THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

REPORT FOR THE YEARS

1943, 1944, 1945

TABLE OF CONTENTS

I. TRUSTEES

To serve until 1949

THE COMMANDANT (Admiral R. R. Waesche), U. S. Coast Guard, Washington, D. C.
MARION EPPLEY, Eastover, Newport, R. I.
LAMAR R. LEAHY, 910 Park Avenue, New York, N. Y.
THE DIRECTOR (Admiral L. O. Colbert), U. S. Coast & Geodetic Survey, Washington, D. C.
B. W. ST. CLAIR, 10 Arrow Street, Cambridge, Mass. (Deceased).
EDWARD H. SMITH, Commander Third Coast Guard District, 42 Broadway, New York, N. Y.

To serve until 1948

HENRY B. BIGELOW, Museum of Comparative Zoölogy, Cambridge, Mass.
VANNEVAR BUSH, 1530 P Street, N. W., Washington, D. C.
A. G. HUNTSMAN, University of Toronto, Toronto, Canada.
DANIEL MERRIMAN, Box 2025 Yale Station, Yale University, New Haven, Conn.
ALFRED C. REDFIELD, Woods Hole Oceanographic Institution, Woods Hole, Mass.
HENRY L. SHATTUCK, 50 Federal Street, Boston, Mass.

To serve until 1947

ISAIAH BOWMAN, Johns Hopkins University, Baltimore, Md.
E. G. CONKLIN, Princeton University, Princeton, N. J.
ROSS G. HARRISON, Yale University, New Haven, Conn.
THE HYDROGRAPHER (Admiral G. S. Bryan), U. S. Hydrographic Office, Washington, D. C.
FRANK R. LILLIE, 5801 Kenwood Avenue, Chicago, Ill.
HARLOW SHAPLEY, Harvard University, Cambridge, Mass.

To serve until 1946

CHARLES FRANCIS ADAMS, 15 State Street, Boston, Mass.
THOMAS BARBOUR, Museum of Comparative Zoölogy, Cambridge, Mass. (Deceased).
JNO. A. FLEMING, Carnegie Institution, Washington, D. C.
FRANK B. JEWETT, 195 Broadway, New York, N. Y.
ALBERT E. PARR, American Museum of Natural History, New York, N. Y.
ELIHU ROOT, JR., 31 Nassau Street, New York, N. Y.

Ex Officio

COLUMBUS O'D. ISELIN, Woods Hole Oceanographic Institution, Woods Hole, Mass.
LAWRASON RIGGS, 120 Broadway, New York, N. Y.

OFFICERS

HENRY B. BIGELOW, President of the Corporation, Museum of Comparative Zoölogy, Cambridge, Mass.
LAWRASON RIGGS, Treasurer, 120 Broadway, New York, N. Y.
COLUMBUS O'D. ISELIN, Clerk of the Corporation, Woods Hole Oceanographic Institution, Woods Hole, Mass.

II. MEMBERS OF THE CORPORATION

CHARLES FRANCIS ADAMS, 15 State Street, Boston, Mass.
THOMAS BARBOUR, Museum of Comparative Zoölogy, Cambridge, Mass. (Deceased)
HENRY B. BIGELOW, Museum of Comparative Zoölogy, Cambridge, Mass.
ISAIAH BOWMAN, Johns Hopkins University, Baltimore, Md.
VANNEVAR BUSH, 1530 P Street, N.W., Washington, D. C.
THE COMMANDANT (Admiral R. R. Waesche), U. S. Coast Guard, Washington, D. C.
E. G. CONKLIN, Princeton University, Princeton, N. J.
THE DIRECTOR, (Admiral L. O. Colbert), U. S. Coast & Geodetic Survey, Washington, D. C.
BENJAMIN M. DUGGAR, Lederle Laboratories, Inc., Pearl River, N. Y.
MARION EPPLEY, Eastover, Newport, R. I.
JNO. A. FLEMING, Carnegie Institution, Washington, D. C.
ALEXANDER FORBES, 610 Harland St., Milton, Mass.
ROSS G. HARRISON, Yale University, New Haven, Conn.
A. G. HUNTSMAN, University of Toronto, Toronto, Canada
THE HYDROGRAPHER (Admiral G. S. Bryan), U. S. Hydrographic Office, Washington, D. C.
COLUMBUS O'D. ISELIN, Woods Hole Oceanographic Institution, Woods Hole, Mass.
FRANK B. JEWETT, 195 Broadway, New York, N. Y.
LAMAR R. LEAHY, 910 Park Avenue, New York, N. Y.
FRANK R. LILLIE, 5810 Kenwood Avenue, Chicago, Ill.
ALFRED L. LOOMIS, Tuxedo Park, N. Y.
DANIEL MERRIMAN, Box 2025 Yale Station, Yale University, New Haven, Conn.
T. H. MORGAN, California Institute of Technology, Pasadena, Calif. (Deceased).
ALBERT E. PARR, American Museum of Natural History, New York, N. Y.
ALFRED C. REDFIELD, Woods Hole Oceanographic Institution, Woods Hole, Mass.
LAWRASON RIGGS, 120 Broadway, New York, N. Y.
ELIHU ROOT, JR., 31 Nassau Street, New York, N. Y.
B. W. ST. CLAIR, 10 Arrow Street, Cambridge, Mass. (Deceased).
HARLOW SHAPLEY, Harvard University, Cambridge, Mass.
HENRY L. SHATTUCK, 50 Federal Street, Boston, Mass.
EDWARD H. SMITH, Commander Third Coast Guard District, 42 Broadway, New York, N. Y.
T. WAYLAND VAUGHAN, 3333 P Street, Washington, D. C.

III. REPORTS OF THE TREASURER

To the Members and the Trustees of the
Woods Hole Oceanographic Institution:

Gentlemen:

1943

The accounts for the year 1943 have been audited by Messrs. Stagg, Mather & Hough, public accountants.

During the year bonds costing $132,190 were redeemed at a net profit of $3,002.88 (after adding applicable reserve for amortization). There was invested during the year in bonds $37,112.50 and in stocks $8,856.93. Uninvested cash at the end of the year in endowment fund was $94,362.56, which was invested shortly thereafter.

In addition to the amount of $27,168.51 due from the General Account to the Special Income account at the end of 1942, there was withheld during the year further special income of $2,688.75 plus an adjustment of $23.50, making a total of $29,880.76 due this fund at the end of 1943. The continued holding of these funds due Special Income in the General Fund was necessitated by the unavoidable delay in the payment of the vouchers on Government projects.

The indebtedness of the Government to the Institution increased from $69,335.10 at the end of 1942 to $233,642.75 at the end of 1943. Of this amount all but about $500 had been received from the Government prior to the date of this report. This indebtedness is, however, claimed to be subject to a refund to the Government of $15,838.82. There was spent for the account of the Government during the year $464,303.34, in addition to which overhead allowances, calculated in accordance with the provisions of the contracts with the Office of Scientific Research and Development in the amount of $98,639.49, were charged to the Government, of which, however, $15,838.82 may be subject to refund, as above stated.

The net loss on the contracts from the Bureau of Ships paid out of our own income was $7,205.76.

On account of the lack of cash, due to financing of the Government contracts, the appropriation of $4,800 from the General Fund to the Reserve for Periodic Replacements had not been transferred at the end of the year and is still due from the General Fund to that Reserve Fund. At the end of the year that fund consisted of

Bonds of the book value of . . . . . (Market value of $17,327.50)	$17,195.00
Cash	31,463.18
Indebtedness from General Fund	4,800.00
	$53,458.18

The total income of the Institution from its endowment funds after the payment of custodian fees, was $111,540.78. The total expenditures, excluding direct contract expenditures for the Government and including the loss on the Bureau of Ships contracts, amounted to $129,831.76. Reducing this by the sum of $82,800.67, being the net amount allocable to overhead expenses chargeable to the Government, leaves a net expense chargeable to the Institution's own funds of $47,031.09, resulting in net excess of income over expenses of $64,509.69.

The cash position was, however, not improved, due to the increase in accounts receivable from the Government as above stated. Practically our entire surplus of $137,000 was employed in financing Government contracts, as well as the balances due the Reserve Fund and Special Income Account above referred to, in addition to which it was necessary to borrow from the Bankers Trust Company from time to time on demand notes at 2% per annum. At the end of the year there was due the Bank on these loans the sum of $90,000. However, it is proposed by the Office of Scientific Research and Development that in the future we secure advances on account of the projects undertaken for that office, which in a short time should enable us to pay off all the loans and free our surplus.

The gross income on the securities in the Endowment Fund, excluding special income (extra dividends) was about 4.4% of cost and 4.47% of value at the end of the year.

The market value of the securities in the Endowment Fund at the end of the year was $18,724.09 under the cost, a situation which has considerably improved since that time.

1944

The accounts for the year 1944 have been audited by Messrs. Stagg, Mather & Hough, public accountants.

During the year bonds costing $170,943.75 were redeemed at a net profit of $10,886.24 (after adding applicable reserve for amortization).

During the year $179,018.60 was invested in bonds and $85,317.74 in stocks. The uninvested cash in the Endowment Fund at the end of the year was $10,573.67.

In addition to the amount of $29,880.76 due from the General Account to Special Income Account at the end of 1943 there was withheld during 1944 further special income of $3,238.75 plus an adjustment of $31.50 making a total of $33,151.01 due this fund at the year end. The continued withholding of these funds due Special Income Account was due to the financing of Government contracts.

The indebtedness of the Government at the end of the year 1944 had increased from $233,642.75 to an adjusted net of $293,754.62. Of this

indebtedness more than $50,000 remains unpaid at the date of this report.

There was spent directly for the Government the sum of $805,502.89 in addition to which an adjusted overhead allowance calculated in accordance with the provisions of the contracts with the O.S.R.D. in the amount of $126,926.93 was agreed on.

Contracts "A" and "D" with the Bureau of Ships resulted in a direct loss in 1944 to the Institution of $17,859.19 and also in an indirect loss of $14,747.79 unrecoverable overhead.

The appropriation of $4,800 for the reserve for periodic replacements for 1944 as well as that for 1943 has not been transferred to that Reserve Fund. At the end of the year that Fund consisted of —

Bonds of the book value of . . . . . (Market $48,408.70)	$48,262.50
Cash (including $9,600 due from General Fund)	10,437.64
	$58,700.14

The total income of the Institution from its Endowment Funds after the payment of custodian fees, was $111,331.24. This is $208.54 less than in 1943, and $293.39 more than in 1942. The total expenditures, excluding direct contract expenditures for the Government and including the loss on the Bureau of Ships contracts, amounted to $255,968.96. Reducing this by the sum of $126,926.93, the adjusted overhead allowance from the Government, leaves a net expenditure of $129,042.03 or $17,710.79 in excess of income. It is to be noted, however, that these expenditures include the investment in capital assets (purchase and improvement of PHYSALIA and LITTLE RELIANCE and additions to Library $27,808; and the unrecoverable direct expenditures on Contracts "A" and "D" $17,859.19).

Our cash position has not improved during the year. Our bank loans increased from $90,000 at the end of 1943 to $165,000 at the end of 1944. Our accounts payable from $15,474.52 to $71,033.68. Our entire surplus as well as the balances due the Reserve for Periodic Replacement Fund and Special Income Account were also used in financing the Government contracts. It was hoped to obviate this by securing advance payments but due to the O.S.R.D. rules banning advance payments on contracts within two months of termination and the fact that our contracts ran only for short periods, being constantly renewed, we received only two such payments.

The rate of return on the investments in the Endowment Fund, at cost, excluding Special Income, was 4.39%; including Special Income it was 4.51%.

At the end of the year 1943, the market value of the securities in the Endowment Fund was approximately $19,000 under the cost. At the end of 1944, this situation had markedly improved and there was an excess of market value over cost in all classes of securities. Our preferred stocks having an excess value of $69,069.93, our common stocks $34,464.42, and our bonds $61,501.93 over amortized cost.

1945

The accounts for the year 1945 have been audited by Messrs. Seamans, Stetson and Tuttle, C.P.A. of Boston.

During the year bonds costing $392,028 were redeemed at a net profit of $21,859.90. To this must be added $3,054.73, the applicable reserve for amortization, and an additional profit of $10,402.02 derived from the sale and redemption of stock, making a total net profit of $35,316.65.

During the year $241,811.62 was invested in bonds and $150,532.65 in stocks, leaving $108,868.58 uninvested at the end of the year.

The amount due from General Account to Special Income Account rose during the year from $33,151.01 to $37,094.76. The continued withholding of these funds due Special Income Account is a result of the financing of Government contracts.

The indebtedness of the Government rose during the year from $292,691.50 ($293,754.62 plus $4,352.68 billed after December 31, 1944, less $5,415.80 in overhead) to $468,991.71 not including unrecovered overhead of $34,129.70.

There was spent directly for the Government $859,188.06 in addition to which there was spent for General Overhead $159,222.11 and for Overhead on boats $112,978.74. Of these amounts $35,555.52 had not been recovered at the end of the year, but $29,725.68 was carried forward as recoverable in 1946. The remaining balance of $5,829.84 was accounted for by a charge to Institution expenditures of $1,372.64 representing the Institution's share of costs of work done under Contract A, and a charge of $4,457.20 to Government Allowances received for costs not otherwise provided for in the contracts.

The appropriations of $4,800 for the Reserve for Periodic Replacements for 1943, 1944 and 1945 have not been transferred to the Depreciation Fund. This fund consists of bonds of the book value of $40,200 (market $41,643.75) and cash (including $14,400 due from current funds) of $24,548.26, or a total of $64,748.26.

The total income of the Institution from its Endowment Fund after the payment of custodian fees was $116,969.34. This is over $5,000

more than in 1944. The net Institutional expenses amounted to $73,784.54 leaving a balance of $43,184.80.

Our cash position has not improved during the year. Our bank loans increased from $165,000 at the end of 1944 to $360,000 at the end of 1945. Our accounts payable decreased from $71,033.68 to $53,310.80.

Our entire surplus as well as the balances due the Reserve for Replacements and Special Income Account as well as the proceeds of the bank loans are involved in the financing of the Government contracts. It is hoped that this condition will improve during the year.

The return on the investments held at the end of the year excluding stock dividends was at the rate of a trifle over 4% on their cost.

At the end of the year the securities in the Endowment Fund were worth $2,844,919.11 which is $430,709.40 in excess of their cost.

Balance sheets and statements of income and expenses for the years 1943, 1944 and 1945 are appended, also the statement of income and expenses for 1942.

Respectfully submitted,

LAWRASON RIGGS
Treasurer

WOODS HOLE OCEANOGRAPHIC INSTITUTION — BALANCE SHEET

ASSETS

ENDOWMENT FUND ASSETS	*Quoted Market Value*	*December 31, 1945*		*December 31, 1944*		*December 31, 1943*	
Endowment Fund Assets:							
Bonds (less Reserve for Amortization of Bond Premiums. Note A)	$1,039,996.24	$974,803.09		$1,122,456.82		$1,113,099.43	
Stocks	$1,804,922.87	1,439,406.62		1,354,731.15		1,269,413.41	
Cash		108,868.58	$2,523,078.29	10,573.67	$2,487,761.64	94,362.56	$2,476,875.40
Reserve Fund Assets:							
Bonds	$10,150.00	$9,800.00		12,777.50		4,737.50	
Stocks	$16,346.75	19,099.02		19,099.02		19,099.02	
Cash		4,512.59	33,411.61	319.32	32,195.84	7,656.63	31,493.15
			$2,556,489.90		$2,519,957.48		$2,508,368.55
PLANT ASSETS							
Laboratory Plant:							
Land		$27,072.32		27,072.32		$27,072.32	
Buildings		332,202.26		323,063.12		323,213.12	
Laboratory Equipment		21,361.93		21,361.93		21,361.93	
Library		15,900.00		15,100.00		14,300.00	
Crew Room Equipment		—	$396,536.51	557.95	$387,155.32	557.95	$386,505.32
Ketch "Atlantis"							
Construction		$218,674.47		$218,674.47		$218,674.47	
Equipment		27,298.50	245,972.97	27,298.50	245,972.97	27,298.50	245,972.97
Ketch "Physalia"			23,408.00		23,658.00		—
Power Boat "Anton Dohrn"			17,145.67		17,145.67		17,145.67
Small Boats and Equipment			13,528.85		10,070.55		6,570.55
			$696,592.00		$684,002.51		656,194.51
Depreciation Fund Assets (for periodic replacements)							
Bonds (Quoted Market Value, 12/31/45, $41,643.75)		$40,200.00		48,262.50		17,195.00	
Cash (Note B)		24,548.26	64,748.26	10,437.64	58,700.14	36,263.18	53,458.18
			761,340.26		$742,702.65		$709,652.69

CURRENT ASSETS

Current Funds Cash		$47,419.19			$27,124.36			$14,794.91	
Less: Amount due Special Income Fund	$37,094.76			$33,151.01			$29,880.76		
Amount due Depreciation Fund	14,400.00	51,494.76	($4,075.57)	9,600.00	42,751.01	($15,626.65)	4,800.00	34,680.76	($19,885.85)
Special Income Fund Assets									
Bonds (Quoted Market Value, 12/31/45, $8,500.00)		$8,500.00			$8,300.00			$8,100.00	
Stocks (Quoted Market Value, 12/31/45, $5,761.00)		4,345.66			3,513.77			2,872.21	
Cash (Note B)		38,190.40	51,036.06		34,042.98	45,856.75		30,616.98	41,589.19
Accounts Receivable									
United States Government Contracts									
Invoiced at December 31	$239,922.53			$92,246.37			$167,120.01		
Invoiced after December 31	229,069.18			200,445.13			67,802.53		
Unrecovered Overhead	34,129.70	$503,121.41		5,415.80	$298,107.30		(15,838.82)	$219,083.72	
Insurance Claims		1,105.00			18,189.85				
Advances to Scientists		6,679.64			5,444.23			1,311.97	
Sundry		1,663.13	512,569.18		415.68	322,157.06		1,325.68	221,721.37
Supplies in Stock			12,874.87			3,885.92			
Deferred Charge to Government Allowances			4,330.46						
			$576,735.00			$356,273.08			$243,424.71
Total Assets			$3,894,565.16			$3,618,933.21			$3,461,445.95

NOTES: Amounts shown in parentheses indicate negative figures.

A Applicable Reserve for Amortization of Bond Premiums deducted from Endowment Fund Bonds. $2,557.88 $5,120.53 $6,403.07

B Includes amounts due from Current Funds Cash as indicated under latter account.

WOODS HOLE OCEANOGRAPHIC INSTITUTION — BALANCE SHEET (*Continued*)

FUNDS, LIABILITIES AND SURPLUS

	December 31, 1945			*December 31, 1944*			*December 31, 1943*	
ENDOWMENT FUNDS								
Endowment Fund—General		$2,000,000.00			$2,000,000.00			$2,000,000.00
Endowment Fund—For Upkeep of Plant		419,419.96			419,419.96			419,419.96
		$2,419,419.96			$2,419,419.96			$2,419,419.96
Add Accumulated Net Gain on Securities Called or Sold		103,658.33	$2,523,078.29		68,341.68	$2,487,761.64		57,455.44	$2,476,875.40
Reserve Fund		$23,658.07			$23,395.57			$23,395.57	
Add Accumulated Reserve Fund Income		9,753.54	33,411.61		8,800.27	32,195.84		8,097.58	31,493.15
			$2,556,489.90			$2,519,957.48			$2,508,368.55
PLANT FUNDS									
Plant Fund—General		$607,642.13			$607,642.13			$607,642.13	
Plant Fund Reserve—Transferred in Prior Years from Current Surplus	$76,360.38			$48,552.38			$47,752.38		
Add Appropriations from Current Funds:									
Library Additions	800.00			800.00			800.00		
Administration Building	9,139.14			—			—		
Boat "Mytilus" (Note C)	3,458.30			—			—		
Ketch "Physalia"	—			23,658.00			—		
Boat "Little Reliance"	—			3,500.00			—		
	$89,757.82			$76,510.38			$48,552.38		
Deduct:									
Sale of Equipment	$250.00			$150.00			—		
Crew Room Equipment	557.95			—			—		
	$807.95	88,949.87	$696,592.00	$150.00	76,360.38	$684,002.51	—	48,552.38	$656,194.51
Reserve for Periodic Replacements			64,748.26			58,700.14			53,458.18
			$761,340.26			$742,702.65			$709,652.69
CURRENT LIABILTIES AND SURPLUS									
Accounts Payable			$53,310.80			$71,033.68			$15,474.52
Notes Payable—Bankers Trust Company			360,000.00			165,000.00			90,000.00
Surplus									
Balance at December 31, previous year	$120,239.40			$137,950.19			$73,440.50		
Add Excess of Income over Expenditures for the current year	43,184.80			(17,710.79)			64,509.69		
Balance at December 31, current year			163,424.20			120,239.40			137,950.19
			576,735.00			$356,273.08			$243,424.71
Total Funds, Current Liabilities, and Surplus			$3,894,565.16			$3,618,933.21			$3,461,445.95

NOTES: Amount shown in parentheses indicates negative figure.
C. Boat "Mytilus" acquired in 1943 and charged to Operations that year.

Income from Endowment Funds and Special Income Fund and Expenditures Applicable thereto
For the Years Ended December 31, 1945 and December 31, 1944

	Year Ended December 31, 1945			*Year Ended December 31, 1944*		
Income						
From Endowment Funds:						
Interest	$45,619.15			$47,722.88		
Dividends	72,600.40			64,828.33		
From Special Income Funds	435.01	$118,654.56		393.31	$112,944.52	
Less Custodian Fees and Expense		1,685.22			1,613.28	
Total Income			$116,969.34			$111,331.24
Institution Expenses						
Upkeep of Plant:						
Buildings and Grounds	2,739.73			6,525.44		
"Atlantis"	16,124.79			7,961.35		
"Asterias"	—			1,325.00		
"Anton Dohrn"	—			2,004.16		
Insurance (Note D)	—			4,270.87		
Depreciation	4,800.00	23,664.52		4,800.00	26,886.82	
Operating Expenses:						
"Atlantis"	3,556.47			21,036.89		
Scientific Salaries	18,111.13			5,354.14		
Scientific Supplies and Equipment	3,788.29			2,999.34		
Administration	1,755.71			712.35		
Traveling Expenses	1,628.97			596.89		
Contribution to Retirement Fund	1,603.73			1,587.49		
Amortization of Bond Premiums	492.08			722.45		
Publications	176.75			619.92		
Library (Note D)	—			1,100.00		
Bachelor Officers' Quarters (Net)	—	31,113.13		(311.73)	34,417.74	
Other Expenses						
Excess of Expenditures:						
Contract A	1,372.64			5,573.32		
Contract D	—			12,285.87		
Overhead:						
Current Year (Note E)	7,945.11			14,747.79		
Years, 1940, 1941 and 1942 (Note F)	—	9,317.75		7,322.49	39,929.47	
Expenditures for Permanent Plant Additions						
New Building	9,139.14			—		
Additions to Library	800.00			800.00		
Purchase Price and Cost of Installing New Motor-Ketch "Physalia"	—			23,658.00		
Purchase Price—Boat "Little Reliance"	—			3,500.00		
	9,939.14			27,958.00		
Less Amounts Received for Sale of Equipment	250.00	9,689.14		150.00	27,808.00	
Total Expenditures			73,784.54			129,042.03
Excess of Income over Expenditures			$43,184.80			—
Excess of Expenditures over Income			—			$17,710.79

NOTES: Amount shown in parentheses indicates negative figure.

D. Insurance and Library charges included in Overhead in 1945; made directly to Institution Expenses in 1944.

E. Overhead in 1945 apportioned to Institution Expenses on basis of ratio of Institution salaries to total salaries, including Government work. 1944 amount determined by different method which had the effect of apportionment but also includes Overhead loss on fixed-price Government contracts.

F. Overhead item for 1940, 1941 and 1942 represents amount deemed to be excessive recoveries from Government in those years and charged accordingly in 1944.

Statement of Income from Endowment Fund Investments and from Current Assets, and Expenses Applicable thereto, including Expenditures for Permanent Plant Additions (Less Allowance for General Overhead by the United States Government) for the Years Ended December 31, 1943 and December 31, 1942

	Year Ended December 31, 1943			*Year Ended December 31, 1942*		
Income:						
From Endowment Funds:						
Interest	$52,594.35			$51,777.88		
Dividends	60,534.81			60,849.84		
Net profit on preferred stocks called during the year, Special income	16.50			—		
		$113,145.66			$112,627.72	
Less—Custodian fees and expenses		1,604.88			1,589.87	
			$111,540.78			$111,037.85
Expenses:						
Upkeep of Plant:						
Upkeep of buildings and grounds	$11,608.22			$17,365.22		
Upkeep of "Atlantis"	469.87			9,393.41		
Upkeep of "Asterias"	134.23			611.34		
Upkeep of "Anton Dohrn"	4,858.53			3,369.28		
Insurance	6,045.77			7,129.83		
Depreciation	4,800.00			4,800.00		
		$27,916.62			$42,669.08	
Operating Expenses:						
Operation of "Atlantis"	10,888.85			$26,263.45		
Operation of "Anton Dohrn"	4,026.68			4,547.94		
Operation of "Asterias"	—			891.75		
Operation of "Mytilus"	4,597.81			—		
Operation of "Reliance", "Little Reliance" and other boats	7,963.35			—		
Scientists' salaries	19,576.63			23,218.70		
Scientific supplies and equipment	1,012.85			3,584.28		
Traveling expenses	1,386.15			881.28		
Publications	980.13			1,846.37		
Administration	31,247.71			14,171.23		
Amortization of bond premiums	1,008.74			1,288.63		
Contribution to retirement fund	1,382.64			1,382.83		
Interest on bank loans	414.73			152.22		
Mess (net)	2,851.05			785.93		
Housing (net)	5,316.59			—		
Library	1,050.00			—		
Station-wagon	205.47			—		
		$93,909.38			$79,014.61	
Total expenses		$121,826.00			$121,683.69	
Loss or gain on U. S. Government contracts (net):						
Loss on Contract A (less profit of $1,584.72 applicable to 1942)	9,830.37			—		
Less—Gain on Project No. 10	2,624.61	7,205.76		—		
		129,031.76			121,683.69	
Expenditures for permanent plant additions:						
Additions to library		800.00			800.00	
		129,831.76			122,483.69	
Deduct:						
Allowance for gen. overhead, by U. S. Government	98,639.49			$40,562.96		
Less—Excess charges on account of overhead on Government OSRD Contracts (B and C)	15,838.82	82,800.67	47,031.09	—	40,562.96	$81,920.73
Excess of income over expenses			$64,509.69			$29,117.12

IV. REPORT OF THE DIRECTOR FOR THE YEARS 1943, 1944, AND 1945

BY C. O'D. ISELIN

Introduction

The last published Annual Report of the Woods Hole Oceanographic Institution was for the year 1942. This indicated that the volume of work being carried out under government contract was increasing rapidly and that many of the members of our staff had dropped their normal studies. As the war progressed the number of unclassified projects being continued sank to a very low level and thus during the past three years there has been little that could be published concerning our activities. Furthermore, the publication of the Treasurer's report for the years after 1942 would have revealed the magnitude, if not the nature, of the investigations being undertaken at the request of the government.

Now that the war is over and the security regulations have been relaxed, it has become possible to present a general picture of the part played by this laboratory in the war effort. It should be emphasized at the outset that we at Woods Hole were by no means the only group in this country working on the military applications of oceanography, nor should we be given credit for more than a minor share of the successes. First under the leadership of the National Defense Research Committee and more recently under the direction of the Bureau of Ships and the Hydrographic Office all laboratories concerned with problems involving the sea have worked in closest collaboration. Each group conducted investigations for which their facilities and experience were best adapted, in most cases only part of a given project being carried out at any one laboratory. This "production line" system was on the whole very effective, the final assembly usually taking place within the Navy. In this way the limitations of a civilian organization in war time were largely overcome.

The history of our war time research program properly begins with the "Atlantis" observations of February 1937 off Guantanamo, Cuba. Using closely spaced mercurial thermometers, diurnal warming and its effect on sound transmission were studied in collaboration with the U.S.S. "Semmes". These preliminary observations, which were amplified during the following August, opened our eyes to the fact that physical oceanography plays a significant role in subsurface warfare. The only immediate effect, however, was to stimulate the development of the bathythermograph, an instrument much better adapted to the measurement of shallow thermal gradients than the conventional reversing thermometers.

In 1939 our second contact with naval applications of oceanography became established when Dr. Selman A. Waksman was asked to direct an investigation of the role of the slime film which forms on antifouling paints. Before two years had passed we found ourselves deep in the many interesting aspects of fouling, especially the fouling of more or less toxic surfaces. This investigation has in fact continued, under contract with the Bureau of Ships, right up to the present. However, we hope to complete our final reports during 1946.

It was not until the late summer of 1940 that we were asked to undertake a serious study of the role of oceanography in subsurface warfare. Although the possibilities could only be dimly foreseen, the National Defense Research Committee did not hesitate to back this research with all necessary funds. Thus almost overnight the number of qualified physical oceanographers in the country became entirely inadequate to deal with the several practical applications of their subject to modern warfare at sea. From that time on the personnel problem has been our chief one. The mistake that was made was that we did not at the outset undertake a teaching program. When the war began in earnest in December 1941 it was too late to organize such a program.

Increase in Staff

During the summer of 1940, the last normal year, there were about 60 people working in the laboratory. Although in science manpower is a poor measure of productivity, it may be of interest to list the total number of people employed here on August 31 during the past 6 years:

1941	107
1942	96
1943	173
1944	262
1945	335

Only part of this increase can be attributed to oceanography, for beginning in 1942 we turned over the top floor of the laboratory to a group working on explosives problems for the National Defense Research Committee. This group, which also grew very rapidly, became known as the Underwater Explosives Research Laboratory, Woods Hole Oceanographic Institution. Since September 1945 this project has been financed by a direct contract between the Bureau of Ordnance of the Navy Department and the Institution. Gradually the explosives research has become amalgamated with the more strictly oceanographic investigations. As time went on it became evident that the physics of an underwater explosion could

not very well be kept separated from the physics of the environment. In fact, as will be explained more fully below, explosives have become an important tool in physical oceanography, in much the same way as in geophysics.

Returning to the figures listed above, even if only about half of the increase in staff during recent years was due to investigations more strictly oceanographic than explosions, how was it possible to find any such number of investigators with training in oceanographic research? The answer is that for the most part during the war period we have not been engaged in oceanographic research, but in the practical applications of physical oceanography. Thus geophysicists, geologists, meteorologists and biologists, to mention only a few of the types of investigators, all found a way to contribute to the work at hand. However, the stimulation to oceanography has been very considerable. Many investigators in allied fields have become genuinely interested in the ocean. Improvements in instrumentation have resulted in a large mass of new observations which have been studied, both from the practical point of view and from the standpoint of pure oceanography. Thus a number of important scientific advances have been made, but not nearly in proportion to the increase in our staff.

Since in general these results have not yet been worked up in a form suitable for publication in the oceanographic journals, one of the objectives of the present report is to present a summary of the investigations made by our war time staff. The individuals chiefly responsible will be mentioned under each subheading.

Increase in Laboratory and Shop Facilities

Such a large increase in staff would have been out of the question if only laboratory work had been involved for there are but 35 rooms in our main building. We have had recurring crises, but for the most part the field work has kept a considerable percentage of the staff away from Woods Hole. Also during the winter months we have been able to use space at the Marine Biological Laboratory as needed. Thus it has been the housing problem in the town, rather than laboratory facilities that has been the chief limitation.

The first major improvement to the main laboratory building was to equip a small machine shop in the basement. After about a year a larger shop was required and the former "Atlantis" crew room was fitted up as an instrument shop, the other room being reserved for general work with less precise tools.

Beginning in 1943 we acquired the use of the former Penzance Garage

property next door. This permitted welding, brazing, pipe cutting, blacksmith work and tinsmith work to be taken out of the main building. It also provided ample storage space for government furnished equipment, lumber and other heavy supplies. The stock room, and an office for shipping and receiving were established in the former garage building. There remained some space for repairing boats, engines and automobiles. At the same time of course the wharf facilities were increased and the problem of parking cars was solved. It is difficult to see how we will ever manage to give up the use of this property which about doubles the useable space outdoors and more than doubles storage and workshop facilities.

Until about a year ago the administrative staff remained in the main laboratory building, in the end occupying four precious laboratories. Now all of the administrative personnel are housed in a temporary, two-story, wooden building, erected in the back yard in the former parking space. A smaller temporary building, which is used as an electrical laboratory, has been placed near the wharf, parallel to the pump house.

Meanwhile of course, the service departments such as drafting, duplicating, and photography had grown. When possible such work has been moved to the Marine Biological Laboratory, although both of our own dark rooms are still in routine use.

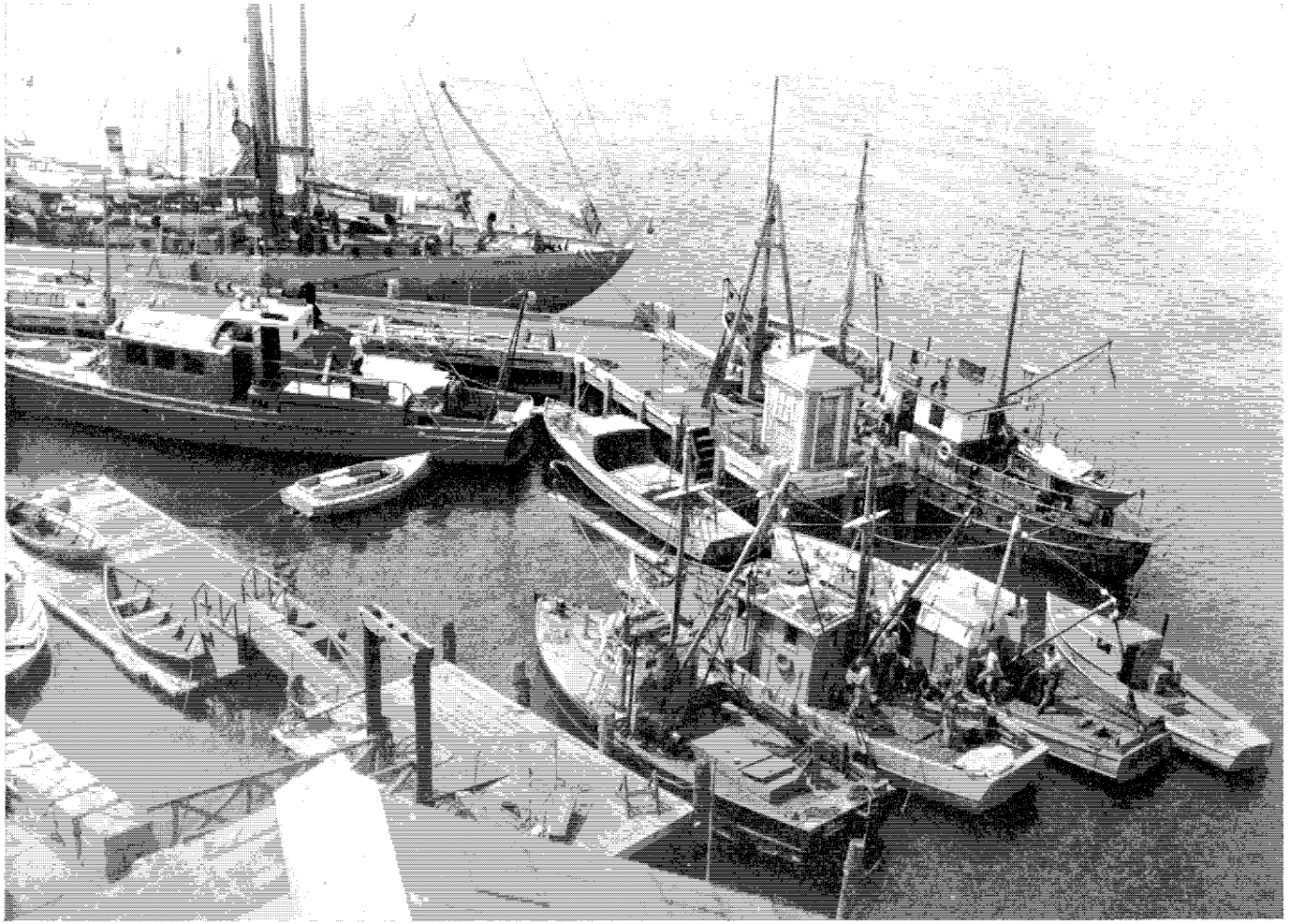
In many of the larger laboratory rooms temporary partitions have been erected in order to subdivide the space. In other cases many more people have managed to work in a given room than had ever been thought practical. Frequent reassignment of space has been necessary as the emphasis of the work shifted. Thus one way or another we have managed to provide more or less adequate laboratory facilities for the many different projects that have been undertaken during the war period.

Boats

While we could not easily enlarge the laboratory, we had no trouble expanding our floating facilities. At one time as many as twelve assorted craft were being operated. Not all of these were actually owned by the Institution. From time to time Navy vessels have been assigned here for duty and some of the boats have been bought with contract funds. However, the Institution's own fleet has been expanded considerably.

With "Atlantis" and "Asterias" as a nucleus, the "Anton Dohrn", a gift from the Carnegie Corporation, was modernized in 1942. Next we bought "Mytilus", a relatively fast launch. She was followed in 1944 by "Physalia", a 64-foot motor-sailer of modern design and finally in 1945

View of the Laboratory from Main Street Showing the Parking Lot in Front of the Former Penzance Garage and the New Administration Building



The Northern End of the Wharf and Part of the Fleet of Boats Used During the Summer of 1945

we purchased "Reliance" which is almost a duplicate of "Asterias". The characteristics of these assorted craft can be listed as follows:

	Length in feet	Displacement in tons	Engine Horsepower
"Atlantis"	142	420	250
"Asterias"	40	8	40
"Anton Dohrn" . .	66	45	100
"Mytilus"	41	7	110
"Reliance"	38	7	35
"Physalia"	64	42	170

When the government financed vessels are added, it is evident that we must have a very considerable repair and maintenance problem on our hands. Mr. John Churchill has had this responsibility among several other major ones and he has organized an efficient repair crew of ship carpenters, electricians and mechanics. As time permitted, improvements have been made in all of the boats, both structural and mechanical. Especially, the electrical power supply and other facilities essential to the scientific work have been augmented.

With the exception of "Atlantis" it is of course a coastwise fleet. Since the first years of her reconversion we have seldom sent the "Anton Dohrn" more than a day's run offshore. Except in summer the "Physalia" too has been similarly restricted. Yet up to the present they have served their purposes very well indeed. We are lucky at Woods Hole to have sheltered and relatively deep waters so near at hand. It is seldom that within a day's sail of Woods Hole conditions cannot be found suitable for a given experiment.

The operation of "Atlantis" since she was laid up at Lake Charles, Louisiana, early in the war can be summarized as follows:

Cruise No.	Date	Region
129	Apr. 23–July 4, 1945	Woods Hole, Nassau and Bermuda
130	Aug. 8–11, 1945	Continental shelf, south of Block Island
131	Aug. 18–Sept. 12, 1945	Southeast of Bermuda
132	Oct. 11–16, 1945	Continental shelf, south of Block Island
133	Oct. 19–27, 1945	Slope water area, south of Martha's Vineyard
134	Nov. 13–21, 1945	Slope water area, southeast of Nantucket
135	Dec. 3–4, 1945	Continental shelf, south of Martha's Vineyard
136	Dec. 7–9, 1945	Continental shelf, south of Martha's Vineyard
137	Dec. 12–19, 1945	Block Island southward to Gulf Stream

Library

We have continued to set aside annually $800 toward the purchase of oceanographic books, journals, etc., for the library of the Marine Biological

Laboratory. There is now a considerable unexpended balance which has been set aside for the time when it will again be possible to resume buying in Europe. In addition, we have been making substantial annual contributions toward the administrative expenses of the library.

Publications

The following contributions were published during 1943, 1944 and 1945:

No. 252 R. B. MONTGOMERY. Generalization for Cylinders of Prandtl's Linear Assumption for Mixing Length. *Annals N. Y. Acad. Sci.*, Vol. VLIV, Art. 1, pp. 89–103. 1943.

No. 293. NIELS HAUGAARD and LAURENCE IRVING. The Influence of Temperature upon the Oxygen Consumption of the Cunner (*Tautogolabrus adspersus* Walbaum) in Summer and in Winter. Journ. Cellular and Comp. Physiol., Vol. 21, No. 1, pp. 19–26. 1943.

No. 298. P. F. SCHOLANDER, NIELS HAUGAARD and LAURENCE IRVING. A Volumetric Respirometer for Aquatic Animals. *Review of Sci. Instruments*, Vol. 14, No. 2, pp. 48–51. 1943.

No. 302. G. A. EDWARDS and LAURENCE IRVING. The Influence of Temperature and Season upon the Oxygen Consumption of the Sand Crab, *Emerita talpoida* Say. *Journ. Cellular and Comp. Physiol.*, Vol. 21, No. 2, pp. 169–182. 1943.

No. 313. G. A. EDWARDS and LAURENCE IRVING. The Influence of Season and Temperature upon the Oxygen Consumption of the Beach Flea, *Talorchestia megalophthalma*. *Journ. Cellular and Comp. Physiol.*, Vol. 21, No. 2, pp. 183–189. 1943.

No. 319. GORDON A. RILEY. Physiological Aspects of Spring Diatom Flowerings. *Bull. Bingham Oceanographic Coll.*, Vol. VIII, Art. 4, pp. 1–53. 1943.

No. 323. WILLIAM SCHALLEK. The Reaction of Certain Crustacea to Direct and to Diffuse Light. *Biol. Bull.*, Vol. 84, No. 1, pp. 98–105. 1943.

No. 325. SELMAN A. WAKSMAN, DONALD B. JOHNSTONE and CORNELIA L. CAREY. The Effect of Copper upon the Development of Bacteria in Sea Water and the Isolation of Specific Bacteria. *Sears Found. Journ. Mar. Res.*, Vol. V, No. 2, pp. 136–152. 1943.

No. 326. ROBERT W. PYLE. The Histogenesis and Cyclic Phenomena of the Sinus Gland and X-Organ in Crustacea. *Biol. Bull.*, Vol. 85, No. 2, pp. 87–102. 1943.

No. 327. EARL H. MEYERS. Life Activities of Foraminifera in Relation to Marine Ecology. *Proc. Amer. Philos. Soc.*, Vol. 86, No. 3, pp. 439–458. 1943.

No. 328. GEORGE L. CLARKE, E. LOWE PIERCE and DEAN F. BUMPUS. The Distribution and Reproduction of *Sagitta elegans* on Georges Bank in Relation to the Hydrographical Conditions. *Biol. Bull.*, Vol. 85, No. 3, pp. 201–226. 1943.

No. 329. A. A. ABRAMOWITZ, F. L. HISAW and D. N. PAPANDREA. The Occurrence of a Diabetogenic Factor in the Eyestalks of Crustaceans. *Biol. Bull.*, Vol. 86. No. 1, pp. 1–5, 1944.

No. 330. RICHARD E. LEE. A Quantitative Survey of the Invertebrate Bottom Fauna in Menemsha Bight. *Biol. Bull.*, Vol. 86, No. 2, pp. 83–97. 1944.

No. 331. ALFRED H. WOODCOCK. A Theory of Surface Water Motion Deduced from the Wind-Induced Motion of the Physalia. *Sears Found. Journ. Mar. Res.*, Vol. V, No. 3, pp. 196–205. 1944.

No. 332. LOUIS W. HUTCHINS. An Annotated Check-list of the Salt-Water Bryozoa of Long Island Sound. *Trans. of Conn. Acad. of Arts and Sciences.*, Vol. 36, pp. 533–551. 1945.

No. 333. HENRY B. BIGELOW and WILLIAM C. SCHROEDER. New Sharks from the Western Atlantic. *Proc. New England Zool. Club.*, Vol. XXIII, pp. 21–36. 1944.

No. 334. W. J. CLENCH and C. G. AGUAYO. A New Tropical Buccinum from Cuba. *Revista Sociedad Malacologica.* Vol. 2, No. 2, pp. 67–68. 1944.

No. 335. BOSTWICK H. KETCHUM, JOHN D. FERRY, ALFRED C. REDFIELD and ARTHUR E. BURNS, JR. Evaluation of Antifouling Paints by Leaching Rate Determinations. *Industrial and Engineering Chemistry.* Vol. 37, No. 5, pp. 456–468. 1945.

No. 336. GEORGE TAYLOR SCOTT. The Influence of H-ion Concentration on the Mineral Composition of *Chlorella pyrenoidosa. Journ. Cellular and Comp. Physiol.*, Vol. 25, No. 1, pp. 37–44. 1945.

No. 337. GEORGE TAYLOR SCOTT. The Mineral Composition of Phosphate Deficient Cells of *Chlorella pyrenoidosa* during the Restoration of Phosphate. *Journ. Cellular and Comp. Physiol.* Vol. 26, No. 1, pp. 35–42. 1945.

No. 338. FRED B PHLEGER, JR. Vertical Distribution of Pelagic Foraminifera. *Am. Journ. of Sci.*, Vol. 243, pp. 377–383. 1945.

No. 339. WARREN H. YUDKIN. Occurrence of Thiaminase in Marine Teleosts. *Proc. Soc. for Experimental Biol. and Medicine.*, Vol. 60, pp. 268–69. 1945.

Personnel

During the war years a total of 63 employees left the laboratory for active duty with the armed forces.

As discussed in an earlier section of this report, the number of workers has greatly increased since the last published Annual Report. These workers, primarily engaged on government contracts from 1942 to the present time, are listed below as of December 31, 1945. For completeness, all those whose term of service exceeds six months are included. A single year following a name indicates the entire period of service to be within that calendar year, two years denotes the beginning and end of employment, and one year followed by a dash indicates the year of employment and that he was still with the Institution at the end of the year 1945.

Scientists

Rolf F. Arentzen	1943–1945	Peter G. Bergmann	1945–
Arnold B. Arons	1943–	Stanley Bergstrom	1945–
Melvin Arsove	1944–	William C. Bohn	1945–
Thomas S. Austin	1944–	Richard M. Brown	1944–
John C. Ayers	1944–	William S. Butcher	1941–
David Barnes	1943–	Henry R. Cattley	1945–

Robert H. Cole 1942–
J. Stacey Coles 1943–
Robert D. Cotell 1945–
Wesley E. Curtis 1944–
John C. Decius 1944–
Edward S. Deevey, Jr. . . . 1943–
W. T. Edmondson. 1943–
John E. Eldridge 1943–1945
Gardner Emmons 1944–
David B. Ericson 1945–
John D. Ferry 1941–1945
William L. Ford 1944–
George Fraenkel 1943–
Frederick Fuglister 1941–
Paul M. Fye 1942–
Gabriel Gever 1945–
Richard Geyer 1944–1945
William E. Gordon 1943–
Robert W. Griffin 1945–
Edward J. Groth 1945–
Raymond R. Halverson . . 1944–1945
D. F. Hornig 1943–1944
J. L. Hough 1943–1945
Otis E. Hunt 1945–
Donald B. Johnstone . . . 1942–1943
George Kahler 1945–
William D. Kennedy . . . 1943–
D. E. Kirkpatrick 1942–1945
Marvin S. Klapper 1945–
Arthur A. Klebba 1944–
Victor Kumin 1943–1944
Emil Lehmann 1943–1944
Leonard N. Liebermann . . 1944–
Nelson Marshall 1943–1944
Kenneth McCasland . . . 1945–
R. J. McCurdy, III 1940–
Sterling McNees 1945–
Frank J. Mather, III . . . 1945–
Milton Miller. 1943–
Emmeline Moore 1944–1945
Irvin M. Newell 1945–
Philip Newmark 1942–
Charles Niffenegger 1944–
Palmer Osborn 1943–1944
Ernest Patterson. 1942–1945
Roger Patterson 1945–
James A. Peoples 1945–
Frederick deW. Pingree . . 1943–
Martin J. Pollak 1940–1944
Charles M. Pomerat 1942–1943
Robert S. Price 1943–
Donald M. Reynolds . . . 1941–1944
Kenneth Reynolds. 1943–1944
Harry H. Robinson 1944–1945
Henry Russell 1943–1944
Marshall Schalk. 1943–
William Schevill 1943–
William G. Schneider . . . 1943–
George T. Scott 1941–1944
Philip S. Shafer 1945–
Abraham M. Shanes. . . . 1942–1944
Nathaniel Shear. 1945–
R. F. Shropshire 1943–1944
William S. Shultz 1943–
Charles P. Slichter 1943–
John P. Slifko. 1942–
Eastman Smith 1944–1945
F. G. Walton Smith 1943–1945
Aaron Spector 1945–
Ralph W. Spitzer 1943–1945
David S. Stacey 1942–1945
Nelson Steenland 1944–
Henry M. Stommel 1944–
Elijah Swift, Jr. 1945–
Charles W. Tait. 1944–1945
Herman A. Templin . . . 1944–
Edward M. Thorndike . . 1942–1943
David Todd 1943–1945
Harry J. Turner 1944–
Adelaide Vine 1942–
Allyn C. Vine 1940–
William S. Von Arx 1945–
Charles M. Weiss 1939–
George N. White, Jr. . . . 1945–
Rupert Wildt 1945–
Donald A. Wilson 1944–
E. Bright Wilson 1943–1944
William W. Wood 1943–1945
George Woollard 1942–
J. L. Worzel 1940–
Arthur J. Yaspan 1945–
Thomas Zandstra 1943–1944
Donald J. Zinn 1945–

Technicians

John M. Aitchison 1945–
Jean Arentzen 1943–1945
Barbara Atwood 1945–
Catherine G. Ayers 1944–1945
L. H. Barbour 1943–
Thomas C. Bardwell . . . 1945–
Beverly A. Berg 1942–1945
Ruth Billard 1945–
Charles F. Blevins 1944–
Barbara Brooks 1942–
Patricia Brown 1943–
Vertene Brown 1945–
Elizabeth T. Bunce 1944–
Margaret Burrows 1944–1945
W. Graham Campbell . . . 1945–
Jeanne Carritt 1942–1943
Helene Chamberlain . . . 1945–
Ermine A. Christian 1945–
Gloria S. Clark 1945–
Mary C. Cobb 1942–
Richard L. Cole 1943–1945
Elizabeth Copeland 1943–1944
Jeanne D. Conners 1944–1945
Barbara A. Cotter 1945–
Dorcas H. Crary 1941–1944
Dorothy Day 1944–
William E. Day 1945–
Raymond E. Deysher . . . 1941–1944
Elizabeth S. Diaco 1945–
Kathryn M. Doane 1944–
Jean DuMont. 1943–1944
Gerritt Duys, Jr. 1944–
Yvette Edmondson 1945–
Margaret K. Ewing 1942–
Barbara M. Ferry 1942–1944
Harold P. Field 1944–
Constance French 1943–
Nancy N. Friar 1945–
Bernice E. Grahn 1944–1945
Eunice S. Groh 1944–
Margaret F. Halverson . . 1944–1945
Gardner Handy 1942–1945
Barbara Hathaway 1944–
Marion W. Hawes. 1945–
Kristi Hay 1944
Anne L. Hayer 1944–1945
Carlyle R. Hayes 1945–
Mary Hegarty 1945–
Eleanor Hern 1944–
Janet R. Jenkins 1944–1945
Janet Johnson 1945–
Richard L. Kaye 1944–1945
Dorothy Keen 1944–
Jean D. Kennedy 1943–1945
Priscilla Knott 1943–1945
Jean Lacey 1944–1945
Frederick B. Laidlaw . . . 1943–1944
Helen S. Magee. 1943–1945
Mary L. McClung 1943–1945
Sol W. Malaskey 1945–
John G. Mangan 1945–
John P. Manry 1944–1945
Virginia Maple 1943–
Mildred Melody 1943–1945
William Metcalf 1945–
Virginia Milanese 1943–1944
Robert B. Mills 1945–
Frances Moore 1943–1945
Elizabeth W. Olmsted . . . 1944–1945
Elliott Orr 1943–1945
Zoe Ann Orr 1944–1945
Johnson Parker 1941–1944
Barbara Perkins 1945–
Hazel Pingree 1943–
Lynn D. Quick 1944–1945
Mary Anne Rogers 1945–
Francis C. Ronne 1944–
Dorothy Ryder 1943–
Eileen Scharff 1943–
Margaret Scharff 1944–
Jean Schneider 1943–1944
Ruth E. Senate 1945–
Deskin H. Shurbet 1942–1943
Vernon Smith 1943–1945
Anne E. Snipes 1945–
Oakes Spalding 1941–
Elizabeth Sparks 1945–
Beverly L. Steele 1944–1945
Edith Stokey 1943–1945
Pearl E. Struth 1945–
Doris T. Tassinari 1944–
Alice K. Taylor 1945–
Vivian Templin 1945–
Anne Thomas 1943

Wesley B. Thompson . . . 1944–1945
George B. Tirey 1941–
Evangeline Tollio 1944–
Sonia Trabun 1945–
Betsy A. Turner 1944–
Mary Turner 1944–
Virginia Vail 1944–
Ruth L. Von Arx 1945–
Sylvia Weare 1944–
Fleeta Wilkie 1943–1944
Frances Williams 1943–1944
Catherine Wingate 1945–
Grace L. Winter 1945–
L. V. Worthington 1941–1943

Laboratory Assistants

Herbert Alberts 1942–
Dorothy Allen 1943–1944
Ruth W. Allen 1942–1943
Nellie Anderson 1943–
Jean Arons 1943–1944
David Baldwin 1944–1945
Elizabeth P. Barber 1944
Abner Briggs 1943–1944
Joan A. Brown 1944–
Margaret Butler 1944–1945
Elizabeth F. Cole 1941–
Georgiana Deevey 1945–
Dorothy Donnelly 1944–
Robert W. Donnelly 1945–
George P. Dutra 1945–
Beverly Emery 1943–
Alice Ferris 1943–
Axel Frank 1943–1945
Carl A. Frank 1943–1945
Alex. C. Frue 1945–
Mary Gerbacia 1943–1944
Robert A. Goffin 1943–
George A. Gordon 1945–
Nancy Hamlen 1944–1945
Harold L. Handy 1944–1945
Wilfred H. Huntington . . . 1944–
Helen S. Hutchins 1944–
Roger Kuhn 1943–1945
Anne E. Lawrence 1944–1945
Doris M. Lumbert 1945–
John R. Martin 1943–1945
Margaret W. Miller 1944–1945
George Ostiguy 1945–
Beth R. Perry 1943–1945
Carol Peterson 1943–1945
Janet Peterson 1945–
John M. Powers 1941–1945
Lavenna Putman 1943–1944
Alfred G. Redfield 1942–
Martha Redfield 1942–1944
Beatrice Reynolds 1943–1944
Albert J. Riehl 1944–
Marilyn Rockwell 1945–
Solange Saulnier 1943–1944
George F. Savery 1942–1944
Harold Schweidenback . . . 1945–
Nancy Sisson 1943–
Philip Spalding 1942–
Joan M. Spillane 1943–1944
Joan L. Stacey 1944–1945
Richard Stansfield 1942–
James R. Sullivan 1945–
Esther Tsiknas 1944–1945
Iona Walker 1945–
Charles L. Wheeler 1943–
Howard H. Williams . . . 1942–1944
Allen L. Windle 1945–
Fred C. Woodward, Jr. . . 1945–

Administration

Norman T. Allen 1941–
C. L. Barber 1943–1944
Edwin T. Bryant 1945–
Clinton Cahoon 1945–
Edith L. Cassick 1944–1945
John Churchill 1942–
Katherine Churchill 1943–1945
Marcus Conlan 1942–
Marie G. Dever 1944–1945
Mary Donald 1945–
T. S. Perry Griffin 1944–
Caroline M. Reiser 1945–
Ethelyn T. Slifko 1940–
Ethel E. Wagner 1945–

Secretaries

Virginia P. Alberts 1943–
Jeanne Backus 1943–
Patricia Backus 1943–
Arshales Baker 1943–
Phyllis M. Behnke 1945–
Madeline Broadbent . . . 1944–
Vivien Brown 1944–
Mary L. Campbell 1944–
Anne Castellini 1943
Charlotte G. Christian . . . 1941–1945
Genevieve C. Doyle 1945–
Evelyn Fleming 1943–1944
Ruth E. Fye 1942–
Anita W. Gallagher 1945–
Willia Harlow 1945–
Marion L. Havener 1944–1945
Mary Howze 1943–1945
Romayne L. Jeffery 1944–1945
Norma A. Joseph 1945–
Blanche Klapper 1945–
Lucile V. Korf 1944–1945
Lucile A. Krause 1945–
Florence K. Mellor 1944–
Dorothy Onan 1943–1944
Betty P. Ostiguy 1945–
Anne Palmer 1943–
Helen M. Penney 1944–1945
Camille Piccolli 1945–
Calla Shelton 1945–
Edith H. Sparks 1945–
Troy Tapp 1943–1944
Evelyn M. Taylor 1944–1945
Lois M. Vaetsch 1945–
Charlotte Vail 1944–
Chessie M. Williams . . . 1945–
Ruth A. Wirick 1944–

Maintenance and Shop Workers

Robert Adams 1943–
Clarence Anderson 1945–
John W. Barlow 1943–1945
Forrest W. Blake 1944–
R. H. Bodman 1942–
Warren E. Brightman . . . 1943–
Milton F. Buckley 1943–1944
Carl N. Carlson 1944–
James S. Condinho 1945
Henry Churbuck 1942–1945
John William Condon . . . 1932–
James Francis Diaco 1944–1945
Paul Dingwell 1943–1944
Edith Dorsett 1943–1945
Elwood Eldridge 1943–1945
Stanley Eldridge 1940–
Leola Erskine 1943–1944
Wayne J. Fisher 1944–1945
Fred Gaskell 1945–
Charles E. L. Gifford . . . 1944–
Francis X. Glynn 1941–1944
Reuben Hamblin 1942–1943
Frank O. W. Handy 1942–
Harry H. Handy 1943–
Hiram C. F. Harlow 1944–1945
Seaver R. Harlow 1943–
Sterling W. Haverfield . . . 1945–
Harry Hodgkins 1944–
Elijah Howes 1942–
William L. Howes 1943–
Robert Liljestrand 1942–1943
Benjamin Lintner 1945–
Henry Mandly, Jr. 1937–
Wallace R. Marrow 1945–
Carleton Mixer 1944–
David Molleur 1945–
Kenneth Morrison 1943–
Ellen A. Murphy 1945–
Esther Owen 1943–1945
Angelo S. Pacheco 1944–
Sidney F. Peck 1943–
Wm. L. Plamondon 1944–
Joseph Quinlan 1945–
Oliver W. Robinson 1944–
James Salthouse 1941–
George H. Savery 1943–1944
Nat Simmons 1945–
Ida Soderland 1943–
Otto Solberg 1944–
Lawrence A. Thayer 1944–

Catherine Turner	1944–	Hallet Wagstaff	1943–
Kenneth Turner	1943–1944	Carleton Wing	1940–
Thomas Turner	1943–1945	Nathaniel Wing	1942–

Boatmen

Edwin Athearn	1941–1944	Dana R. Lange	1940–1944
Harold Backus	1931–	Elliott Mayhew	1943–
Elmer Barstow	1943–	Herbert E. Mayhew	1943–1944
Lennert S. Blomberg	1944–	Paul Mayhew	1943–
Lloyd H. Bosworth	1944–1945	Albert Nickerson	1944–1945
Russell Bosworth	1944–	Alfred E. Norton	1944–
Hartley Cassidy	1943–1945	Gilbert Oakley, Jr.	1940–
Clarence F. Chase	1944–1945	Joseph A. Orr, Jr.	1944–1945
Hans Cook	1934–	William D. Payne	1944–
Benjamin Cromwell	1945–	Ray Peters	1945–
Herbert M. Davidson	1945–	Matthew F. Pells	1944–1945
Ernest Dean	1944–	Stanley E. Poole	1941–
Charles G. Dyer	1945–	Elmer L. Rogers	1944–
Donald Fay	1945–	C. Otto Schweidenback	1945–
Albert O. Fischer	1944–	Edward A. Shaffner	1943–1944
William F. Gallagher	1945–	Ernest Siversen	1935–
F. Lawrence Goodwin	1945–	Harry C. Studley	1944–1945
John P. Harlow	1944–1945	Ralph Tilton	1943–1944
Nils C. Iverson	1945–	Gordon W. Weeks	1944–1945
Arvid Karlson	1945–	Norman C. West	1943–
Leroy C. Lair	1943–	David L. Whittemore	1943–1945

Scientific Program

The following summary of the major investigations undertaken during the past three years will deal primarily with the scientific aspects of the various problems, rather than with their practical applications. As stated previously, throughout the war period the reverse emphasis prevailed. Thus the scientific advances may appear to be rather small, considering the size of the staffs involved.

1. Antifouling paints and fouling organisms.

A staff of about twenty persons under the general supervision of Dr. Alfred C. Redfield has been busy throughout the war period in studies designed to improve understanding of the performance of antifouling paints, and to increase knowledge concerning the distribution and rate of growth of the fouling organisms. Dr. Bostwick H. Ketchum and Dr. John Ferry have worked primarily on the physical chemistry of paint systems. Dr. Louis Hutchins and Dr. Edward Deevey have been concerned mainly with the biological aspects of fouling. Most of the work has been under contract

with the Bureau of Ships (Research and Standards Section), but the Institution also contributed some funds for the biological studies.

On the technical side the main objective was to develop a quicker and more reliable method of testing the antifouling characteristics of paints. This involved, first of all, learning how the paints prevented fouling. It was found that the rate at which the toxic dissolved from a paint was the most important factor in determining its effectiveness. The copper leaches from some paints too rapidly and thus the antifouling properties are quickly lost. Other paints are so insoluble that the toxic remains locked up in the paint coating and does not poison the organisms which settle on its surface. It became possible to develop purely chemical methods of measuring the leaching rate of antifouling paints which can be carried out in the laboratory, and are independent of the availability of fouling organisms.

Once the importance of the rate of dissolution of the paint was demonstrated, the next obvious step was to examine the physical and chemical properties of the toxics, and organic matrix ingredients, and of the complete paint system so as to be able to control the process. These studies have led to new and definite ideas about the way in which paints behave during exposure to sea water, and about the way in which various components of paint determine its effective behavior. The design of paint is thus passing out of the cook book stage onto a more secure engineering basis. As a by-product, new information has been secured about the solubility reactions of copper compounds and of various resins with sea water.

In all this development an important factor has been the close cooperation which has been achieved between the Navy's paint laboratories and the group at Woods Hole.

In order that the chemical studies could be checked by exposing panels painted with the various experimental formulations, the Institution maintained a test station at Miami where fouling is severe throughout the year. Dr. C. M. Pomerat, Dr. F. G. Walton Smith, and Mr. Charles M. Weiss, who in turn supervised this work also found time to make many valuable studies of the fouling process and of the biology of the organisms involved. In addition the station was used to an increasing degree for testing paints and other materials for the various Navy paint laboratories. Extensive tests of the actual performance of antifouling paints in service were also conducted from the Miami station. This work was greatly facilitated by the cooperation of the University of Miami, which made space available in its Marine Laboratory and was helpful in many other ways.

The need for detailed information on the tendency for various naval installations to foul led to the collection of a large number of samples of the growth from navigation buoys and their mooring chains from all parts

of the coast of the United States. The study of this material has already provided much new information on the depth and distance from shore at which fouling is to be expected, the relation of temperature to its rate of growth, and the geographical limits of the occurrence of the various species. The collections provide an uniquely comprehensive sampling of the sessile marine organisms of the sea coast. Their complete study should result in a very valuable contribution to biogeography.

Eight scientific papers have already been published, or are in press, in which the results of these chemical and biological by-products of the fouling studies are presented, and others should follow. In addition, at the present time a book is being written to be entitled "Marine Fouling and its Prevention". This will not only summarize the work carried on here during recent years for the Bureau of Ships, Navy Department, but it will also review critically the extensive scientific and technical literature on the subject. The chapters dealing with paint technology were distributed in preliminary form last September to the interested agencies and individuals for criticism. It is expected that the remainder will be completed and the book be ready for press by the end of the summer of 1946.

The completion of this book will mark a natural turning point in such studies. As an oceanographic laboratory we have carried the technological problems of the prevention of fouling to the point where they can be turned over to the paint laboratories with a clear understanding of the requirements imposed by biological considerations. On the other hand, it has become apparent that the fouling organisms themselves afford an opportunity which has not been adequately exploited for the study of many problems in the geographical distribution of marine organisms and the productivity of the sea. Studies of this sort could be profitably continued.

2. Temperature distribution in the surface layer of the North Atlantic.

Under this heading fall the studies which have become possible through the very great improvements in the bathythermograph which were achieved during 1941 and 1942. Starting with a relatively crude instrument, which could be used only at slow speeds, Dr. W. M. Ewing and Mr. Allyn C. Vine developed the basic idea behind Dr. A. F. Spilhaus' original design to the point where reliable temperature-depth curves down to roughly 150 meters could be secured from vessels traveling at speeds up to 20 knots. The applications of the bathythermograph to subsurface warfare are such that the Navy procured and put into routine services a considerable number of these instruments. At the present time from the North Atlantic alone some 60,000 records have accumulated.

This extensive file of new temperature data has been combined with the pre-war, published, subsurface temperature observations in such a way

that studies of the seasonal and diurnal thermal cycle are greatly facilitated. Under the direction of Mr. Frederick Fuglister average monthly values of the temperature at various standard levels down to 200 meters have been tabulated for each 30 minute square in the North Atlantic. The data are of course unevenly distributed, both with time and in the geographical sense; however, by combining observations from somewhat larger areas it is possible to follow the seasonal changes in considerable detail. Especially in the triangular sector between Cape Hatteras, Bermuda and the Grand Banks the average monthly values are derived from observations made over a considerable number of years. Thus we are approaching the time when studies of the annual temperature variations over relatively large areas of the ocean might be undertaken.

Many of the bathythermograph records, especially from the western North Atlantic, are in the form of sections of closely spaced lowerings. These are very helpful in determining the location of the important oceanographic boundaries such as the edge of the Gulf Stream and the offshore limits of coastal water. They also show in very satisfactory detail the mixing processes which occur near the margins of the currents. At present it can be considered that because of bathythermograph observations oceanography in this respect is somewhat ahead of meteorology.

In some regions temperature data alone, however detailed, are difficult to interpret in the absence of corresponding salinity measurements. The ideal arrangement would be to measure both temperature and salinity as a function of depth and then automatically combine them to record density. Several promising advances have been made in this direction. Various types of conductivity cells have been designed and tested. Electrical circuits have been worked out so that salinity or density can be recorded on deck as the conductivity cell and a suitable thermal element are lowered into the sea at the end of an electrical cable. This type of instrument has been shown to be practical and useful for observations down to a depth of about 200 meters. The next step will be to build a self powered instrument to be lowered from a hydrographic winch so that much deeper soundings will be possible. Such an instrument is still in the design stage. Enough tests of the various component parts have been made so that we are quite confident that the desired accuracy can be gained. The instrument, if successful, will be analogous to a barometer in meteorology in that it will sum the density of the water column through which it is lowered and thus rather directly will permit the relative topography of the sea surface to be plotted. If closely spaced observations of this type can be made without too much delaying the ship, much more reliable studies of the dynamics of ocean currents can be carried out than has been possible with the conventional water-bottles and reversing thermometers.

3. Air turbulence and convection over the ocean.

These studies stemmed from Mr. Alfred Woodcock's interest in the curious correlations between specific flight routines of herring gulls and co-existing thermal and flow relationships between sea and air. He accumulated evidence that when the air is gaining heat from the sea some sort of patterned convective motions are set up. There was evidence that these motions were similar to small scale convection cells which have been studied in the laboratory.

His war time studies of air motions were first centered around the problem of predicting the performance of smoke screens over the water, and especially in gaining a better understanding of the relatively complicated thermal structure which may exist in the lower air near a beach. A simple mechanical air thermograph, to be raised by a kite or balloon, was developed which greatly facilitated measurements of vertical temperature gradients at low elevations. This instrument is more inconvenient in use than the bathythermograph which serves the corresponding purpose in the oceans. This is due primarily to the widely differing physical constants of sea to air and to the simple fact that the observing platform does not move with the medium measured, as does the ship. With the aid of the air thermograph and other standard instruments, analysis of smoke screen behavior could be placed upon a physical basis. These studies were useful in furthering an understanding of lower air motion and have led directly to methods for deriving a much more complete physical picture of the air-sea inter-relationships.

As the program expanded Dr. Jeffries Wyman took over general supervision of the group studying low level meteorological phenomenon over the ocean. Instruments were developed to record wet and dry bulb temperatures simultaneously in order to help determine the scale of the convective motions under various conditions of wind and air-water temperature difference. More recently a considerable variety of recording instruments, including sensitive accelerometers and a new type of psychrograph, have been specially adapted for use on a relatively slow aeroplane. This is in preparation for studies of the structure of the lower atmosphere in the course of long flights over the ocean. It is also expected that arrangements can be made for the plane to collaborate with a surface vessel in studies of the heat exchange between the two mediums. The development and testing of suitable instruments for this program was practically completed in 1945.

4. Sea, swell and surf.

The methods developed at the Scripps Institution of Oceanography for forecasting sea and swell, and the studies of surf carried out principally

at the University of California emphasized the need for improved instruments to record sea and swell. Accordingly, early in the war we were asked to undertake such a development and at the same time to study the surf conditions along the Atlantic coast.

The early instrumental work was carried out under the supervision of Dr. W. M. Ewing. More recently Mr. Arthur Klebba has been in direct charge of the wave instrument program. Dr. George Clarke, assisted by Mr. Gardner Emmons and others, carried out measurements of the surf at a number of points along the coast and used these data to check several problems related to the forecasting methods.

Knowledge concerning waves advanced very rapidly during the war period and the results are being published by the Hydrographic Office. Wave theory, on the whole, outstripped the observational program, mainly because of the lack of suitable instruments. Recently, following a British development, Mr. Klebba has constructed a wave period analyzer which has great promise in the future of wave research. This instrument takes the record from his swell recorder and resolves the frequencies of the various wave trains making up the swell. An experimental wave recorder station is being set up at Cuttyhunk Island, about 14 miles west of Woods Hole, and it is expected that during 1946 another station will be installed at Bermuda where deep water wave characteristics can be conveniently recorded.

5. Underwater acoustics.

This subject is intimately bound up with physical oceanography and submarine geology. During the war years, under contracts administered by the National Defense Research Committee very great advances have been made. The contributions of the many investigators at the several laboratories engaged in this work will shortly be published. Since March 1944 the work in underwater acoustics at Woods Hole has been continued under contract with the Bureau of Ships (Underwater Sound Design Section).

From the oceanographic standpoint, perhaps the most interesting development in underwater acoustics is the system proposed by Dr. W. M. Ewing for locating survivors at sea. To date nearly all of the research in this connection has been carried out by members of our staff. The basic ideas involved have recently been made public by the Navy Department under the code name SOFAR.

Dr. Ewing realized that at mid-depths over large areas of the ocean there exists a layer where the speed of sound is at a minimum, forming a so-called sound channel. This layer is just below the main thermocline and thus varies slightly in depth geographically. Over most of the North Atlantic

the minimum velocity layer is at a depth of about 1300 meters. Because of refraction effects, signals emitted in this layer can travel very long distances without having to undergo either bottom or surface reflection. Thus acoustical transmission in this layer is relatively efficient and a receiver located at similar depth can record signals originating several thousand miles away.

It is convenient to use a small bomb (one or two pounds of explosives) as the sound source. Mr. J. L. Worzel, who has taken an active part in this project, worked out the details of a very simple fuse to fire a bomb near the desired depth. The time differences in the arrival of this signal at three widely spaced receiving stations establishes a fix. At the present time the Navy is planning to set up an experimental operating system to monitor the flight routes in the eastern North Pacific.

In order to study the potentialities of this means of communication and location, in 1944 we established a receiving station on Eleuthera Island in the Bahamas. This station was in operation for nearly a year during which time signals were recorded from wide areas of the North Atlantic, the maximum range being 3200 miles. For the sound to reach the receiver it is necessary that no obstruction occur along the great circle track between the source and the receiving station. Thus it is possible to sweep acoustically large areas of the ocean and to locate any submerged mountain peaks which interrupt the permanent sound channel. Several probable shoal areas in the North Atlantic have already been located in this manner.

It is clear that if Sofar is to become at all widely used in Air-Sea Rescue, the study of the distribution of temperature and salinity at mid-depths, and the charting of submerged peaks will be greatly stimulated. The ultimate limitations of the system will be determined by these factors, rather than by the sensitivity of the receiving equipment.

The environment of course influences acoustical transmission in many other ways. Especially for the higher frequencies, the vertical thermal structure becomes important. For the lower frequencies in deep water and for the higher frequencies in shallow water the bottom sediments must often be taken into account. Short period internal waves and very small scale thermal structure have also received some attention because they too influence the transmission of sound. It is believed that sound has become an important auxiliary means of exploring the ocean and that acoustical studies will continue to be carried out in close association with oceanography.

Special mention should be made of the considerable number of sediment charts prepared during recent years under the direction of Mr. Henry C. Stetson. All available sedimentary data from the continental shelf along the Atlantic and Gulf coasts were reexamined by Mr. Stetson, and a com-

plete set of sediment charts prepared for publication by the Hydrographic Office. He also undertook studies of the coastal sediments in many foreign areas, as required by the Hydrographic Office. The resulting charts have recently been released to the public.

While this was a rather specialized form of submarine geology, in that the sediments were classified under only six headings, nevertheless, it has led to a better general understanding of the distribution of the basic types of marine sediments and of the factors influencing this distribution.

6. Seismic Refraction Measurements in Shallow Water.

In 1944 as part of some studies undertaken for the Naval Ordnance Laboratory, Dr. W. M. Ewing and Mr. J. L. Worzel were able to work a number of seismic stations in Chesapeake Bay, off Jacksonville, near the Virgin Islands, off Barbados, off the Orinoco River and in the Gulf of Paria. Their instrumentation was superior to that previously used at sea and in each locality they obtained definite evidence as to the thickness of the unconsolidated sediments. The high quality of the records has served to clarify many problems of the transmission of sound waves both in the water and through the bottom. The results have been reported in preliminary form at a meeting of the Geological Society of America.

The many seismograms obtained in the course of the work provided excellent data for studies of the dispersion of the water wave, phenomena noted previously in which the higher frequency sound arrives ahead of the lower. Using the new data, Dr. C. L. Pekeris has recently completed a theoretical study which establishes a complete and detailed explanation of the observed dispersion in terms of bottom structure and the depth of the water. As the wave length of the sound approaches the depth of the water ray acoustics do not hold and wave acoustics must be used. The theory shows that a wave is developed which travels along the ocean floor and that measurement of the dispersion in the water wave may be used to determine the sound velocity in the ocean bottom to a depth approximately equal to the depth of the water. Although it has been used to date only in shallow water, the method is feasible for oceanic depths. During 1946 Dr. Ewing expects to resume field work in the application of geophysical methods to problems in submarine geology.

7. Underwater explosive phenomena.

As mentioned previously, during the war period a considerable proportion of our staff has been engaged in studying the physics of explosions, both in the air and in the water. In both media much of the work has centered around the problem of developing better gauges for measuring the pressure wave produced by an explosion. At first relatively small charges

were sufficient for calibrating and evaluating the various types of gauges studied, but inevitably we found ourselves working with larger and larger amounts of explosive materials.

Permission was secured to establish magazines and a small chemical laboratory for making up special charges on Nonamesset Island, directly across Woods Hole Harbor from the main laboratory building. The schooner "Reliance" was bought with contract funds and gradually fitted out with all the necessary instrumentation for explosive experiments in Vineyard Sound. From time to time the "Atlantis" has been used for special experiments which could best be carried out at greater distances from Woods Hole. Various other smaller craft have also been employed in this work. However, since research on explosives, even when they are used in the sea, is only remotely connected with oceanography, no attempt will be made here to discuss the full scope of this particular part of our war time program, the results of which will before long become available through the Office of Scientific Research and Development.

At the outset the explosives investigations were directed by Dr. E. Bright Wilson, Jr. He was succeeded by Dr. Paul C. Cross when Dr. Wilson had to leave to become a Division Chairman of the National Defense Research Committee. Dr. Paul Fye, Dr. Robert H. Cole, and Dr. J. Stacy Coles have had the primary responsibility in the underwater work, while Dr. William Kennedy has been in direct charge of the air blast measurements. It is expected that this particular part of our program will be terminated during 1946.

It should perhaps be added that from the standpoint of oceanography this work has been of value because much experience has been gained in carrying out elaborate and precise experiments at sea. The use of complicated electronic instruments on shipboard is a relatively new problem, but in all probability it will be a continuing one in oceanography.

V. STAFF

(As of December 31, 1945)

COLUMBUS O'D. ISELIN, Associate Professor of Physical Oceanography, Harvard University, and Associate Curator of Oceanography, Museum of Comparative Zoölogy; Director.

ALFRED C. REDFIELD, Professor of Physiology, Harvard University; Associate Director.

CLIFFORD A. BARNES, Lieut. Comdr., U. S. Coast Guard Reserve; Associate in Physical Oceanography.

DEAN F. BUMPUS, Associate in Oceanography.

CORNELIA L. CAREY, Associate Professor of Botany, Barnard College; Associate in Marine Bacteriology.

GEORGE L. CLARKE, Associate Professor of Zoölogy, Harvard University; Marine Biologist.

PAUL C. CROSS, Professor of Physical Chemistry, Brown University; Associate in Chemistry.

WILLIAM MAURICE EWING, Associate Professor of Geology, Columbia University; Associate in Submarine Geology.

LOUIS W. HUTCHINS, Associate in Marine Biology.

BOSTWICK H. KETCHUM, Associate in Marine Biology.

RAYMOND B. MONTGOMERY, Physical Oceanographer.

FRED B. PHLEGER, JR., Associate Professor of Geology, Amherst College; Associate in Submarine Geology.

NORRIS W. RAKESTRAW, Professor of Chemistry, Brown University; Chemical Oceanography.

CHARLES E. RENN, Associate Sanitary Biologist, Massachusetts Dept. of Public Health; Associate in Marine Bacteriology.

GORDON A. RILEY, Research Associate, Bingham Oceanographic Foundation; Marine Physiologist.

C. G. ROSSBY, Professor of Meteorology, University of Chicago, and Assistant Chief, U.S. Weather Bureau, Washington, D. C.; Associate in Physical Oceanography.

MARY SEARS, Lieut. Comdr., U. S. Naval Reserve (W); Planktonologist.

H. R. SEIWELL, Lt. Col., Corps of Engineers, U. S. Army; Physical Oceanographer.

FLOYD M. SOULE, Comdr., U. S. Coast Guard Reserve; Associate in Physical Oceanography.

ATHELSTAN F. SPILHAUS, Major, Weather Division, U. S. Army Air Forces; Physical Oceanographer.

HENRY C. STETSON, Associate Curator of Oceanography and Alexander Agassiz Fellow, Museum of Comparative Zoölogy; Submarine Geologist.

SELMAN A. WAKSMAN, Professor of Microbiology, New Jersey Agricultural Experiment Station; Marine Bacteriologist.

EDMOND E. WATSON, Associate Professor of Physics, Queen's University; Physical Oceanographer.

ALFRED H. WOODCOCK, Physical Oceanographer.

JEFFRIES WYMAN, Associate Professor of Biology, Harvard University; Associate in Oceanography.

JOHN MCGILVRAY, JR., Comptroller.

HELEN F. PHILLIPS, Secretary to the Director.

WILLIAM C. SCHROEDER, Business Manager.

WILLIAM SCHROEDER, Superintendent of Buildings and Grounds.