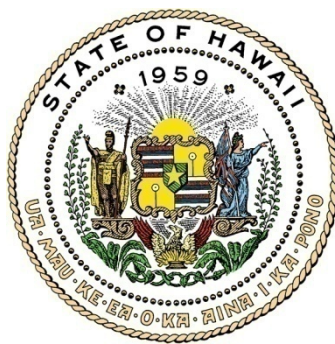


# *Survey of Ocean Science and Technology Activity in Hawaii*

**2007**



**Department of Business, Economic Development and Tourism  
July 2009**

This report has been cataloged as follows:

Hawaii. Dept. of Business, Economic Development and Tourism. Research and Economic Analysis Division.

Survey of ocean science and technology activity in Hawaii, 2007. Honolulu: 2009.

1. Marine resources-Economic aspects-Hawaii.  
GC1021.H3.H32.2009

**Cover photo:** Scientist working on the Hawaii Ocean Time-series (HOT) program inspects ocean water samples. Since October 1988 the HOT program has been making repeated observations of the hydrography, chemistry and biology of the water column at the deep-water Station ALOHA (A Long-Term Oligotrophic Habitat Assessment) located 100 km north of Oahu. The objective of this research is to provide a comprehensive description of the ocean at a site representative of the North Pacific subtropical gyre. Approximately once per month researchers visit the water station to measure the thermohaline structure, water column chemistry, currents, optical properties, primary production, plankton community structure, and rates of particle export. Courtesy UH School of Ocean and Earth Science and Technology (SOEST).

# Survey of Ocean Science and Technology in Hawaii, 2007

## Table of Contents

EXECUTIVE SUMMARY .....	4
Jobs .....	5
Historical Data .....	6
II. INDUSTRY ANALYSIS: 2002-2007 .....	8
A. Sources of funding.....	8
B. Performers .....	10
C. Subject Areas .....	11
D. Jobs .....	12
III. HISTORICAL DATA.....	13
IV. CONCLUSIONS.....	15
V. REFERENCES.....	16

### Tables and Figures

Table 1. Total Expenditures for Ocean Science and Technology in Hawaii, 2002-2007.....	4
Figure 1. Summary.....	5
Table 2. Full-time Equivalent (FTE) Jobs in Ocean Research Employment, 2002-2007 .....	6
Table 3. Total Ocean Science and Technology Expenditures in Hawaii, by Subject Areas.....	6
Table 1a. Total Expenditures, Ocean Science and Technology in Hawaii, by Source and Performer, 2002-2007 .....	8
Table 1b. Total Expenditures, Ocean Science and Technology in Hawaii by Percent of Total.....	9
Figure 1. Sources of Revenue, Hawaii Ocean Science and Technology, Federal and all Sources, 2002 to 2007. ....	9
Figure 2. Funding Received by Hawaii Performers, Ocean Science and Technology, 2002 to 2007. ....	10
Table 2. Expenditures in Hawaii, by Subject Areas, Ocean Science and Technology, 2002 to 2007 .....	11
Table 3. Full-Time Equivalent (FTE) jobs in Ocean Science and Technology 2002 to 2007 .....	12
Table 4. Total Ocean Science and Technology Expenditures in Hawaii, by Subject Areas .....	13

# Survey of Ocean Science and Technology in Hawaii, 2007

## EXECUTIVE SUMMARY

The most recent survey of expenditures on ocean science and technology in Hawaii revealed total expenditures in 2007 were nearly \$146 million, down \$10 million from \$156 million in 2006. From 2002 to 2007, expenditures in ocean science and technology showed mixed performance. For the period

as a whole, expenditures increased 3.8%. Expenditures grew vigorously from 2002 to 2004, reaching \$176 million. However since then, overall expenditures have declined consistently. The 2007 total for expenditures of \$146 million was 17.4% below the 2004 peak.

**Table 1. Total Expenditures for Ocean Science and Technology in Hawaii, 2002-2007**

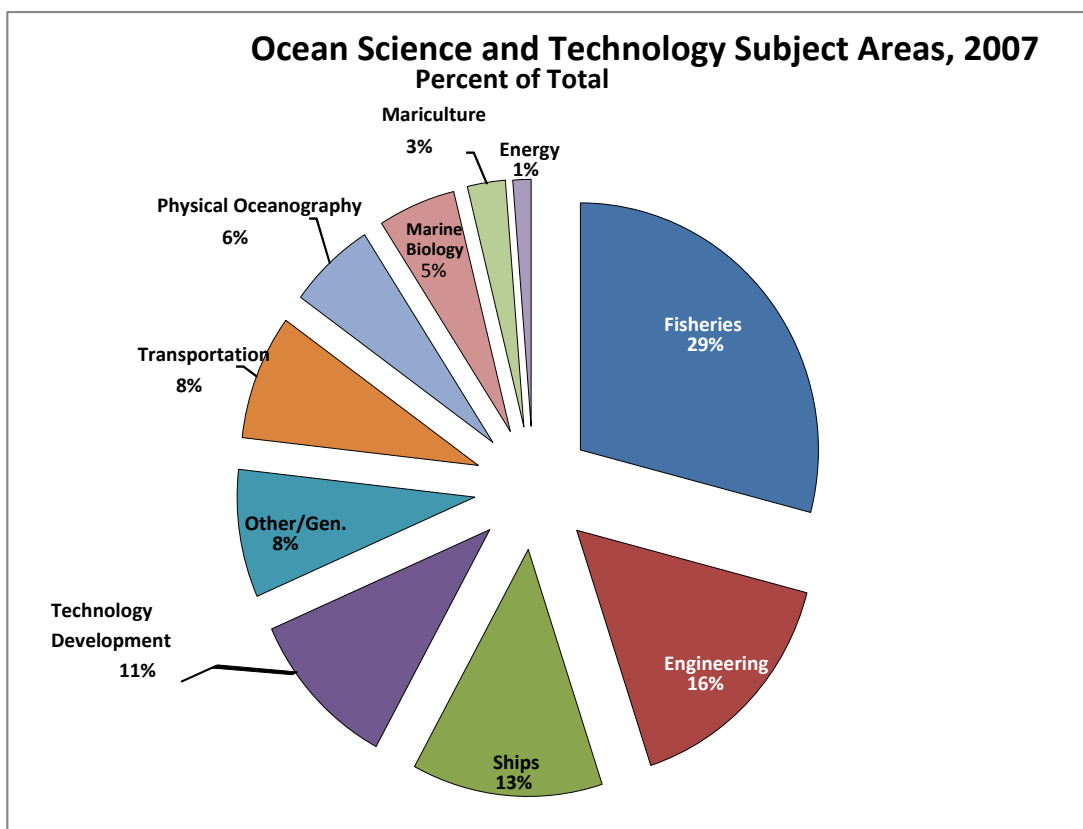
	Expenditures in Millions of Dollars						Percent Change	
	2002	2003	2004	2005	2006	2007	2006-2007	2002-2007
<b>I. BY SOURCE</b>								
<b>Outside Hawaii:</b>								
Federal	116.4	139.8	143.4	129.1	131.5	118.1	-10.2	1.4
International	2.3	3.3	8.0	4.7	3.5	6.2	80.2	172.4
U.S. Mainland	5.0	2.6	3.3	9.4	2.7	3.4	29.4	-31.7
<i>Subtotal</i>	123.8	145.7	154.6	143.2	137.6	127.8	-7.1	3.3
<b>In Hawaii:</b>								
State	11.2	5.2	8.6	7.4	10.0	7.8	-22.2	-30.8
Private	4.0	2.6	7.7	11.6	6.9	8.6	24.7	112.0
County	0.9	0.9	5.2	1.9	1.0	0.8	-16.8	-9.4
Non-profit	0.4	0.3	0.2	0.3	0.3	0.7	110.0	89.9
<i>Subtotal</i>	16.5	9.0	21.6	21.1	18.1	17.8	-1.8	8.0
<b>Total</b>	<b>140.3</b>	<b>154.7</b>	<b>176.3</b>	<b>164.2</b>	<b>155.8</b>	<b>145.6</b>	<b>-6.5</b>	<b>3.8</b>
<b>II. BY PERFORMER</b>								
Federal	39.4	39.7	43.9	50.6	52.7	50.9	-3.3	29.3
State	12.6	11.0	23.6	13.0	14.6	13.5	-7.4	7.2
Univ of Hawaii	21.4	23.4	39.4	35.2	29.5	22.8	-22.7	6.7
Hawaii Private	59.4	73.1	60.1	56.0	51.9	55.7	7.2	-6.3
Hawaii Non-profit	7.5	7.5	9.1	9.4	7.1	2.7	-62.5	-64.5
<b>Total</b>	<b>140.3</b>	<b>154.7</b>	<b>176.3</b>	<b>164.2</b>	<b>155.8</b>	<b>145.6</b>	<b>-6.5</b>	<b>3.8</b>

**Source: DBEDT**

By expenditure subject areas, Fisheries represented the largest single category of Ocean Science and Technology activity in

2007. This was followed by engineering, ships, and technology development.

Figure 1. Summary



**Source: DBEDT**

About half of the subject categories showed growth in expenditures from 2002 to 2007 and half showed declines. The most notable increase was in technology development, growing from just \$500,000 in 2002 to \$15.3 million by 2007. Transportation grew from no expenditures in 2002 to \$11.9 million in 2007. Fisheries increased from \$30.0 million in 2002 to \$42.4 million in 2007. The largest decline occurred in engineering (which fell from \$30.4 million to \$23.2 million over the period) and surveying, (declining from \$11.4 million to \$1.2 million).

### Jobs

Ocean science and technology firms provided just under 1,350 full time equivalent jobs in 2007. Similar to the pattern of expenditures, jobs in the ocean science and technology sector in the 2002 to 2007 period showed mixed performance. Jobs grew early in the period, peaking around mid decade (2005) at about 1,630 full time equivalent positions. Since then, jobs have slipped back to below the 2002 level.

**Table 2. Full-time Equivalent (FTE) Jobs in Ocean Research Employment, 2002-2007**

Sector	2002	2003	2004	2005	2006	2007
Federal	404	432	467	459	427	411
State	57	56	52	52	52	53
University	519	519	523	523	507	507
Hawaii Private	467	505	461	495	322	300
Hawaii Non-profit	113	113	111	98	95	77
<b>Total</b>	<b>1,559</b>	<b>1,625</b>	<b>1,614</b>	<b>1,627</b>	<b>1,403</b>	<b>1,348</b>

Source: DBEDT

**Historical Data**

Despite the more recent easing of activity, Hawaii's ocean science and technology sector has seen impressive growth over the last 20 years. Looking only at comparable categories, total revenues rose from an annual average \$63 million in 1987/89 to a high of \$157 million for 2002/04, before

settling back to an average of \$133 million in 2005/07. The category showing the most pronounced long-term growth in terms of expenditures has been Fisheries. From 1987/89 to 2005/07, its average annual growth rate has exceeded 12%, with expenditures increasing from an average \$5.2 million for 1987/89 to \$43 million in 2005-2007.

**Table 3. Total Ocean Science and Technology Expenditures in Hawaii, by Subject Areas****(3-year annual average, in millions of dollars)**

Subject Area	1987-1989	1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	2005-2007
Energy	8.2	9.2	3.7	0.1	0.0	0.2	1.8
Mariculture	6.9	10.5	11.8	5.3	5.3	8.7	7.8
Engineering	4.9	6.8	5.7	12.2	22.2	30.9	20.2
Fisheries	5.2	5.8	8.3	17.3	19.3	36.8	42.9
Ships	4.6	4.0	4.9	5.8	8.1	21.1	17.1
Marine Biology	2.3	5.3	5.6	4.7	5.4	5.7	6.5
Geology/Geophysics	3.5	3.2	2.9	3.4	3.4	2.5	1.7
Physical Oceanography	1.9	4.3	5.5	7.7	11.4	9.6	9.3
Surveying	0.7	4.0	1.4	2.5	2.6	7.1	1.3
Chemistry	0.5	2.5	3.0	2.2	1.7	1.6	0.5
Mining/Minerals	1.0	1.3	0.9	0.2	0.1	0.0	0.0
Water Quality	0.3	1.5	2.9	1.2	1.2	4.2	1.3
Coastal Development	0.1	0.7	0.8	0.5	1.1	2.5	3.4
Other General	22.8	35.8	26.5	24.4	22.9	17.6	8.1
Transportation	0.0	0.0	0.0	0.0	0.2	0.5	8.7
Recreation	0.1	0.2	0.2	0.1	0.4	0.5	1.2
Law/Policy	0.0	1.3	5.1	0.1	0.2	0.4	0.6
<b>Sub Total</b>	<b>63.1</b>	<b>96.5</b>	<b>89.2</b>	<b>87.7</b>	<b>105.2</b>	<b>149.9</b>	<b>132.5</b>
Software Sales					1.3	1.3	0.9
Equipment Sales/Purch					0.2	0.0	0.8
Technology Development					9.6	5.9	21.0
<b>Grand Total</b>	<b>63.1</b>	<b>96.5</b>	<b>89.2</b>	<b>87.7</b>	<b>116.4</b>	<b>157.1</b>	<b>155.2</b>

Source: DBEDT

## I. INTRODUCTION

This study will focus on the results of an updated survey of Ocean Science and Technology activity in Hawaii conducted for years 2006 and 2007. It is the fifth in a series of studies produced by DBEDT since 1987 focusing on trends in the funding sources, performers, subject areas, and employment in Ocean Science and Technology activity (see References section for a list of previous reports).

Ocean activities in Hawaii, ranging from marine biology to specialized software development, have been the focus of State interest and development efforts since the late 1980s. The sector is made up of multiple specialties, sources of financing and performing organizations, including private businesses, non -profit organizations, academic research institutions, and State and Federal government agencies.

In order to monitor performance of the sector, estimates of gross revenues and jobs have been developed through a survey of organizations engaged in the various specialties and through reviews of contract records for the University of Hawaii. The survey initially included 17 subject areas which were increased to 20 areas in 1999.

Thanks to funding made available through Act 148 (SLH 2007), DBEDT was able to conduct an updated survey covering expenditures and employment for 2006 and 2007. The survey attained 100% response from surveyed organizations. DBEDT is grateful to those many dedicated public and private organizations that provided information for this report.

Since the purpose of this study is to provide a timely report on results of the updated expenditures survey, a detailed review of the various subject areas and projects underway in Ocean Science and Technology was not conducted. Such a review may be the subject of a follow-up report.

This survey was conducted under contract by East-West Business Consultants, Dr. Andrea LaBarge, Principal Investigator. Results were compiled and analyzed for this report by Dr. Ming Zhang of DBEDT's Research and Economic Analysis Division (READ). The project was a joint effort by READ and the Science and Technology Branch of the Strategic Industries Division of DBEDT.

## II. INDUSTRY ANALYSIS: 2002-2007

This section examines recent performance in the Ocean Science and Technology sector from 2002 to 2007. A longer-term look at performance in the sector is presented in section III.

The total annual expenditure on ocean science and technology is broken down in three ways: 1) by source of funding, 2) by performing organization, and 3) by the subject area of the activity funded. In addition, jobs by major sector are presented in subsection D.

### A. Sources of funding

Table 1a shows total expenditures for ocean science and technology in Hawaii and growth

rates by source of funding and performing organizations during the 2002 to 2007 period. Table 1b shows the proportion that sources and performers accounted for in total expenditures. Expenditures on Ocean Science and Technology activities in Hawaii rose from \$140.3 million in 2002 to \$145.6 million in 2007, an average annual growth rate of 0.7% (Table 1a). However, over the five-year period, annual performance has been mixed. Annual growth rates ranged from a positive 14.0% from 2003- 2004 to a negative 6.9% from 2004 to 2005. Between the 2004 peak in expenditures of \$176.3 million there has been a consistent decline averaging 6.2% per year.

**Table 1a. Total Expenditures, Ocean Science and Technology in Hawaii, by Source and Performer, 2002-2007**

	Expenditures in Millions of Dollars						Percent Change					
	2002	2003	2004	2005	2006	2007	02-03	03-04	04-05	05-06	06-07	02-07
<b>I. BY SOURCE</b>												
<b>Outside Hawaii:</b>												
Federal	116.4	139.8	143.4	129.1	131.5	118.1	20.0	2.6	-10.0	1.9	-10.2	1.4
International	2.3	3.3	8.0	4.7	3.5	6.2	44.6	140.5	-40.9	-26.5	80.2	172.4
U.S. Mainland	5.0	2.6	3.3	9.4	2.7	3.4	-48.0	27.1	182.3	-71.7	29.4	-31.7
<i>Subtotal</i>	<i>123.8</i>	<i>145.7</i>	<i>154.6</i>	<i>143.2</i>	<i>137.6</i>	<i>127.8</i>	<i>17.7</i>	<i>6.1</i>	<i>-7.4</i>	<i>-3.9</i>	<i>-7.1</i>	<i>3.3</i>
<b>In Hawaii:</b>												
State	11.2	5.2	8.6	7.4	10.0	7.8	-53.3	63.7	-13.7	34.9	-22.2	-30.8
Private	4.0	2.6	7.7	11.6	6.9	8.6	-36.5	201.2	49.3	-40.5	24.7	112.0
County	0.9	0.9	5.2	1.9	1.0	0.8	3.6	448.4	-63.7	-47.2	-16.8	-9.4
Non-profit	0.4	0.3	0.2	0.3	0.3	0.7	-16.8	-39.7	47.4	22.3	110.0	89.9
<i>Subtotal</i>	<i>16.5</i>	<i>9.0</i>	<i>21.6</i>	<i>21.1</i>	<i>18.1</i>	<i>17.8</i>	<i>-45.2</i>	<i>139.5</i>	<i>-2.6</i>	<i>-13.9</i>	<i>-1.8</i>	<i>8.0</i>
<b>Total</b>	<b>140.3</b>	<b>154.7</b>	<b>176.3</b>	<b>164.2</b>	<b>155.8</b>	<b>145.6</b>	<b>10.3</b>	<b>13.9</b>	<b>-6.8</b>	<b>-5.2</b>	<b>-6.5</b>	<b>3.8</b>
<b>II. BY PERFORMER</b>												
Federal	39.4	39.7	43.9	50.6	52.7	50.9	0.9	10.6	15.1	4.2	-3.3	29.3
State	12.6	11.0	23.6	13.0	14.6	13.5	-13.0	115.5	-44.8	11.9	-7.4	7.2
Univ of Hawaii	21.4	23.4	39.4	35.2	29.5	22.8	9.3	68.8	-10.8	-16.2	-22.7	6.7
Hawaii Private	59.4	73.1	60.1	56.0	51.9	55.7	23.1	-17.8	-6.8	-7.3	7.2	-6.3
Hawaii Non-profit	7.5	7.5	9.1	9.4	7.1	2.7	0.9	21.4	2.8	-24.8	-62.5	-64.5
<b>Total</b>	<b>140.3</b>	<b>154.7</b>	<b>176.3</b>	<b>164.2</b>	<b>155.8</b>	<b>145.6</b>	<b>10.3</b>	<b>13.9</b>	<b>-6.8</b>	<b>-5.2</b>	<b>-6.5</b>	<b>3.8</b>

Source: DBEDT



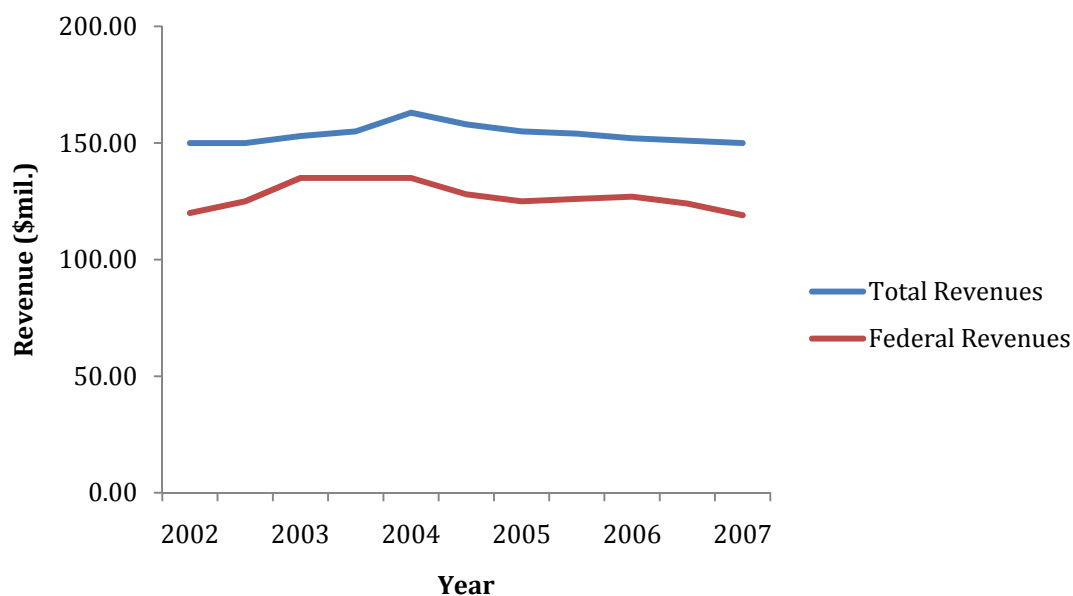
**Table 1b. Total Expenditures, Ocean Science and Technology in Hawaii, by Percent of Total**

Percent of Total Expenditures						
	2002	2003	2004	2005	2006	2007
<b>I. BY SOURCE</b>						
<b>Outside Hawaii:</b>						
Federal	83.0	90.3	81.3	78.6	84.4	81.1
International	1.6	2.1	4.5	2.9	2.2	4.3
U.S. Mainland	3.6	1.7	1.9	5.7	1.7	2.4
<i>Subtotal</i>	88.2	94.2	87.7	87.2	88.3	87.8
<b>In Hawaii:</b>						
State	8.0	3.4	4.9	4.5	6.4	5.3
Private	2.9	1.7	4.4	7.0	4.4	5.9
County	0.6	0.6	2.9	1.1	0.6	0.6
Non-profit	0.3	0.2	0.1	0.2	0.2	0.5
<i>Subtotal</i>	11.8	5.8	12.3	12.8	11.7	12.2
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>II. BY PERFORMER</b>						
Federal	28.1	25.7	24.9	30.8	33.8	35.0
State	9.0	7.1	13.4	7.9	9.4	9.3
Univ of Hawaii	15.3	15.1	22.4	21.4	18.9	15.7
Hawaii Private	42.4	47.3	34.1	34.1	33.3	38.2
Hawaii Non-profit	5.3	4.9	5.2	5.7	4.5	1.8
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Table 1b and Figure 1 show that the Federal government is by far the most significant source of funds for Ocean Science and

research. Funding ranged from 79% to 90% total funding over the 2002 to 2007 period.

Figure 1. Sources of Revenue, Hawaii Ocean Science and Technology, Federal and all Sources, 2002 to 2007.



Foreign and Mainland sources of expenditures have provided a much smaller proportion. Mainland sources have ranged from 1.7% to 5.7% of total expenditures. International sources of expenditures have ranged from 1.6% to 4.5% over the 2002 to 2007 period.

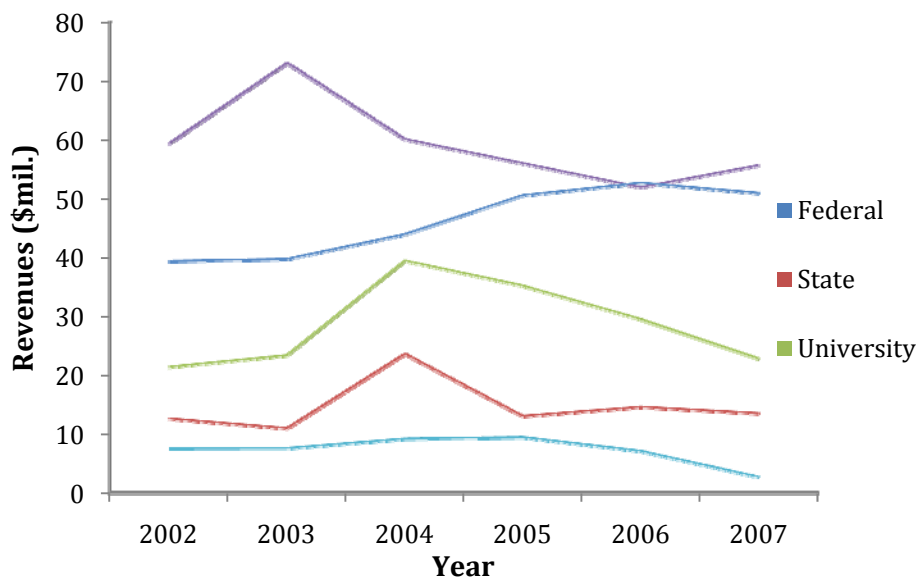
Sources of spending obtained within the state have ranged from a low of 5.8% in 2003 to a high of 12.8% in 2005. Expenditures by the State government have represented the largest proportion of in-state funding, followed by expenditures of the private sector, counties and non profits in that order.

The major proportions have remained relatively stable over the five-year period, with about 88% of expenditures from out-of-state sources and 12% percent raised within the state.

### B. Performers

The private sector has generally been the major performer in Hawaii’s Ocean Science and Technology sector (Table 1b & Figure 2). However, that dominance declined over the 2002 to 2007 period, with the private sector falling from a high of 47% of expenditures in 2003 to 33% in 2006. That proportion recovered a bit to 38% in 2007. Performance among Federal agencies has been the second highest and has generally increased in importance over the 2002-2007 period. From a low of 25% of expenditures in 2004, Federal agencies as performers increased to 35% in 2007. The University of Hawaii as a performer has ranged from 15% of expenditures in 2002 and 2003 to 22% in 2004. For 2007 the University accounted for about 16% of expenditures as a performer.

Figure 2. Funding Received by Hawaii Performers, Ocean Science and Technology, 2002 to 2007.



### C. Subject Areas

The Fisheries category has been the most heavily funded subject area over the 2002 to 2007 period. In 2007 it accounted for more than \$42 million in expenditures, or about 29% of all expenditures on Ocean Science and Technology.

The subject area that has shown the most pronounced growth since 2002 has been technology development, although it lost some ground in the latest survey. Technology development increased from \$500,000 in 2002 to nearly \$28 million in 2005. The category subsequently declined to \$15 million in 2007.

Surveying showed the most decline among subject categories, falling from \$11 million in 2002 to just over \$1 million in 2007.

Engineering peaked in 2003 at \$40.0 million and started to decline to 2007's \$23.2 million. The Other/General category declined from 2002's \$19.7 million to 2007's \$4.6 million at the annual rate of negative 25.2%. The category of Ships was one of the leading subject areas during 2002-2007, and it remained very steady around \$18 million.

Table 2. Expenditures in Hawaii, by Subject Areas, Ocean Science and Technology, 2002 to 2007

(in millions of dollars)

Subject Area	2002	2003	2004	2005	2006	2007
Other/Gen.	19.7	17.8	15.3	14.7	5.2	4.6
Engineering	30.4	40.0	22.2	16.2	21.3	23.2
Water Quality	0.8	3.9	7.8	3.1	0.2	0.6
Transportation	0.0	0.2	1.4	0.3	13.9	11.9
Fisheries	30.0	37.2	43.2	41.8	44.7	42.4
Mariculture	6.7	4.9	14.6	11.8	7.8	3.8
Surveying	11.4	7.4	2.4	1.4	1.5	1.2
CZM/Coastal Develop	1.6	2.3	3.5	3.0	5.9	1.1
Energy	0.1	0.3	0.1	2.7	1.0	1.8
Mining/Minerals	0.0	0.0	0.0	0.0	0.0	0.0
Recreation	0.2	0.0	1.2	0.5	1.8	1.3
Geo & Geophysics	4.3	1.7	1.6	3.1	1.4	0.5
Ships	18.4	21.3	23.5	18.3	14.0	18.9
Phy Oceanography	9.5	6.1	13.1	8.2	11.1	8.6
Marine Biology	4.0	6.1	7.1	8.6	3.3	7.7
Chemistry	1.0	1.4	2.5	0.4	0.6	0.5
Law/Policy	0.1	0.5	0.6	0.9	0.4	0.4
Software Sales	1.4	1.4	1.1	0.8	0.9	1.1
Equipment Sales/Purch.	0.0	0.1	0.0	0.0	1.6	0.9
Tech. Development	0.5	2.2	15.0	28.6	19.1	15.3
<b>TOTAL</b>	<b>140.3</b>	<b>154.7</b>	<b>176.3</b>	<b>164.2</b>	<b>155.8</b>	<b>145.6</b>

### D. Jobs

Ocean science and technology firms provided just under 1,350 full time equivalent jobs in 2007 (Table 3). This was about 200 fewer jobs than in 2002, or a 13% decline. Similar to the pattern of expenditures, jobs in the ocean science and technology sector in the 2002 to 2007 period showed mixed performance. Jobs grew early in the period, peaking around mid decade (2005) at about 1,630 full time equivalent positions. Over the subsequent two years, jobs slipped back to below the 2002 level.

The Federal sector was the only area to show gains in employment over the 2002-2007 period, while Hawaii's private sector showed the most decline.

During the period, the University provided the largest number of full-time equivalent jobs in ocean research, followed by the Federal government and Hawaii's private sector. The State and non-profit sectors ranked consistently lowest in ocean research employment.

Table 3. Full-Time Equivalent (FTE) jobs in Ocean Science and Technology 2002 to 2007

<b>Sector</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Federal	404	432	467	459	427	411
State	57	56	52	52	52	53
University	519	519	523	523	507	507
Hawaii Private	467	505	461	495	322	300
Hawaii Non-profit	113	113	111	98	95	77
<b>Total</b>	<b>1,559</b>	<b>1,625</b>	<b>1,614</b>	<b>1,627</b>	<b>1,403</b>	<b>1,348</b>

Source: DBEDT

### III. HISTORICAL DATA

Historical data for Ocean Science and Technology activities are available for most subject areas from 1987. Table 4 shows the available historic data developed through the series of surveys conducted over the period. Three-year annual averages have been used in order to help smooth the effects of multi-year grants that can cause fluctuations in year-to-year data.

As the table indicates, additional subject categories for software, equipment, and technology development were added beginning in 1999. As a result, total expenditures for the 1999 to 2007 period are not directly comparable to the 1987 to 1998 period. Only the performance of individual subject area components and the subtotal for the 17 common subject areas from 1987 to 2007 can be compared.

Table 4. Total Ocean Science and Technology Expenditures in Hawaii, by Subject Areas

**(3-year averages, in millions of dollars)**

Subject Area	1987-1989	1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	2005-2007
Energy	8.2	9.2	3.7	0.1	0.0	0.2	1.8
Mariculture	6.9	10.5	11.8	5.3	5.3	8.7	7.8
Engineering	4.9	6.8	5.7	12.2	22.2	30.9	20.2
Fisheries	5.2	5.8	8.3	17.3	19.3	36.8	42.9
Ships	4.6	4.0	4.9	5.8	8.1	21.1	17.1
Marine Biology	2.3	5.3	5.6	4.7	5.4	5.7	6.5
Geology/Geophysics	3.5	3.2	2.9	3.4	3.4	2.5	1.7
Physical Oceanography	1.9	4.3	5.5	7.7	11.4	9.6	9.3
Surveying	0.7	4.0	1.4	2.5	2.6	7.1	1.3
Chemistry	0.5	2.5	3.0	2.2	1.7	1.6	0.5
Mining/Minerals	1.0	1.3	0.9	0.2	0.1	0.0	0.0
Water Quality	0.3	1.5	2.9	1.2	1.2	4.2	1.3
Coastal Development	0.1	0.7	0.8	0.5	1.1	2.5	3.4
Other General	22.8	35.8	26.5	24.4	22.9	17.6	8.1
Transportation	0.0	0.0	0.0	0.0	0.2	0.5	8.7
Recreation	0.1	0.2	0.2	0.1	0.4	0.5	1.2
Law/Policy	0.0	1.3	5.1	0.1	0.2	0.4	0.6
<b>Sub Total</b>	<b>63.1</b>	<b>96.5</b>	<b>89.2</b>	<b>87.7</b>	<b>105.2</b>	<b>149.9</b>	<b>132.5</b>
Software Sales					1.3	1.3	0.9
Equipment Sales/Purch					0.2	0.0	0.8
Technology Development					9.6	5.9	21.0
<b>Grand Total</b>	<b>63.1</b>	<b>96.5</b>	<b>89.2</b>	<b>87.7</b>	<b>116.4</b>	<b>157.1</b>	<b>155.2</b>

Using just the subtotal for the 17 common subject areas between 1987 and 2007, the Ocean Science and Technology sector has seen ups and downs over the last 20 years but has managed impressive net growth over the full period.

The period 1987 to 1992 showed strong growth. However, this was followed by declining revenues for most of the remainder of the 1990s. Activity returned to a growth

phase in the first half of this decade, with a decline setting in around mid-decade.

Overall, average annual expenditures rose from \$63 million in 1987-89 to a high of \$150 million in 2002-04, before settling back to \$133 million in the 2005-07 period.

The category that has shown the most pronounced growth in terms of expenditures over the 20-year period has been Fisheries. From 1987-89 to 2005-07, it grew from \$5.2

to \$42.9 million. This is an average annual growth rate of around 12%.

Only four categories showed a net decline over the 20 year period. Those were Energy, Geology/Geophysics, mining/minerals and the miscellaneous category of "Other General." However, energy has experienced positive growth since the 1999-2001 period.

More recently, in the 1999 to 2007 period, expenditures on technology develop projects

in ocean science and technology have accelerated, making this a major subject area. Averaging \$21 million per year from 2005 to 2007, technology development has more than doubled from its 1999-2001 average.

#### IV. CONCLUSIONS

Based on this long-running survey, ocean science and technology activity in Hawaii has grown significantly over the last 20 years, although there have been periods of contraction in the activity. The industry appears to be going through a modest contraction since middle of the decade in terms of overall expenditures and employment.

Despite the recent overall declines, some areas of the sector have shown notable strength for the 2005-2007 period, including fisheries, marine biology, transportation, technology development, energy and several others to a lesser extent.

In terms of sources of funding for ocean science and technology, the Federal government is by far the most significant investor in Hawaii, with the State and private sector distant runners up.

Of the \$146 million invested in the ocean science and technology sector during 2007, 38% flowed into private sector research and sales, 35% to Federal research programs, and 16% to the University of Hawaii. Other State agencies picked up 9% of the investment, with the remaining 2% going to non-profit organizations.

## V. REFERENCES

Corbin, E., A.L. LaBarge and H.E. Deese, "Growth and development of the Hawaii ocean science and technology industry," in Oceans '04 MTS/IEEE /Techno-Ocean '04 Proceedings. Washington, DC.: Marine Technology Society and IEEE, 2004.

MacDonald, C.D. and A.L. LaBarge, "Ocean R&D spending patterns in Hawaii: analysis and outlook," in Proceedings of the Fourth Pacific Congress on Marine Science and Technology, vol. II. Honolulu, HI: PACON International, 1990

MacDonald, C.D. and A.L. LaBarge, "Focus on ocean R&D: a sweepstakes industry for Hawaii," in MTS '93 Proceedings. Washington, D.C.: Marine Technology Society, 1993

MacDonald, C.D., A.L. LaBarge and E. Corbin, "Changing markets and emerging performer in Hawaii's ocean R&D industry," in OCEANS '97 Proceedings, vol. II. Washington, D.C.: IEEE and Marine Technology Society, 1997