book of this type exists. There are several books available on the theory of transducers, and many books treat transducers to some extent, but the primary missing elements are (1) detailed design procedures and (2) construction techniques and materials. Several of the books in preparation (see Appendix H) deal with transducers (e.g., Hanish; Wilson; Woolett) and should be useful; but to the limited extent that we understand their coverage, we doubt that they (even in combination) will completely satisfy the perceived need of the sonar community.

This book on transducers is the highest-priority recommendation of the Committee.

Transducer Arrays: Beamforming, Steering, and Scanning

This recommended book is intended to be a companion to the transducer book and could be considered a part of the same book. There was strong survey support for this type of book (24 recommendations). Arrays are critical components of all sonar systems and of most experimental/research equipment. The book should provide a detailed coverage of array design, beamformation, steering, and scanning. It should cover both analog and digital implementations; both phase-shift and time-delay methods; and line, planar, cylindrical, spherical, and conformal configurations. Aperture shading is also an important topic. The nonlinear parametric arrays, both transmitting and receiving, should be covered, as should the effect of the environment on array performance. Coherence of the wave front across an array should be considered. The coverage should range from low-frequency arrays for surveillance (fixed and mobile) to high-frequency arrays for mine classification. Array elements should include active units, reflectors, lenses, and horns. To be complete, the book should cover theory, design procedure, and construction practice.

In the radar field there are a number of excellent books that treat radar antennas and arrays, and the theory of arrays is essentially the same for both radar and sonar. Currently, the sonar community makes heavy use of these

books. However, because there are important differences in implementation of array theory between radar and sonar, the Committee believes that the sonar community needs its own book. Several of the acoustics books cover arrays but not in much detail. We are not aware of any existing book that has the coverage of the book recommended.

The Committee places this book in the nigh-priority category. It likely will need to be written by a team of authors with a good editor and editorial board.

Sonar System Design

A significant fraction of the sonar R&D community is involved in sonar system design and engineering, yet no existing book treats this topic in a uniform and organized manner. There are, however, a number of such books for the radar field, and some of these could serve as models for the sonar book. It should cover the fundamentals of design, concept formulation, parameter studies, etc. It must include some treatment of all the system elements, such as transducers, arrays, signal processing, displays, and human factors. It should be both general and detailed in that it should be useful to those that must design a wide variety of sonars: active and passive, low frequency and high frequency, low and high resolution, small and large systems.

The survey gave strong recommendations for this type of book, and the Committee does the same. Urick's Principles of Underwater Sound touches on this topic in various places, but it is not a systems engineering book. This book might be written by a single author, but it might be more feasible to organize a team of authors. However, it is essential that the end product be a unified treatment.

Sonar Applications and Systems

A number of survey respondents recommended individual books, each treating a special sonar application (e.g., 1 of the 22 items under part I-D of the survey form) while several recommended a single volume with a chapter devoted to each of the applications. The Committee believes that the latter recommendation is the most feasible. Some of the topics might justify a full-length book treatment but many do not. Yet there is a need to summarize the state of development for these various applications. We do not believe that any suitable book exists that does this.

It is recommended that a book be developed in which a chapter, written by a specialist in that area, would be devoted to each of the major sonar applications (e.g.,

active ASW sonar, submarine passive sonar, torpedo sonar, minehunting sonar, etc.). The aim would be to provide the reader with a survey of the field in each application. It should be especially useful to newcomers and to those who have a broad responsibility in the application of sonar. Each chapter should include a bibliography of important references.

It will be important to have a good editor and editorial board. Each chapter should be critically reviewed by several experts in that field.

The matter of security classification is important for this book. Much of the material would be unclassified but, clearly, for some applications much will be classified. One might have both an unclassified edition and a classified edition. Another approach would be to have a stand-alone classified volume and a supplemental classified document (perhaps part CONFIDENTIAL and part SECRET) that would not stand alone in that it would not repeat material from the unclassified volume.

The Committee believes that this book, in combination with the sonar system book, the transducer book, and the array book, will serve to cover the applications areas adequately.

The Physics of Underwater Sound

The survey yielded a number of recommendations for books dealing with fundamental ocean acoustics, especially variability of the medium, effects of the environment, etc. The Committee has reviewed these recommendations and compared them with material in existing books. Its conclusion is that a gap does exist and that the community would be well served by a unified treatment of the physics of underwater sound. Urick's excellent book does not include much theory (it was not intended to do that). It is proposed that this new book would complement Urick's book. It should meet the need for a good general textbook in underwater acoustics. It should be a practical book in that the level of treatment should not be so advanced as to be useful to only a small fraction of the community, and it should place special emphasis on sound in the real ocean where variability and fluctuations are the norm.

The Committee places this book in the high priority category.

Sea Tests: Planning, Design, Operation, and Analyses; Statistical Design and Analysis

Sea tests and experiments are an extremely important part of underwater acoustics research and development.

They are expensive, and thus each exercise should be successful and should produce the maximum amount of useful data. Most people who plan and execute sea tests have to learn the hard way--by experience, perhaps supplemented by personal communications. At least two groups gave a strong recommendation for a practical book on how to plan, design, and conduct sea tests. The Committee concurs with this recommendation. The book should include as much practical information and advice as feasible. Examples and case histories should be included. Equipment should be discussed. Types of sea tests should include basic research experiments and equipment evaluation.

Other respondents suggested the need for a practical book on probability and statistics for underwater acoustics applications. A large number of books have been written on probability and statistics, but many acousticians have had little formal education in these subjects and have difficulty in interpreting the literature for this application. The Committee believes that this subject area can and should be included as a major section of the book on sea tests. Statistical design should be an important aspect in planning at-sea tests, and statistical analysis is needed for processing and interpreting the data.

Oceanography for Underwater Acousticians

Obviously, oceanography and underwater acoustics are closely related, but many acousticians have little formal education in oceanography. The more they know about oceanography the better they can do their work. There are a host of excellent books on oceanography, but most underwater acousticians and sonar developers do not have or do not take the time to digest the published material. One respondent recommended a book entitled "What Every Underwater Acoustician Should Know About Oceanography," and a Committee member quipped that the title should be expanded to include "And No More." The Committee believes that this type of book would be very useful to the community and recommends it in the spirit of improving the efficiency and quality of the R&D program. This book should include fundamentals and should cover the areas of physical, geological, biological, and chemical oceanography, keeping in mind that the intended audience is the underwater sound community.

Computer-Aided Detection and Classification; Artificial Intelligence; Man-Machine Interfaces; Interactive Displays

There is a present and growing large body of literature on these subjects and progress is rapid. It is the Committee's opinion that the underwater acoustics community is not fully aware of these developments and their potential and is not taking advantage of them. It is felt that a unifying book, written with the sonar developer in mind as the audience, would well serve to bridge the communication gap.

Three Recommended Compendia

The preceding eight recommendations have called for the writing of new books. Another approach is to collect selected published journal papers and publish them in a single volume. We refer to such a collection as a compendium; the term "source book" is also used. Publishing a compendium generally requires less effort and is less expensive than publishing a totally new book. The Benchmark Series in Acoustics is an example of this type of publication (and one volume deals with underwater acoustics); the Institute of Electrical and Electronics Engineers (IEEE) has a series of such books. There are a number of topics in underwater acoustics for which it would be feasible to prepare compendia. The Committee feels that for three topics the compendium form of publication would be appropriate and useful. These deal generally with ocean acoustics.

Shallow Water Acoustics

Interest in shallow water acoustics has waxed and waned several times during the post-World War II period, and its popularity seems to be on the increase at the moment. The Committee considers it to be an important and timely topic and believes that a number of valuable papers (from journals and symposia proceedings) exist, which, if compiled into a single book, would be very useful to the community. Shallow water has various meanings, but in general we consider the water to be shallow (from an acoustics viewpoint) if the interaction of the sound with the ocean floor is a significant factor.

Arctic Acoustics

As with shallow water acoustics, interest in arctic acoustics seems to fluctuate with time. However, it is generally agreed that the arctic is an area important to the Navy and its true importance is likely to increase. Through the years a number of good papers have been published on the subject (in journals and in symposia proceedings) and the Committee recommends that a select group of the most important ones be collected and reprinted in book form.

Radiated Noise

Clearly, this will be a classified document if it is to be of real value to the underwater sound community. This is a very important topic, and the Committee believes that a compendium of existing papers would be useful to the sonar community.

Some General Comments on Compendia

There are other topics for which a compendium would be a useful addition to the literature and for which suitable papers exist; the three listed above are considered by the Committee to be the most important ones, but we do not intend to discourage other collections. There are also a number of examples of special issues of journals being devoted to a single topic. Some of these might be considered for republication. In general, a compendium is not likely to be as useful as a unified book on the same topic, but it has some compelling advantages in terms of feasibility.

Several Miscellaneous Documents

Listed below are several recommended documents that are of a different nature than those discussed earlier. In one sense, these are of lower priority, since the material already exists; but in another sense, they are important because they can be very useful and can save researchers a great deal of time. The cost to develop these documents should be modest.

Catalog of Navy and Commercial Sonar Equipment

A number of respondents commented on the value of such a catalog. Its primary value is in saving time. Such catalogs have existed in the past, and the Committee recommends that the information be updated and expanded to include civilian sonar as well. The binding should be such that new material can be inserted as it becomes available. It would probably be necessary to have both classified and unclassified volumes.

Patent Abstracts

Patents form an important and often neglected part of the scientific and engineering literature. A study of patents can provide new ideas on how to develop a device or system, may trigger yet other inventions, and may prevent reinventions. A regular feature of the Journal of the Acoustical Society of America is a section on patent reviews; typically, about two pages per issue relate to underwater sound devices. A reprint of selected underwater sound-related devices (a compendium) would seem to be a useful document. The ASA might be receptive to publishing such a compendium if the Navy would agree to purchase some minimum number of copies.

Bibliographies, Glossaries, and Dictionaries

Good selective bibliographies are always valuable. A complete (unannotated) bibliography of all reports, papers, and books on underwater sound would be voluminous and probably would find little use. One group of respondents recommended that for each subtopic of underwater acoustics a selected bibliography of key articles, reports, and books be developed and published. A newcomer to the field would then have only a manageable number of documents to digest to "get up to speed." Such a set of bibliographies should be valuable to librarians who face a difficult problem in deciding which documents they need in order to meet the requirements of their clients. The Committee considers this to be a good concept and recommends implementation.

The booklist developed in the course of this study is a useful bibliography and we recommend that it be published and distributed as a separate document. Numerous respondents commented on the value of this list.

Every field of science and technology has its own set of special terms, acronyms, etc., and underwater acoustics is no exception. Frequently in meetings one may have dif-

ficulty in following the discussion because of not knowing the meaning of numerous acronyms. A collection of such terms, together with brief definitions or explanations, would be a useful document. It would need to be loose-leaf and to have blank pages for each user to add terms.

A Definitive History of Underwater Sound and Sonar

The value, importance, and impact of a good definitive history for any field of science or technology should not be underestimated. Such histories serve to interest new people in a field and educate newcomers (and old timers). They are valuable reference documents. We are all better off if we have some perspective on the historical development of our field of interest.

Such a book does not exist for the subject of sonar and underwater sound. A number of individuals have written memoirs or covered selected aspects (e.g., Marvin Lasky, A. B. Wood, Elias Klein, F. V. Hunt, and others) and the Red Books contain much of interest, but the definitive history has yet to appear. The ideal author should be a skilled historian of science, an expert in the field, a good writer, old enough to personally remember many of the events, and young enough (and energetic enough) to finish the book. We may have to settle for something less than the ideal. Some oral histories (recordings) should be collected before it is too late. A collection of histories of individual groups might be one feasible approach. To be complete, developments in other countries should be included. A compendium of existing papers would be of considerable interest and is entirely feasible.

Topics for Which No New Books are Recommemded

It is obvious that the 15 new books recommended do not cover in depth all of the areas of underwater acoustics and applications. The Committee did not make recommendations of new books for these areas (some of which received a significant number of recommendations from the survey respondents; see Appendix I) because (1) it was felt that suitable books exist and/or (2) books are in preparation that may well satisfy the need. However, some of these topics deserve some brief discussion.

Ocean Acoustics

The recommended new book, Physics of Sound in the Sea, should fill much of the need in this area. Further-

more, there are several books in preparation that may cover this area quite well (see Appendix I). These include books in preparation by Dyer, Uses of Sound in the Sea, and Boyles, Lectures on the Theory of Acoustic Propagation in the Ocean. Urick is close to publication of a book on ambient noise in the ocean, and Ross has a set of reports in this area. We understand that Newbauer's book, Target Strength and Echo Structure, is also close to publication. Also there already exist several good books which deal heavily with propagation, scattering, and reverberation. We do note, however, that a compendium of recently published papers on underwater sound propagation might be feasible and would complement the recommended compendia on shallow water acoustics and arctic acoustics.

Signal Processing

Although there were a number of recommendations for books on signal processing, we find it difficult to justify a recommendation for a new one in view of the very large number of books that already exist on this subject and because at least two new books are in preparation (by Winder and Stocklin and by Unkowitz).

MISCELLANEOUS TOPICS RELATED TO NEW BOOKS

Military Security Classification

Clearly, the subject of underwater acoustics and sonar involves material that should and must be classified. Equally clear is the fact that security classification hampers the dissemination of information even among those who are qualified to receive such information. In a closed society or in a very small country where all of the R&D in a particular subject is done in a single activity, there is little reason to assimilate technical information and publish it in an open format. In the United States, however, the R&D program in underwater acoustics is both large and diffused. It is conducted in Navy research centers, in university research centers and academic departments, and in a host of industrial organizations. Communication of the results of R&D from the performer to the many groups who have an interest in them is a major problem, and failure to communicate results means less than full use of them. The distillation of the products of R&D into concise forms such as books and journal papers is a proven, effective means of communication. It is a recognized fact that obviously, if the publications are in the public domain, the communication reaches both friend and (potential) foe.

When we publish books, the USSR makes good use of them. When the USSR publishes books (and they do), we make good use of them (in English translation). The question is whether we gain more than we lose when we publish a book in an area of military interest. It is assumed that we will not publish anything that is of such recognized sensitivity as material on radiated noise levels of our submarines, detection ranges, or a host of similar topics or anything that is considered a real breakthrough in science or technology. With that caveat, the Committee believes that the U.S. Navy will gain more than it will lose by the publication of the recommended books. Some of those recommended will be classified, but most should not be. In several instances it seems reasonable to have a classified and an unclassified version. It is our belief that the best procedure is to write a good book covering the topic in an organized, logical manner and then to review the book and delete those parts that should clearly remain classified. The deleted portions can be published separately.

In brief, we believe that the best way to maintain advantage and true security is through rapid and significant progress. Intended or not, this has been and is the policy in some other fields, for example, radar.

Categories of Publishers

There is a variety of types of publishers that should be considered if the Navy elects to sponsor some or all of the recommended books.

Commercial publishing houses come to mind first since they are professionals in the field. In general, the products are of high quality, the availability of the books is widely advertised, and the books are kept in stock for a number of years. Commercial book prices, however, tend to be rather high.

The Government Printing Office is a viable and often appropriate choice. Again, the quality is high and the unit cost typically is less than for commercial publication. Advertisement usually is at a lower level than for commercially published books, but our survey results indicate that books published by GPO are well known in the community.

Some nonprofit publishers to be considered include the U.S. Naval Institute, the National Academy Press, and university presses. Professional societies also should be considered. As noted in this report, The Acoustical Society of America has a book reprinting program, and the IEEE has a compendium publication program.

Regardless of the choice of publisher, we recommend that the Navy agree to purchase some minimum number of any of the books it sponsors and to distribute them to the var-

ious research centers and offices that perform R&D for the Navy. This will ensure that the books reach those people who should make use of them.

Unfinished Work

It should come as no surprise that the Committee did not accomplish all the tasks that had been planned for this phase of the literature survey. We comment on three of these.

Scientific and Technical Reports

We do not feel that we have made a very thorough survey of scientific and technical reports to identify those of a broad summary or tutorial nature. Some 140 reports were listed by respondents, but we believe they represent only a small fraction of the reports in existence. The Committee has not made the effort to examine these reports in detail, but it is clear that many of them are of the type we sought to identify. A broader distribution of these reports would be a service to the community. Reprinting would be required in most instances.

As noted earlier, we recommend that a more thorough search be made of the report literature and that a listing of those selected (after careful screening) be widely distributed to members of the underwater sound community. The titles should be grouped by topic, and there should be at least two lists, one for unclassified reports and one for classified documents.

Survey of Journal Articles and Symposium Papers

A survey of the journal literature was not included in the original plans of the Committee, but such a survey would be useful. This could best be done by organizing a small ad hoc group for each major topic area to survey the journal publications, both U.S. and foreign (there probably are no more than a dozen relevant journals), and the proceedings of several symposia series. The results of this work could be used in at least two ways. First, this could be the basis for preparation of selective bibliographies (as recommended earlier), and second, it could be the basis for selecting papers to be included in compendia.

Detailed Description of Recommended Books

For several reasons the Committee has chosen not to provide an in-depth description of each of the recommended books, nor are recommendations made for authors of these books. If the Navy should elect to sponsor the preparation of the recommended books, we recommend that a small editorial advisory board be established for each book. These boards, comprising specialists in the field, would first develop detailed outlines for the books, collect a bibliography, decide on format, and select authors. Subsequently, they would monitor the progress of the work, review the material at appropriate times to ensure that the products will meet the intended goals, and review the final manuscripts.

4 CONCLUDING REMARKS

The Committee believes that the magnitude and nature of the responses to the survey indicate a high level of interest by the underwater sound community in this project. We believe that the results of the survey will be of interest and value to the community. The revised and expanded list of books, together with the list of reports, should be useful to individuals and valuable additions to their technical libraries.

The Committee concludes that a group of new books would significantly improve the efficiency and quality of the R&D program. This conclusion is based on the survey responses and on analysis and study by the Committee. The modest list of recommended books, when combined with existing books and those in preparation, will provide an adequate set of reference documents for the field of underwater acoustics. In fact, this combination would be comparable to an updated version of the Red Books, which many respondents seem to want.

The total cost of writing and publishing a series of books should be but a tiny fraction of the annual R&D budget for underwater acoustics, and the Committee believes that the cost would be greatly outweighed by the benefits. Monetary cost is not the problem, however, and neither is the identification of needed books. The major and crucial problem will be to identify appropriate authors and to make arrangements enabling them to have the time necessary to write the books in timely fashion. This is no small obstacle and it is one reason why compendia have been recommended wherever they seem to be acceptable.

The submission of this report concludes work on the task assigned to the present Committee, but the report itself is merely the first phase of a broader task. The Committee seeks feedback both from the Navy sponsors and the underwater sound community. Some may well take issue with specific recommendations of the Committee, but perhaps the results of the survey together with the discussion in the report will generate interest and activity in book preparation, whether or not the books are exactly in line with the recommendations. If this proves to be the case, the Committee will feel its efforts have been worthwhile.

The original survey responses contain much useful information that does not appear explicitly in the report. This is a useful data base, and it will be retained in the NSB files for use by any who may be involved in subsequent phases.

APPENDIX A

THE SURVEY QUESTIONNAIRE

Cover Letter
Instruction Sheet
Part 1--Topical Outline
Part 2--Open Ended Questions
Book List

September 21, 1982

Dear :

Since the close of WWII the U.S. Navy and other agencies of the government have sponsored a great deal of research and development relating to underwater acoustics and sonar. The primary form of documentation of the results of this large volume of work has been the scientific or technical report. Such reports typically had a very limited initial distribution and after a lapse of time they often are difficult to retrieve. As a result, other (and later) workers often are not aware of the prior work and thus do not make use of it or repeat it.

In recognition of this situation, the U.S. Navy has asked the Naval Studies Board (NSB) (an activity of the National Academy of Sciences: National Research Council) to survey the community concerned and to recommend summary books and/or other actions which would contribute to the efficiency and quality of the Navy's research and development program. The NSB has established this Committee on Navy Scientific and Engineering Literature which seeks your help in carrying out this task.

The committee feels that it is essential to have specific inputs from a broad spectrum of the current underwater acoustics community, through the means of a fairly detailed questionnaire (Attachment One). Following a careful analysis of the responses, the committee should be able to make prompt and practical recommendations to the Navy.

The first product of the survey will be to identify a "library" of books on underwater acoustics which summarize (and distill) the useful work of the past several decades. Some of the components of this library already exist but others may have to be prepared. The primary anticipated user of the library would be the scientists and engineers who perform research and development for the U.S. Navy, but others (managers, students et al.) also should find it of value. The aim of such a library is to provide information in adequate detail so that it will not be necessary for the worker to resort to large numbers of specialized original reports. In particular, it is believed that such a library would be of enormous value to those newly entering this field.

The committee is fully aware of the important restriction of military security classification. Some of the recommended documents will likely have to be classified and bound separately.

In responding, we urge that you duplicate the survey questionnaire (in the number needed) and distribute them to a representative cross-section of your professionals working in the field of underwater acoustics. A sample of at least 10 percent of these staff members would be appropriate. We suggest that it is important to obtain responses both from senior as well as junior staff since the latter likely will be the primary beneficiaries of the "library." The completed forms should be returned to you for submission as a packet to the Naval Studies Board together with your own views both as an individual and, if appropriate, reflecting your laboratory or group. In particular, we would appreciate your guidance to the committee on priorities and the form (i.e., surveys, reviews, handbooks, single author or multi-author commissioned volumes, etc.) to which a new publication program might be responsive, as well as those individuals who should be enlisted in this effort.

Needless to say, we are depending heavily on your interest and support and, of course, your reasonably prompt response. In the interim, please do not hesitate to call me if any questions arise in the preparation of your response.

We strongly urge you and your staff to participate in this survey. We repeat that your response is essential.

Sincerely,

Chester M. McKinney
Chairman
Committee on Navy Scientific
and Engineering Literature

Enclosures

ATTACHMENT ONE
September 21, 1982

SURVEY OF UNDERWATER ACOUSTICS SCIENTIFIC AND ENGINEERING LITERATURE

Please Return To:
Naval Studies Board
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418
By: October 25, 1982

NAME:_____ TITLE:_____

ORGANIZATION:_____

ADDRESS:_____ TELEPHONE:_____

HIGHEST ACADEMIC DEGREE:_____ NUMBER OF YEARS IN THIS FIELD:_____

INSTRUCTIONS

(Suggestion: If you have only a very limited amount of time to devote to the completion of this survey, please concentrate on your primary field of interest.)

"Level of Interest" Column; Part I:

Identify your interest in each subfield according to:

1. Main line of your work.
2. Closely related to your work.
3. Loosely related to your work.
4. Unrelated but of interest.
5. No interest.

"Listed" Column; Part I:

Enter the sequence number(s) of references from the attached list (Attachment Two) which you consider to be significant for the subfield.

"Unlisted" Column:

In Part II-A, list additional (existing) reference books which you feel should be included on the list, using the continuation of the numerical sequence. Insert these numerical sequence identifiers in the "Unlisted" Column of Part I.

"Needed" Column:

In part II-E, list new books which you believe are needed but are not now available using a Roman numeral sequence. Insert these Roman numeral identifiers in the "Needed" Column of Part I.

Part I

UNDERWATER ACOUSTICS - TOPICAL OUTLINE

UNDERWATER ACOUSTIC SUBFIELD	Level of Interest	References		
		Listed	Unlisted	Needed
A. OCEAN ACOUSTICS				
1. Fundamentals. Wave Equation, Reflection, Refraction, Diffraction, Speed of Sound, Absorption.				
2. Wave Propagation. Ray and Normal Mode, Shallow and Deep Water, Reflection at Boundaries, Various Channels, Models, Arctic Propagation.				
3. Reverberation. Volume, Bottom, Surface.				
4. Masking Noise. Ambient Noise, Self Noise, Self Noise Reduction.				
5. Radiated Noise from Ships, Submarines and Aircraft. Radiated Noise Reduction.				
6. Target Strength and Echo Structure.				
B. SOUND SOURCES AND SENSORS				
(Principles, Design, Fabrication, Limits) 1. Reciprocal. (Piezoelectric, Magnetostrictive, Electrodynamic, Reflectors, Horns, Lenses.)				
2. Nonreciprocal. (Explosives; Air Guns, Gas Guns, Arcers, Sparkers, Thumpers, Electromechanical, Hydrodynamic, Lasers.)				
3. Nonlinear Parametric Arrays.				
4. Transducer Test Equipment, Facilities and Techniques.				
C. SIGNAL PROCESSING				
1. Spatial Arrays. Beamforming, Beam Steering, Beamscanning. Time Delay and Phase Shift. Design and Materials. Monopulse Arrays. Passive Ranging.				
2. Temporal Processing. Modulation, Detection, Correlation, Spectral Analysis.				
3. Decision Criteria. Recognition Differential, Detection/Classification/Identification. Aural Detectability.				
D. SONAR SYSTEM DESIGN AND ANALYSIS				
1. General (All Applications).				
2. Active Sonar for ASW.				
3. Passive Sonar for ASW and SSW.				
4. Fixed Surveillance (Active and Passive).				
5. Towed Line Arrays.				
6. Sonobuoys.				
7. Depth Sounders, Bottom Mapping Sonar.				
8. Minehunting Sonar.				

UNDERWATER ACOUSTIC SUBFIELD	Level of Interest	References		
		Listed	Unlisted	Needed
D. SONAR SYSTEM DESIGN AND ANALYSIS (Continued)				
9. Torpedo Sonar.				
10. Torpedo Detection sonar.				
11. Swimmer Detection Sonar.				
12. Diver Carried Sonar.				
13. Acoustic Mine Mechanisms.				
14. Acoustic Minesweeping Devices.				
15. Underwater Acoustic Communications Devices.				
16. Test Equipment and Techniques.				
17. Beacons, Transponder, Echo Repeaters.				
18. Test Equipment and Techniques.				
19. Data Recording.				
20. Sonar Electronics				
21. Sonar Mechanical Design				
22. Acoustic Countermeasures				
(Deception, Jamming, etc.).				
E. DISPLAYS AND OPERATOR INTERFACES				
1. Man-Machine Interface.				
2. Interactive Data Display.				
3. Computer Aided Detection and Classification				
4. Artificial Intelligence.				
F. PERSONNEL TRAINING (INCLUDING EQUIPMENT)				
G. MISCELLANEOUS				
1. Patent Abstracts for UWS Device.				
2. Computer Programs for UWS Calculations, Data Processing, etc.				
3. Acoustical Structures. Baffles, Domes, Absorbers, Reflectors, etc.				
4. Catalogue of Navy Sonars and Other Underwater Sound Devices.				
5. Catalogue of Commercially Available Underwater Sound Equipment.				
6. Bibliographies.				
7. Dictionary of UWS Terms, Acronyms, Projects, etc.				
8. History of Underwater Sound and Sonar.				
9. Animal Sonar. Porpoise, Bats.				

PART II

Please make your responses to the topics listed below on this sheet. Attach additional sheets as necessary. Please separate your responses by using the same sequence as this list.

A. Additions and corrections to the list of Underwater acoustics Books (see Attachment Two).

B. Books which you know to be under preparation. (Author(s), titles, brief description, and status.)

C. Published books now out of print which should be reprinted. Identify with an * those which should be updated prior to republication. (List only the sequence number of the book from Attachment II.)

D. Scientific and technical reports of a summary or tutorial nature which would be of general interest to the underwater sound community. Flag with ** those reports which (perhaps with some revision, additions, etc.) would be suitable for publication as books.

E. Recommendations for topics for books <u>new</u> needed (with <u>brief</u> description). Suggestions for author(s) or editor(s) would be appreciated.

Please make your response on this page and the reverse side. Attach additional sheets as necessary.

ATTACHMENT TWO

LIST OF PUBLISHED BOOKS AND MONOGRAPHS RELATED TO UNDERWATER ACOUSTICS

Most of the books listed deal with underwater acoustics; however, a very selected number of books on general acoustics and specialized topics are included. Also a few technical reports are listed.

1. Aigner, F., Unterwasserschalltechnik; grundlagen, ziele und grenzen, submarine akustik in theorie und prazis, M. Krayn, Berlin, 1922.

2. Albers, V.M., Underwater Acoustics, Vol. II, Proceedings of an Institute sponsored by the Scientific Affairs Committee of NATO and conducted by The Pennsylvania State University at The Technical University of Denmark, Copenhagen, Denmark, Plenum Press, New York, 1967, 25 July - 6 August 1966, 416 pp.

3. Albers, V.M., (Ed.), Underwater Acoustics, Plenum Press, New York, 1963.

4. Albers, V.M., Underwater Acoustics Handbook, Pennsylvania State University Press, 1960, 290 pp.

5. Albers, V.M., Underwater Acoustics Handbook II, Pennsylvania State University Press, 1965, 356 pp, $19.50.

6. Albers, V.M., Underwater Sound, Halsted, 1972, 468 pp, $22.00.

7. Albers, V.M., (Ed.) Underwater Sound, Dowden, Hutchingon, and Ross, Stroudsburg, Pennsylvania, 1972, 480 pp, $20.00.

8. Anan'eva, A.A., Ceramic Acoustic Detectors, Plenum Press, New York, 1970, 171 pp, $29.50. Also Consultants Bureau, New York, 1965.

9. Anderson, N.R. and Zahuranec, B.J., (Eds.), Oceanic Sound Scattering Prediction, Plenum Press, New York.

10. Andreeva, I.B., Physical Principles of Sound Propagation in the Ocean, in Russian, Gidrometeoizdat, Leningrad, 1975.

11. Anon., Echo Sounding and Sonar for Fishing, prepared by Food and Agriculture Organization of the United Nations, Fishing News Book Ltd., Surrey, England, 1980, 104 pp, $16.20, paper.

12. Anon., An Introduction to Echo Sounding, ELAC Corp., Kiel, 1965, 146 pp.

13. Anon., (SIMRAD Staff), Fish-Finding with Sonar, Simonsen Radio AS, Oslo, 1965, 96 pp.

14. ANSI, American National Standard Procedure for Calibration of Underwater Electroacoustic Transducers, ANSI SI.20 - 1972 (R1977), 40 pp, $7.00, available from The Acoustical Society of America.

15. Azhazha, V.G. and Shishkova, E.V., Fish Location by Hydroacoustic Devices, translated from Russian by J. Flancreich, Israel Program for Scientific Translations, Jerusalem, 1967. Available from the U.S. Department of Commerce, Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia.

16. Bachmann, W. and Williams, R.B., (Eds.), Ocean Acoustic Modeling, SACLANTCEN CP17, Pts 1-8, 1975.

17. Bark, L.S., Banson, P.P., and Meister, M.A., Tables of the Velocity of Sound in Sea Water, Macmillan, New York, 1964.

18. Barkhatov, A.N., Modeling of Sound Propagation in the Sea, translated from Russian by James S. Wood, Consultants Bureau, New York, 1971.

19. Bartberger, C.L., Technology of Underwater Sound, Naval Air Development Center.

20. Bass, F.G. and Fuchas, I.M., (USSR), Wave Scattering from Statistically Rough Surfaces, translated and edited by C.B. Vesecky and J.F. Vesecky, Pergamon Press, 1979, 536 pp, $75.00.

21. Basset, A.B., Treatise on Hydrodynamics and Sound, 2nd Ed., 1900.

22. Beranek, L.L., Acoustics, McGraw-Hill, 1954.

23. Beyer, R.T., Nonlinear Acoustics, Naval Sea Systems Command, 1974.

24. Bjornio, Leif, (Ed.), Underwater Acoustics and Signal Processing, Proceedings of an Institute, Copenhagen, Denmark, August 1980. NATO Advanced Study Institute, Series C, Vol. 66, Reidel, Boston, 1981, 736 pp, $87.00.

25. Blake, W.K., Mechanics of Flow-Induced Vibration and Sound, Academic Press, New York, 1982.

26. Blokhintsev, D.I., Acoustics of Nonhomogeneous Moving Media, Translated from Russian, N.A.C.A. Tech Memo 1399, 1956.

27. Bobber, Robert J., Underwater Electroacoustics Measurements, Naval Research Laboratory, Washington, D.C., 1970, available from Superintendent of Documents, U.S. Government Printing Office, $3.00, cloth.

28. Bogorodskii, V.V., (Ed.), Radiophysical Methods of Research in the Arctic Ocean and Antarctica, 1968. English translation by Israel Program for Scientific Translations for National Science Foundation, Washington, many acoustic articles, 1970.

29. Bowman, J.J., et al., (Eds.), Electromagnetic and Acoustic Scattering by Simple Shapes, American Elsevier Publishing Co., New York, 1969.

30. Brekhovskikh, L.M., (Ed.), Ocean Acoustics, Nauka, Moscow, 1974. Partial translation JPRS-64008-1 and 2, January 1975.

31. Brekhovskikh, L.M., Waves in Layered Media, translated from the Russian Edition, Moscow, 1973, by Robert T. Beyer, Academic Press, New York, 2nd Ed., 500 pp, $58.00.

32. Budden, K.G., The Waveguide Mode Theory of Wave Propagation, London, Logos Press, 1961. (Academic Press?)

33. Burczynske, J., Introduction to the Use of Sonar Systems for Estimating Fish Biomass, Food and Agriculture Organization, United Nations, 89 pp.

34. Camp, L.W., Underwater Acoustics, Wiley-Interscience, New York, 1970, 308 pp.

35. Carlin, B., Ultrasonics, McGraw-Hill, 1960.

36. Caruthers, J.W., Fundamentals of Marine Acoustics, Elsevier Scientific, 1977, 154 pp, $28.00.

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Vol. 3: A Summary of Antisubmarine Warfare Operations in World War II, 193 pp.
Vol. 4: Methods and Devices Developed for the Selection and Training of Sonar Personnel, 235 pp.
Vol. 5: Magnetic Airborne Detector Program, 152 pp.
Vol. 6A: The Application of Oceanography to Subsurface Warfare, 106 pp.
Vol. 6B: Methods of Submarine Buoyancy Control, 81 pp.
Vol. 7: Principles and Applications of Underwater Sound, 295 pp.
Vol. 8: Physics of Sound in the Sea, 566 pp.
Vol. 9: Recognition of Underwater Sound, 281 pp.
Vol. 10: Basic Methods for the Calibration of Sonar Equipment, 175 pp.
Vol. 11: A Manual of Calibration Measurements of Sonar Equipment, 362 pp.
Vol. 12: Design and Construction of Crystal Transducers, 395 pp.
Vol. 13: The Design and Construction of Magnetostriction Transducers, 487 pp.
Vol. 14: Underwater Sound Equipment I - Listening Systems, 210 pp.
Vol. 15: Underwater Sound Equipment II - Echo Ranging Systems, 237 pp.
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Vol. 17: Underwater Sound Equipment IV - Frequency-Modulated Sonar Systems, 204 pp.
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Vol. 19: Underwater Sound Equipment VI - Countermeasures, 160 pp.
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APPENDIX B

RESPONSE TO THE SURVEY

Questionnaires were mailed to senior individuals (e.g., Technical Directors) at 76 activities. At the time of preparation of this report, responses had been received from 38 activities. There were a total of 263 individual responses.

SURVEY RESPONSES

A.	Navy Laboratories	
	1. NRL (Washington, DC)	31
	2. NRL/USRD (Orlando, FL)	5
	3. NOSC (San Diego, CA)	19
	4. NADC	12
	5. DTNSRDC	21
	6. Naval Oceanographic Office	5
	7. NORDA	4
	8. Naval Postgraduate School	6
	9. ONR	9
	10. Naval Surface Weapons Center (White Oak, MD)	2
		114
B.	University Laboratories	
	11. ARL:PSU	5
	12. APL:UW	5
	13. APL:JHU	10
	14. ARL:UT	13
	15. Florida Atlantic University - Blaine Davidson	1
	16. Catholic Univeristy - Bob Urick	1
	17. MIT - Ira Dyer	1
	18. University of Wisconsin - C. S. Clay	1
	19. Rensselaer Polytechnic	5
		42
C.	Industry	
	20. Bell Laboratories (Whippany, NJ)	29
	21. Raytheon (Portsmouth, RI)	11
	22. Tracor (Austin, TX)	12
	23. Tracor (Rockville, MD)	6
	24. TRW	9
	25. EG&G (Washington, DC)	9
	26. MAR	3
	27. Technology Service Corp (5 NUSC students)	6
	28. Honeywell (Seattle, WA)	5
	29. IBM (Manassas, VA)	3
	30. Magnavox	1
	31. Presearch	2
	32. DONANCO (Don Ross)	1
	33. Cambridge Acoustical Associates	2
	34. International Transducer Corporation	1
	35. Arthur D. Little	1
	36. Image Acoustic	1
	37. Underwater Systems, Inc.	2
	38 Sanders	3
		107
	Grand Total	263

NO RESPONSE

A. Navy Activities
   1. NCSC (Panama City, FL)
   2. DARPA (Arlington, VA)
   3. NUSC (Newport, RI)
   4. NUSC (New London, CT)
   5. NSSC - Information Only (Washington, DC)
   6. NESC - Information Only (Washington, DC)

B. Universities and Nonprofit Activities
   1. MPL/SIO (San Diego, CA)
   2. SIO (San Diego, CA)
   3. WHOI (Woods Hole, MA)
   4. University of Miami (Miami, FL)
   5. Yale University (New Haven, CT)
   6. Lamant-Doherty Geological Observatory (Palisades, NY)
   7. University of Rhode Island (Kingston, RI)
   8. Palisades Geophysical Institute (Miami, FL)
   9. Institute for Defense Analyses (Alexandria, VA)

C. Industry
   1. Institute for Acoustical Research (Miami, FL)
   2. Chesapeake Instrument Division, Gould (Glen Burnie, MD)
   3. Edo Corporation (College Point, NY)
   4. Hydroacoustics, Inc. (Rochester, NY)
   5. Bendix Corporation (North Hollywood, CA)
   6. MSB Systems, Inc. (East Westport, CT)
   7. Bolt, Beranek, & Newman (Cambridge, MA)
   8. Gould, Inc. (Cleveland, OH)
   9. Polar Research Laboratory (Santa Barbara, CA)
   10. General Physics Corp. (Columbia, MD)
   11. Hazeltine Corp. (Braintree, MA)
   12. Westinghouse (Annapolis, MD)
   13. Science Applications, Inc. (McLean, VA)
   14. Westinghouse R&D Center (Pittsburg, PA)
   15. Honeywell, Inc. (Hopkins, MN)
   16. Edo Western Corp. (Salt Lake City, UT)
   17. Tetra Tech, Inc. (Arlington, VA)
   18. Human Factors Research, Inc. (Goleta, CA)
   19. Operations Research, Inc. (Silver Spring, MD)
   20. Singer Co., Librascope (Glendale, CA)
   21. General Electric Co. (Syracuse, NY)
   22. Hydroscience, Inc. (Dallas, TX)
   23. Hughes Aircraft Co. (Fullerton, CA)

APPENDIX C

RESPONDENTS' EXPERIENCE AND BACKGROUND

Years of Experience in the Field of Underwater Acoustics

Years in Field	Number of Respondents
0 - 5	59
6 - 10	40
11 - 15	46
16 - 20	42
21 - 25	33
26 - 30	19
31 - 35	12
36 - 40	6
Total	257

Median: 14 years

Academic Background

Degree	Number of Respondents
None	3
BS/BA	53
MS/MA	78
PhD	127
Total	261

Note: Not all respondents provided information on years of experience and academic background.

APPENDIX D

AREAS OF INTEREST OF RESPONDENTS

Explanation of Columns Marked 1, 2, and 3

1. Main line of your work
2. Closely related to your work
3. Loosely related to your work

(The questionnaire had two other categories:

4. Unrelated but of interest, and
5. No interest.

These data have been omitted on the summary sheet.)

Areas of Interest

Topic	Title	1	2	3
A 1	Ocean Ac.- Fundamentals	99	95	46
2	Ocean Ac. - Propagation	86	90	53
3	Ocean Ac. - Reverberation	50	90	75
4	Ocean Ac. - Masking Noise	86	89	45
5	Ocean Ac. - Radiated Noise	83	89	49
6	Ocean Ac. - Test St. & E.S.	50	82	60
B 1	Sources & Sensors - Reciprocal	39	50	65
2	Sources & Sensors - Non-Recip.	16	39	84
3	Sources & Sensors - Nonlinear	17	41	68
4	Sources & Sensors - Test Equip.	27	44	63
C 1	Sig. Proc. - Spatial	105	88	35
2	Sig. Proc. - Temporal	105	77	36
3	Sig. Proc. - Dec. Crit.	82	73	47
D 1	Systems - General	67	82	52
2	Systems - Active ASW	47	65	60
3	Systems - Passive	101	57	44
4	Systems - Fixed Surv	69	60	52
5	Systems - Towed L.A.	64	81	51
6	Systems - Sonobuoys	39	67	64
7	Systems - Depth Sounder	11	47	63
8	Systems - Minehunting	20	39	53
9	Systems - Torpedo	20	36	53
10	Systems - Torp. Det.	14	47	71
11	Systems - Swimmer Det.	7	20	57
12	Systems - Diver	5	17	50
13	Systems - Mine Mech.	6	25	56
14	Systems - Mine Sweep.	6	15	52
15	Systems - Communications	12	36	68
16	Systems - Test Equip.	25	44	46
17	Systems - Beacons	13	29	64
18	Systems - Test Equip	22	37	50
19	Systems - Recording	23	62	65
20	Systems - Electronics	24	48	53
21	Systems - Mechanical	15	35	60
22	Systems - ACM	17	48	67
E 1	Displays - Man/Mac	32	45	52
2	Displays - Interactive	26	46	59
3	Displays - CAD/CAC	51	51	39
4	Displays - Art. Intel.	15	28	52
F	Personnel Training	7	8	25
G 1	Patent Abstracts	3	18	45
2	Computer Programs	41	68	45
3	Acoustical Structure	25	45	63
4	Sonar Catalogs	21	43	64
5	Sonar Catalogs-Communications	11	32	66
6	Bibliographies	22	56	55
7	Dictionary	17	51	69
8	History	15	34	53
9	Animal Sonar	2	16	41

APPENDIX E

SUMMARY OF BOOK CITATIONS

E-1 Summary of Total Citations for each book on the Survey Book List (see Appendix A) for all of the 49 topics. The book number refers to the number on the Survey Book List.

Special Note: On this total summary sheet for Book Nos. 138 and 139 (Urick's Principles of Underwater Sound, First and Second Editions) where the same respondent cited both 138 and 139 for the same topic, only one citation was counted. To do otherwise would have inflated the count.

E-2 Summary of Citations for Each Book by Topic (24 pages).

See Appendix A for full titles and all authors.

See Appendix A for Full Title of each topic.

Special Note: There were several unfortunate errors in the Survey Forms. Under Topics, D-16 and D-18 are the same topics. In the Book List, two books (Whalen and Winder and Loda) both have the same number (145). There were errors in the bibliographic description for several books, which probably caused some confusion.

E-3 Summary of the number of different books cited three or more times for each topic.

APPENDIX E-1

SUMMARY OF TOTAL CITATIONS FOR EACH BOOK

1	2	47	22	93	5	139	276
2	30	48	0	94	19	140	114
3	60	49	48	95	64	141	137
4	47	50	34	96	90	142	109
5	83	51	40	97	19	143	127
6	66	52	31	98	2	144	2
7	33	53	8	99	207	145	104
8	12	54	1	100	14	146	1
9	3	55	0	101	115	147	0
10	9	56	17	102	32	148	3
11	2	57	0	103	17		
12	5	58	2	104	16		
13	2	59	10	105	64		
14	32	60	2	106	34		
15	0	61	0	107	42		
16	16	62	15	108	3		
17	4	63	26	109	9		
18	10	64	27	110	18		
19	94	65	8	111	122		
20	14	66	2	112	7		
21	5	67	31	113	1		
22	28	68	3	114	36		
23	52	69	81	115	17		
24	27	70	118	116	6		
25	25	71	28	117	71		
26	9	72	3	118	9		
27	103	73	35	119	4		
28	0	74	23	120	8		
29	15	75	7	121	5		
30	39	76	117	122	0		
31	114	77	106	123	23		
32	7	78	10	124	1		
33	1	79	10	125	4		
34	40	80	10	126	7		
35	4	81	1	127	2		
36	6	82	40	128	0		
37	3	83	14	129	10		
38	61	84	4	130	10		
39	38	85	27	131	39		
40	4	86	24	132	78		
41	4	87	4	133	31		
42	95	88	15	134	1		
43	27	89	32	135	2		
44	2	90	12	136	21		
45	13	91	15	137	8		
46	9	92	6	138	551		

APPENDIX E-2

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

		Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis												
		Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
1	Aigner	1													1												
2	Albers	10	4	3	6	2	2							1	2												
3	Albers	17	7	5	9	5	4	3	1		1	4			3												
4	Albers	12	7	5	5	5	4	4			1	2			3												
5	Albers	21	3	6	8	7	6	4	3		1	4	2	1	7	2											
6	Albers	26	6	4	5	4	2	2	1			2			6	1	2	1	2	1	1	1	1	1	1	1	
7	Albers	12	4	1	1	1	1	1			1	2			2	1	2	1	2								
8	Anan'eva							11	1																		
9	Anderson		1	1	1																						
10	Andreeva	4	2	1	1						1																
11	Anon.		1								1																
12	Anon.			1			2				1					1											
13	Anon.		1								1																
14	ANSI							4	1		22																
15	Azhasha																										
16	Bachmann	3	7	2	1	1									2												
17	Bark	1	1									1			1												
18	Backhatov	1	3					1																			
19	Bartberger	22	11	6	6	5	4	6	1	1	1	7	1	3	12	3	5			3							
20	Bass	2	5	6			1																				
21	Basset	2		1	1	1																					
22	Beranek	9	2	1				10	2		2																
23	Beyer	7	2						1	39	2											1					
24	Bjornio					1						9	10	4		1			1								
25	Blake	1			7	12			1			1							1								

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous											
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACM	Man-Machine Interactive Data	CAD CAC	Artificial Intelligence			Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal		
1 Aigner																											
2 Albers																											
3 Albers																		1									
4 Albers																		1									
5 Albers						1			1									1									
6 Albers			1																				1				
7 Albers																							1				
8 Anan'eva																											
9 Anderson																											
10 Andreeva																											
11 Anon.																											
12 Anon.																											
13 Anon.																											
14 AMSI				2		2									1												
15 Ashasha																											
16 Bachmann																	1										
17 Bark																											
18 Backhatov																											
19 Bartberger																											
20 Bass																											
21 Basset																											
22 Beranek				1																							
23 Beyer																											
24 Bjornio								1									1										
25 Blake																		2									

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

		Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis												
		Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
26	Bloknintsev	1	2			2																	1	1	1	1
27	Bobber	1	1					21	9		56	1			1					1						
28	Bogorodskii																									
29	Bowman	3				1	9																			
30	Brekhovskikh	20	17	1	1																					
31	Brekhovskikh	41	55	5	2	3	5				1															
32	Budden	1	3																							
33	Burcsynski							1																		
34	Camp	8	3	2	1		2	10			2	2	2	2	5											
35	Carlin	2	1					1																		
36	Caruthers	3	1	1			1																			
37	Caruthers	1						1			1															
38	Chen					1				1	1	4	19	2	3	2	1	1	1	1	1	1	1	1	1	1	1
39	Chernov	9	18	6	1	1	1						2													
40	Clarke	2		1	1																					
41	Clauser				2	1																				
42	Clay	28	26	18	5	1	5		1			2	1		4	2	1	1			1					
43	Cole			1					21	1						2										
44	Coleman																									
45	Cox	3		1								1			7	1										
46	Crandall	3			1	2		1					1													
47	Cremer	1	1		4	9	1	1												1						
48	Cushing																									
49	Dashen	14	28	1								1	1				1	1	1							
50	DeSanto	9	19	4																						

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous									
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACM	Man-Machine	Interactive Data	CAD CAC	Artificial Intelligence		Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal
26 Bloknintsev																									
27 Bobber				4		3	1											2	2						
28 Bogorodskii																									
29 Bowman																		2							
30 Brekhovskikh																									
31 Brekhovskikh																									
32 Budden																									
33 Burczynski																									
34 Camp																									
35 Carlin																									
36 Caruthers																									
37 Caruthers																									
38 Chen	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1		1								
39 Chernov																									
40 Clarke																									
41 Claueer																									
42 Clay																									
43 Cole							1			1															
44 Coleman																		1							
45 Cox																									
46 Crandall																		1							
47 Cremer																		3	1						
48 Cushing																									
49 Dasben																									
50 DeSanto																2									

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis											
	Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
51 Ewing	17	20			2	1	1																		
52 Ewing	9	19	1																						
53 Farquar			6					1																	
54 Federici	1														2										
55 Fish																									
56 Fitzpatrick				6	8			3																	
57 Forbes																									
58 Galway						1		1																	
59 Gerlach											1	5	2												
60 Haines	2																								
61 Haines																									
62 Halley	1			1	2		1						1	1		7	1	1							
63 Hampton	4	16	5					1																	
64 Hanish	4	2	1	2	5		7	1	1			1					1								
65 Harris					3		2								1										
66 Harvard					1									1											
67 Heuter	2	1					16	4		1		1													
68 Hoar																				1	1	1			
69 Horton	2						1			1	22	34	12	2	3	1	1								
70 Horton	20	7	4	4	3	8	8	2	1	2	11	5	2	20	8	6	3								
71 Hunt	2						23	1		1															
72 IUA	2				1																				
73 Junger	8			2	13	5	1																		
74 Keller	8	13			1																				
75 Kellogg																									

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous											
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACM	Man-Machine	Interactive Data	CAD CAC	Artificial Intelligence		Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal		
51 Ewing																											
52 Ewing																							2				
53 Farquar																								1			
54 Federici																											
55 Fish																											
56 Fitzpatrick																											
57 Forbes																											
58 Galway																											
59 Gerlach																											
60 Haines																											
61 Haines																											
62 Halley																											
63 Hampton																											
64 Hanish																		1									
65 Harris									1									1									
66 Harvard																											
67 Heuter																											
68 Hoar																											
69 Horton													1														
70 Horton									1														2				
71 Hunt																							3				
72 IUA																											
73 Junger																		6									
74 Keller																	1										
75 Kellogg																								7			

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

		Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis												
		Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
76	Kinsler	55	16	8	5	3	5	12			1	5		1	2	2	2	1	1							
77	Kinsler	46	14	6	6	4	3	9	1			3		1	2	2	2	2	2	1						
78	Klock	4	1					1				1	1			2										
79	Klyukin				2	8																				
80	Klyukin				2	8																				
81	Krasil'nikov		1																							
82	Kuperman	7	23	9						1											1					
83	Lamb	7	3	1					1							1										
84	Leehey				3	1																				
85	Levi	5	4	10	1	3	1	1							2											
86	Lindsay	13	3			2		4	1						1											
87	Malecki	2		1																						
88	Marsh	5	9												1											
89	Mason	6	2			1	1	18	1		1							1								
90	Mattiat							11	1																	
91	Maury	1	8		4	2																				
92	McGoldrick	1				5																				
93	Meyer		1		1																					
94	Mix	1									1	2	8	2		1	1	1	2							
95	Morse	32		2	1	3	2	10	1																	
96	Morse	50	14	4	1	5	2	4	2			1			1		1	1	1							
97	Muir	1	1		1					15					1											
98	NAS	2																								
99	NDRC	22	17	13	3	11	13	12	4		7	3	1	4	14	9	3		2	1			6	5	2	3
100	NRC	2	1																					1	1	1

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous										
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACM	Man-Machine	Interactive Data	CAD CAC	Artificial Intelligence		Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal
76 Kinsler				1														1							
77 Kinsler																		2							
78 Klock																									
79 Klyukin																									
80 Klyukin																									
81 Krasil'nikov																									
82 Kuperman																									
83 Lamb									1																
84 Leehey																									
85 Levi																									
86 Lindsay																									
87 Malecki																									
88 March																									
89 Mason									1																
90 Mattiat																									
91 Maury																									
92 McGoldrick																									
93 Meyer																		3							
94 Mix																									
95 Morse								1										4							
96 Morse																		3							
97 Muir																									
98 NAS																									
99 NDRC	2	2	3	2	2	3	3	2	3	5													8		
100 NRC	1	1	1	1		2	1	1																	

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

		Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis												
		Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
101	Officer	39	53	2	2	2	3			1	2	3			3	1	1	2	1							
102	Ol'shevskii	2		28												2										
103	Ol'shevskii	1										2	5	5	1	1										
104	Olson	1						12	1			1			1											
105	Oppenheim											10	40	7	1	1										
106	Pierce	20	6	2			1	1	1						1											
107	Rayleigh	25	6	1			2	5	1	1																
108		2	1																							
109	Richardson				1		1	2		1						1	1										
110	Roberts											3	10	3			1										
111	Ross	3	1	2	42	50	3	3	3			4			1		2	1	1	1							
112	Rudenko									7																
113	Scharfe						1																			
114	Skudrzyk	21	3			2	1	1		1													1	1		1
115	Skudrzyk	2				5																	1	1		1
116	Snowdon				1	3										1										
117	Steinberg							3				55	2	1			2	1	7							
118	Stenzel					1	1	3		1		2														
119	Stenzel		1									1														
120	Stephens	3	4				1																			
121	Stocklin													1	3	1										
122																										
123	Tatarski	7	13	2	1																					
124	Tavolga																									
125	Tavolga				1	1																				

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous										
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACM	Man-Machine Interactive Data	CAD CAC	Artificial Intelligence			Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal	
101 Officer																			1							
102 Ol'shevskii																										
103 Ol'shevskii					1							1														
104 Olson																										
105 Oppenheim							1	1				1					1									
106 Pierce																		2								
107 Rayleigh																							1			
108																										
109 Richardson										1								1								
110 Roberts												1														
111 Ross																		1	1				1			
112 Rudenko																										
113 Scharfe																										
114 Skudrzyk																		3								
115 Skudrzyk																		2								
116 Snowdon																										
117 Steinberg																										
118 Stenzel																							1			
119 Stenzel																							1			
120 Stephens																										
121 Stocklin																										
122																										
123 Tatarski																										
124 Tavolga																								1		
125 Tavolga																								2		

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

		Ocean Acoustics						Sound Sources & Sensors				Processing Signal			Sonar System Design & Analysis										
		Fundamentals	Wave Propagation	Reverberation	Masking Noise	Radiated Noise	Echo Structure	Reciprocal	Nonreciprocal	Nonlinear	Testing	Spatial Arrays	Temporal	Decision Criteria	General	Active for ASW	Passive	Fixed Surveillance	Towed Line	Sonobuoys	Depth Sounder	Minehunting	Torpedo	Torpedo Detection	Swimmer	Diver
126	Tavolga				1	1		1		1																
127	Tavolga																									
128	Tavolga																									
129	Timoshenko	1						3				1			1	1										
130	Timoshenko	2	1			2		2		1		1			1											
131	Tolstoy	9	25	1								2	3		1											
132	Tolstoy	24	39	4	1	1	1						1		3											
133	Tracor	1	1	2			2	1				3	1	4	8	5	2									
134	Tucker														1											
135	Tucker																						1	1		
136	Tucker	6	5					3		1		1			3	1							1	1		
137	(Navy)	1		1										1	3		1									
138	Urick	71	42	43	49	34	36	10	4	2	4	30	8	16	48	18	25	15	11	7	5	6	7	5	4	5
139	Urick	33	17	21	29	21	19	8	7	2	3	14	7	9	17	12	14	7	6	5	1	2	2	1	1	1
140	Urick	15	26	11	7	3	3	1	1	1	1	4	2	3	6	4	1	1	1	1	1	1	1	1	1	1
141	Van Trees											16	55	53	3	2	3			1						
142	Van Trees											14	48	41	2	1	2									
143	Van Trees								1			16	52	46	3	3	3	1	1							
144	Welsby	2																								
145	Whalen/Winder				1				1			14	41	37	1	1	1	1	1			1				
146	Wood																									
147	Yudanov																									
148	Zinchenko		1			2																				

APPENDIX E-2 (Continued)

SUMMARY OF CITATIONS FOR EACH BOOK FOR EACH TOPIC

	Sonar System Design & Analysis										Displays and Operator Interfaces				Personnel Training	Miscellaneous									
	Mines	Minesweeping	Communications	Test Equipment	Beacons	Test Equipment	Record	Electronics	Mechanical	ACN	Man-Machine	Interactive Data	CAD CAC	Artificial Intelligence		Patents	Computer Programs	Acoustic Structure	Navy Catalogue	Commercial Catalogue	Bibliographies	Dictionary	History	Animal
126 Tavolga																								3
127 Tavolga																								2
128 Tavolga																								
129 Timoshenko									1									1						
130 Timoshenko																								
131 Tolstoy																								
132 Tolstoy																								
133 Tracor																								
134 Tucker																								
135 Tucker																								
136 Tucker																								
137 (Navy)																								
138 Urick	4	4	5	3	3	3	3	3	4	3	1	1	1	1	1			1					1	
139 Urick	1	1	1	1	1	1	1	1	1	1								1					1	
140 Urick	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1						1	
141 Van Trees													3											
142 Van Trees													1											
143 Van Trees													1											
144 Welsby																								
145 Whalen/Winder							1						3					1						
146 Wood									1															
147 Yudanov																								
148 Zinchenko																								

APPENDIX E-3

Number of Different Books Cited Three or More Times for Each Topic.

Topic		Books Cited
A	1	56
	2	44
	3	25
	4	20
	5	28
	6	17
B	1	30
	2	9
	3	3
	4	4
C	1	24
	2	16
	3	14
D	1	22
	2	9
	3	8
	4	3
	5	3
	6	3
	7	2
	8	2
	9	2
	10	2
	11	1
	12	2

Topic		Books Cited
D	13	1
	14	1
	15	2
	16	2
	17	1
	18	3
	19	2
	20	1
	21	2
	22	2
E	1	0
	2	0
	3	2
	4	0
F		0
G	1	0
	2	0
	3	6
	4	0
	5	0
	6	0
	7	0
	8	2
	9	2

APPENDIX F

REVISED AND EXPANDED BOOK LIST

The original survey packet included a book list of 148 titles, most of which were specialized to underwater acoustics. The survey requested respondents to suggest other books that they found to be useful in their underwater acoustics research and development. Some 300 additional titles were submitted. While some of these were in the special field of underwater acoustics, most were in such areas as signal processing, wave propagation, general acoustics, radio and radar, optics, oceanography, mathematics, physics, etc. A number of respondents commented that an expanded book list would be a useful document.

The list contained in this appendix is a combination of the original list (with corrections) and most of the titles suggested by respondents. A few titles were omitted (e.g., those in the field of mathematics, general physics, and some nontechnical books) as being outside the bounds of this listing, while a few were omitted because we were unable to adequately identify the book (title, author, publisher, etc.). The Committee has not made an examination of each of the added books. It recognized that for many topics there are equally good books that were not recommended and that are not included. In brief, we have taken the original list and added those titles recommended (except as noted).

The Committee encourages recipients of this report to submit suggestions for other useful and appropriate books, comments on those books listed, and corrections to the list.

Part 1 lists books in (first) author alphabetical order. Part 2 cross references the books by list number and topic.

Part 1

LIST OF PUBLISHED BOOKS AND MONOGRAPHS RELATED TO UNDERWATER ACOUSTICS AND SONAR (REVISED AND EXPANDED)

1. Achenbach, J. D. 1973. Wave Propagation in Elastic Solids. New York: North Holland Publisher.
2. Aigner, F. 1922. Unterwasserschalltechnik; grundlagen, ziele und grenzen, submarine akustik in theorie und praxis. Berlin: M. Krayn.
3. Alais, P., and A. F. Metherell, eds. 1982. Acoustical Imaging, Vol. 10. New York: Plenum Press. 852 pp. (Formerly the series was called Acoustical Holography. Various eds.)
4. Albers, V. M. 1960. Underwater Acoustics Handbook. University Park: Pennsylvania State University Press. 290 pp.
5. Albers, V. M. 1965. Underwater Acoustics Handbook II. University Park: Pennsylvania State University Press. 356 pp.
6. Albers, V. M., ed. 1963 and 1967. Underwater Acoustics, Vols. 1 and 2.
   1962. Vol. 1. Proceedings of London Institute.
   1966. Vol. 2. Proceedings of Copenhagen Institute.
   New York: Plenum Press. 416 pp.
7. Albers, V. M., ed. 1972. Underwater Sound. New York: Halsted. 468 pp.
8. Albers, V. M., ed. 1972. Underwater Sound, Benchmark Papers in Acoustics. Stroudsburg, Pa: Dowden, Hutchingon, and Ross. 480 pp.
9. Albers, V. M., ed. 1973. A. S. A. Suggested Experiments for Laboratory Courses in Acoustics and Vibration. University Park: Pennsylvania State University Press.
10. Anan'eva, A. A. 1970. Ceramic Acoustic Detectors. New York: Plenum Press. 171 pp. Also New York: Consultants Bureau 1965.
11. Anderberg, Michael R. 1973. Cluster Analysis for Application. New York: Academic Press. 359 pp.
12. Anderson, N. R., and B. J. Zahuranec, eds. Oceanic Sound Scattering Prediction. New York: Plenum Press.
13. Andreeva, I. B. 1975. Physical Principles of Sound Propagation in the Ocean. (In Russian.) Leningrad: Gidrometeoizdat.
14. Ani, N. and P. G. Richards. 1980. Quantitative Seismology Theory and Methods, Vols. 1 and 2. San Francisco: W. H. Freeman.

15. Anon. 1980. Echo Sounding and Sonar for Fishing. Prepared by Food and Agriculture Organization of the United Nations. Surrey, Eng.: Fishing News Book Ltd. 104 pp.
16. Anon. 1965. An Introduction to Echo Sounding. Kiel: ELAC. 146 pp.
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Vol. 20: Fluid Dynamics. 293 pp.

Vol. 21: Torpedo Studies. 160 pp.
Vol. 22: Acoustic Torpedoes. 172 pp.
Vol. 23: Index of NDRC Summary Technical Reports of Division 6. 511 pp.

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Part 2
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APPENDIX G

SCIENTIFIC AND TECHNICAL REPORTS RECOMMENDED BY RESPONDENTS

The reports listed in this appendix were recommended by respondents as being of special interest. The Committee has not reviewed tnese reports, and the bibliographical information is incomplete for many of the entries. However, it is felt that it is of value to include this list because many of the reports are known to be useful summaries and compilations. Some recommendations have been omitted because the references were much too incomplete. Recommended journal articles have not been included.

The Committee believes that this list comprises only a small fraction of the good summary/tutorial reports that have been prepared during the past several decades. A more complete listing would be of value. Readers are encouraged to provide additional entries.

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17. Central Intelligence Agency, "National Intelligence Survey, Nos. 104 and 105: Atlases of Various Oceanic Regions," Central Intelligence Agency, 1963. CONFIDENTIAL
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24. Deuser, L. M., "An Environmentally Adaptive Nonparametric Approach to Some Classification Problems in Underwater Acoustics," The University of Texas at Austin, Dissertation, 1975.
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52. Leibowitz, L. M., "Overview of Digital Signal Processing Theory," Naval Research Laboratory, Washington, D.C., 1975, 87 pp.
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54. Leissa, A. W., "Vibration of Shells," NASA SP-288.
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78. (U.S.) Naval Oceanographic Office, "Oceanographic Atlas of the North Atlantic Ocean, Section VI. Sound Velocity," U.S. Naval Oceanographic Office, NP Publication No. 700, 1967 (reprinted 1974).
79. (U.S.) Naval Oceanographic Office, "Operational Oceanography of the Greenland, Norwegian, and Barents Seas for Submarines," NOVOCEANO SP-46, June 1960.
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APPENDIX H

BOOKS IN PREPARATION

1. Adams, B. B., R. N. Baer, M. J. Beran, K. M. Guthrie, J. J. McCoy and J. S. Perkins (NRL, Wasnington, D.C.).
   "The Performance of Sonar Antennas in the Presence of Ocean Volume Scatter"
   Status: In preparation. Expected to be published in 1983.
   Source: Baer, R. N. (NRL)
2. Blackstock, David T., (ARL, The University of Texas at Austin)
   "Fundamentals of Acoustics"
   A general book that deals in part with underwater acoustics.
   Status: Considerable amount of writing completed. Has a contract with publisher.
   Source: Blackstock.
3. Boyles, C. A. (ARL/JHU)
   "Lectures on the Theory of Acoustic Propagation in the Ocean," Vol. I and II
   Has been issued as a report (JHU/APL-STD-R-331, Dec 1980) and used in a short course.
   Status: Awaiting publisher response.
   Source: Biondo, JHU/APL.
4. Carter, Cliff (NUSC)
   "A Collection of Important Sonar Papers"
   Status: Seeking support for publication.
   Source: Schmidt, Honeywell.
5. Dyer, Ira (MIT)
   "Use of Sound in the Sea"
   Lecture notes for a graduate level course.
   Status: Abour 50% ready for book form.
   Source: Dyer.
6. Hanish, Sam (NRL, Washington)
   "Treatise on Acoustic Radiation - Sound Source and Sensors"
   Status: In preparation.
   Source: Hanish.
7. Neal, Edgar H. (EG&E)
   "Handbook of Sonar"
   To be a collection of chapters prepared by individual authors.
   Status: Process of organizing.
   Source: Neal
8. Neubauer, Werner (NRL, Washington)
   "Target Strength and Echo Structure"
   Status: About to be published.
   Source: Munson, NRL.

9. Uberall, H. and G. C. Gaunaurd (NSWC - WO)
"Direct and Inverse Electromagnetic and Acoustic Scattering"
Status: Has been in preparation for some time.
Source: Gaunaurd.

10. Unkowitz, H.
"An Introduction to Signal Processing and Random Processes"
Status: To be published in February 1983.
Source: NADC.

11. Urick, R. J. (Catholic University)
"Summary of Ambient Noise in the Sea Data"
Status: Written. Hope to be published in 1983 by Naval Sea Systems Command.
Source: Urick.

12. Winder, A. and P. Stocklin
"Introduction to Acoustical Space-Time Information Processing"
Second edition of the Winder and Loda book.
Status: Unknown.
Source: Lasky, MAR.

13. Woollett, R. S.
"Theory of Flexing Plate Transducers" (approximate title)
Status: Due to be published in 1983.
Source: Marshall, Sanders.

14. Burdic, W. E.
"Principles of Underwater Acoustic Systems"
Status: Book is nearly complete.
Source: South, APL/JHU.

APPENDIX I

RECOMMENDED TOPICS FOR NEW BOOKS

Topic	Number of Recommendations
Fundamentals (General)	7
Environmental Acoustics (General) and Modeling	6
Propagation	13
Ambient Noise	7
Flow and Other Masking Noise	6
Radiated Noise	5
Reverberation	3
Target Strength and Echo Structure	7
Transducers	18
Transducer Arrays (Including Towed Line and Nonlinear)	24
Transducer Testing (Digital Techniques)	2
Signal Processing (General)	16
Displays, etc. (Including CAD/CAC)	15
Sonar System Analysis and Design (General)	8
Sonar Systems (All Applications)	3
Sonar Systems (Specific Applications)	21
Sea Test: Planning, Design, Operations	2
Statistical Techniques	3
Oceanography for Acousticians	4
Bibliographies	7
Catalogs	6
Dictionaries, Glossaries	3
History	3
Acoustical Structures	3
Computer Programs	2
General and Non-specific	10
Miscellaneous	6
Total	210

APPENDIX J

BOOKS RECOMMENDED BY RESPONDENTS FOR REPRINTING

List No.*	
5	Albers, V. M., Underwater Acoustics Handbook II.
10	Andreeva, I. B., Physical Principles of Sound Propagation in the Ocean. (Two respondents recommended that this book be translated from Russian to English.)
19	Bartberger, C. L., Lecture Notes on Underwater Acoustics
22	Beranek, L. L., Acoustics
27	Bobber, Robert J., Underwater Electroacoustics Measurements.
29	Bowman, J. J., et al., eds. Electromagnetic and Acoustic Scattering by Simple Shapes.
39	Chernov, L. A., Wave Propagation in a Random Medium.
59	Gerlach, A. A., Theory and Application of Statistical Wave-Period Processing. (Believed to be still available from publisher.)
69	Horton, C. W., Sr., Signal Processing of Underwater Acoustic Waves. (Two respondents.)
70	Horton, J. W., Fundamentals of sonar. (Two respondents.)
73	Junger, M. C., and D. Feit, Sound, Structures, and Their Interaction.
96	Morse, P. M. and K. U. Ingard, Theoretical Acoustics.
99	NDRC Division 6 Summary Reports. (Three respondents.)
101	Officer, C. B., Introduction to the Theory of Sound Transmission.
123	Tatarski, V. I., Wave Propagation in a Turbulent Medium.
132	Tolstoy, Ivan and C. S. Clay, Ocean Acoustics Theory and Experiment in Underwater Sound. (Four respondents.)
136	Tucker, D. G. and Gazey, B. K., Applied Underwater Acoustics.

*See Appendix A for list

BOOKS RECOMMENDED FOR REPRINTING NOT ON THE ORIGINAL LIST

Baker, B. B., and E. J. Copson, The Mathematical Theory of Huygens' Principle.

Burdic, W. J., Radar Signal Analysis.

Childers, D. G., and A. Durling, Digital Filtering and Signal Processing.

Gold, B., and C. M. Rader, Digital Processing of Signals.

Rihaczek, A. W., Principles of High Resolution Radar.

Stewart, G. W., and R. B. Lindsay, Acoustics.

Wood, A. B., Textbook of Sound

Noble, B., Methods Based on the Wiener-Hopf Technique for the Solution of Partial Differential Equations. New York: Pergamon. 1958.