

5. DATA ACQUISITION TOOLS AND PROVIDERS DATABASE

5.1. PURPOSE

Part of Task 3, as defined in the California Department of Fish and Game (DFG) Nearshore Ecosystem Database Project (NEDP) was to collect information on remote sensing technologies applicable to nearshore habitat mapping. This information was to include:

- ◆ The types of tools in use and available, as well as emerging new technologies
- ◆ A comparison of the performance specifications for these systems
- ◆ A manufacturers reference list
- ◆ A summary of service providers capable of using these tools to meet DFG mapping needs
- ◆ The relative cost of using these tools to acquire nearshore (0-30 m) habitat data over different ranges of scale and resolution

Here we define “tool” as any piece of hardware or software that is used for acquisition, processing, or display of bathymetric or backscatter data. Our goal was to create a database containing this information in a format useful to DFG personnel charged with planning, acquiring, or using benthic habitat mapping data from nearshore, shallow water environments. Our objective was to collect, organize, and present all relevant information in a useable database. The following categories were used to organize the information: Tools, Tool Manufacturers, Survey Service Providers, Survey Equipment Providers, University Contact List, University Capabilities, and Government and Non-Profit Agencies. Our general approach was to first identify the types of tools most commonly used for acquiring seafloor depth and substrate data as well as new technologies that show promise for shallow water mapping. Once the list was developed, the next objective was to contact as many reliable sources possible to gather information about the relative performance and costs of using these tools, as well as service providers available on the West coast. This information was then compiled into the table presented below as well as a Microsoft Access database as requested by DFG.

A list of common tools was obtained from published reports, personal contacts, trade journals conversations, information packets and survey service provider websites.

5.2. METHODS

Prior to beginning our search for information, a database was developed in Microsoft Access for archiving the information and to allow for queries and relational searches. Data tables were created for each type of entry (tools specification, provider services and costs, etc.), and where appropriate tables have been linked to another table via an intermediate relational table. A unique ID number has been assigned to each entry, and these ID numbers have been placed in a relationship table to allow for crossover queries. Forms have already been developed to aid in, and display the results from the most common types of queries likely to be performed by DFG. Although there is more information in the database than reflected on the current forms, these

forms can be easily adjusted to fit specific needs. New relationships and forms can also be created as needed.

While the database was being setup, a preliminary search for information was done using the web, industry and scientific journals (i.e. *Sea Technology*, *Geology*, etc.), and personal contacts. This search was used to create lists of those manufactures, service providers, universities, survey equipment providers, and agencies capable of meeting DFG mapping needs. Our focus was on technologies suitable for the acquisition and processing of seafloor depth and substrate data along the California continental shelf, with special attention given to the shallow nearshore (0-30 m depth).

Manufacturers were first asked to fax information packets to aid in our initial evaluation of tools. Tools specifications and prices were recorded. Manufactures were then re-contacted to obtain references for relevant tools and any information unavailable in the information packets. Tools were then tabulated and placed in categories such as: multibeam, side scan sonar, processing and acquisition, seabed classification systems and electro-optical systems. Common questions asked were based on model, type, sub-type, cost, swath width (if applicable), resolution (if applicable), max survey speed (if applicable), frequency, max depth, is it hardware or software (yes/no), references, requirements, comments, and user comments.

A Survey Equipment Provider list was obtained from advertisements in *Sea Technology*, web searches and manufacturer references. Information was either faxed or obtained from a company's web site. Rates for commonly used tools were requested and company information (contact, phone number, address, and website address) and comments were recorded.

Lists of Survey Service Providers and universities were created from searches on the web. Representatives for Service Providers and geology or biology departments at universities were contacted via phone to ascertain capabilities. Similar to Tool Manufactures, Service Providers were first asked to fax information packets for evaluation. Requested information included: address, website, phone number, contact name, comments, references, capabilities, tools used for acquiring bathymetric and substrate data, and resolution range. The same information was requested from all state universities (UC and CSU campuses). Here our approach was to first contact the geology department chairs or department secretaries and request a list of faculty members with experience in seafloor mapping. Biology departments were contacted when a university did not have a geology department. We then contacted and interviewed the faculty member to obtain the required information.

Government and Non-profit agencies were identified through references and personal contacts. Projects, contact information, tools used, and comments were recorded. Projects were given an ID number for relational queries. Service providers and universities were also asked to submit cost estimates for typical surveys conducted at three different spatial scales and two levels of substrate backscatter resolution. Spatial scales for scenarios A, B, and C were 1 mile², 10 mile², and 100 mile² respectively. The two different pixel resolutions specified for the substrate backscatter imagery data at each of these scales were 20-50 cm and 1-2 m. All six scenarios had a specified x, y bathymetry posting of 2 m, and vertical resolution of 1 m. All

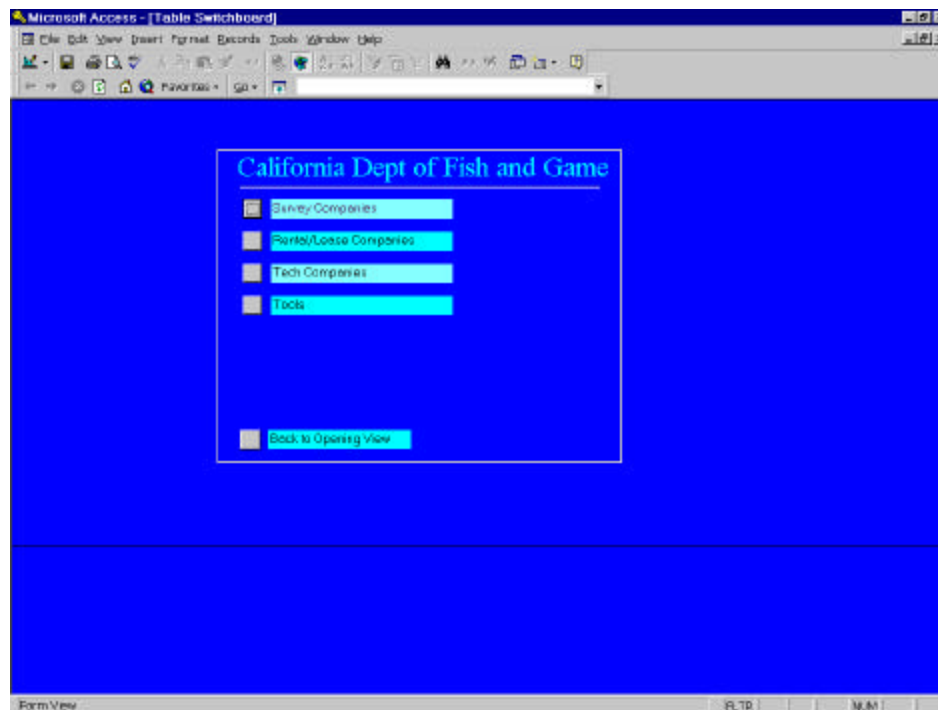
scenarios were based upon the assumption that the service providers had multibeam capabilities.

5.3. RESULTS

The Seafloor Habitat Mapping Tools database was created with an Opening Switchboard and Main Switchboard (Fig. 5.1) to help the user navigate to various tables and forms. A few standard queries have been developed along with display forms. The two forms for consultants and universities capabilities are similar in format (Fig. 5.2). Various questions were asked and the capabilities of each were evaluated as a yes/no answer. For instance, if a company did not have the capability of delivering the data in a GIS vector polygon format, a box next to that category was not checked.

We have used the database to create a series of tables summarizing the information collected to date. Tool manufacturers for multibeam, sidescan sonar, process and acquisition equipment and seabed classification systems are listed in Table 5.1. A total of 16 companies were contacted and listed.

The Tools section consists of the model, type, sub type, cost, swath width (if applicable), resolution (if applicable), max survey speed (if applicable), frequency, max depth, is hardware or software (yes/no), reference, requirements, comments, and user comments. Most pertinent information was included, but a relational query has been set so that each tool is linked to its manufacturer and website, allowing more detailed information to be accessed. The database contains data for multibeam (Table 5.2), side scan sonar (Table 5.3), processing and acquisition (Table 5.4), and seabed classification systems (Table 5.5). There are 16 multibeam tools, 25 side scan sonar tools, 22 processing and acquisition tools, and 2 seabed classification systems



listed.

Figure 5.1. Main switchboard for Tools Database.

Survey Companies
California Department of Fish and Game Remote Sensing Database

Company	SEA Consultants	Multibeam	<input type="checkbox"/>
Contact	Jim Oakden	Side Scan Sonar	<input checked="" type="checkbox"/>
Phone	(831) 479-0277	Habitat Classification	<input checked="" type="checkbox"/>
Address	PO Box 1151 Capitola CA 95010	Groundtruth Video/Classification	<input checked="" type="checkbox"/>
Web Site		Habitat Interpretation	<input checked="" type="checkbox"/>
Comments	able to work inshore & in kel	GIS Habitat Vector Polygon	<input checked="" type="checkbox"/>
References	Cal Trans, CF&G, Moss Land	Able to Produce From Schema	<input checked="" type="checkbox"/>
COST		Other:	No
Resolution		Resolution Capabilities	
Scenario A1:	\$15,000.00	Bathymetry:	1-3 m
Scenario B1:	\$150,000.00	Substrate:	<1 m
Scenario C1:	\$1,500,000.00	Vertical:	<1 m
Tools	Edgetech 260, single beam, ODOM, Hypack, Triton Ellic 355		

Record: 1 of 25
Form View

Figure 5.2. Service providers: Survey Companies database template.

A search for Electro-optical methods was also done. Manufacturer information, descriptions, resolution, system requirements, users, data output, and cost were recorded (Table 5.6). Only four main types of Electro-optical methods were listed. Because most of these technologies are very recent, few companies offer them as survey options. While satellite imagery is used widely by various companies and separate industries it may be of limited value in of mapping subtidal habitats, with the exception of kelp canopy cover.

Information from survey equipment providers on the specifications and costs of frequently used tools is presented in Table 5.7. Survey equipment providers were defined as companies that rent, sell or lease the necessary equip for seafloor mapping. Each company deals with separate equipment and some provide experienced support for setup and (sometimes) acquisition. Since each company deals with a large number of items, a complete list of items was not entered into the database. Only common items were listed in the database. Comments and references for

the company were also included. The database is set with tool ID numbers so that a query can be made to determine rental sources for a particular tool. Six companies have been listed.

Survey Service providers were placed in three categories: Universities, private consultants, and government or non-profit agencies. Geology departments were contacted at all universities within the University of California and California State University systems (Table 5.8). In almost all cases, only one faculty member at each university was involved with marine surveying or had surveying experience. Most work and experience was related to sub-bottom profiling or was done in deep water and done at a very small scale. Very few universities actually owned survey equipment. Most research is done using UNOLS vessels, vessels of opportunity or contracted out to private consultants. Most researchers within the university system had little or no experience with habitat classification based upon substrate identification. Information is pending from UCSD, UCSB, UCLA, and CSU Northridge.

Information about universities that had survey experience was placed in another table (Table 5.9). Capabilities and cost estimates for three standard scenarios at two backscatter resolutions are also shown. A total of 34 universities were contacted; 4 had no response after repeated attempts were made to gain information, 8 have limited capabilities, 5 have full survey capabilities, and 17 have no experience or capabilities.

Government agency and non-profit information is presented in Table 5.10. This information includes agency name, contact, phone number, address, projects, description of projects, and tools used. Seven agencies were contacted.

The contact information and capabilities of private consulting companies is provided in Table 5.11. Cost estimates are listed separately for each company and based upon the same three scenarios used to evaluate university rates Table 5.12. Several companies did not respond with cost estimates and a few companies had no response at all after repeated attempts were made to gain information. Although private service providers have done an extensive amount of seafloor mapping, most referrals for habitat mapping mentioned USGS, MBARI, and Moss Landing Marine Laboratories. Very few organizations or companies seem to have experience in creating habitat maps. Most of the work they reported was related to geologic research (seismic), oil speculation, dredging, telecommunication assessment or sea-lane hazard assessment, although the equipment and techniques used are also applicable to habitat mapping. Six private consulting firms (Racal Pelagos, Fugro, David Evans and Associates, S.A.I.C., C&C Technologies and ABA Consultants) have done extensive biological and near-shore work.

Only four firms replied with cost estimates. C&C Technologies and Fugro West submitted single, itemized quotes, which were extrapolated into separate quotes for the six scenarios. David Evans & Associates submitted two verbal quotes during initial conversations and ABA Consultants submitted two quotes, which were also extrapolated into separate quotes for the six scenarios. Although requests were made, most companies never replied with cost estimates. It appears that only the larger companies have the experience or capabilities necessary for

CDF&G needs. Many of the overseas and smaller companies did not reply to messages or could not be reached.

Many pieces of hardware appear to have capabilities beyond the scope of CDF & G needs. Since deep-water tow equipment will not be used for CDF & G projects, equipment specifications were included, but cost estimates were not requested. Some equipment that is in use or has been used in past research projects is no longer produced or supported.

5.4. CONCLUSIONS

A truly comprehensive list of all survey tools, service providers, equipment providers and manufacturers would be very large and is beyond the scope of this work. We have, however, compiled information from a broad cross-section that we consider to be representative of what is generally available. This information is now archived in the Survey Tools Database created to allow queries for easy access and retrieval, as well as updating of the records.

Careful judgement must be applied when considering the cost estimates obtained from service providers and universities. All contacts stated their reluctance to give any “quote” regarding services when the scenario was so general. As a result, these figures provide general estimates to be used for relative comparison and selection of methods. Accurate quotes for actual survey costs at a given location and time will require more detailed, site specific information. Another consideration when using the database information is that rates for equipment rentals and pricing for equipment purchase can change relatively quickly. During the course of the project, tools (Klein 500 series & ISIS 100) were phased out and discontinued (although technical support will still be provided).

Although many of the hardware tools are easily compared in terms of performance and specifications, software for data acquisition and processing also need to be carefully considered when evaluating the needs and limitations of a survey project. Access to technical support is often critical to the success of mapping projects. Based on conversations with many of the users, some manufacturers appear to supply better customer support than their regional representatives do. Some survey companies have developed proprietary software for hardware and have yet to market these tools.

Table 5.1. Tool Manufacturers. Contains the company, address, phone number, contact person and type of tools manufactured. Tool abbreviations: prs= processing, acq=acquisition, sss=side scan sonar, mb=multibeam, ecs=echosounder.

<i>Company</i>	<i>Address</i>	<i>Phone</i>	<i>Contact</i>	<i>Tools</i>
Caris	264 Rockwood Ave, Fredericton, NB Canada E3B2M2	(506) 458-8533	Derrick R. Peyton	prs
Coda Technologies	9800 Richmond Ave Ste 480 Houston TX 77042	(713) 780-3223	Stacie Talbott	prs
Polaris Imaging Inc	70 Dean knauss Dr. Narragansett, R.I. 02882	(401) 789-2475	John Thayer	prs
Triton Elics Technology	125 Westridge Dr. Watsonville, CA. 95076	(831) 722-7373	Francois Wolf	prs, acq
Meridian Sciences	10015 Old Columbia Rd. Ste A-200 Columbia MD 21046	(410) 381-2270	Jeff Burns	prs
Klein Associates, Inc	11 Klein Dr Salem, NH 03079	(603) 893-6131	Garry Kozak	sss
Edgetech	455 Fortune Blvd Milford MA 01757	(508) 478-9500	Darren Moss	sss
Datasonics	7709 Prospect Place, La Jolla, CA 92037	(619) 259-1011	Brock Rosental	sss
McQuest Marine Sciences Limited	489 Enfield Rd. Burlington, Ontario CAN L7T 2X5	(905) 639-0931	Darren Keyes	ecs
GeoAcoustics	GeoPulseSystemsInc 25 DelanoAve Suite200 RevereMA	(781) 286 2944	George O'Keefe	ecs
Odom Hydrographic Systems,	8178 GSRI Ave. Bldg B Baton Rouge, Louisiana 70820	(504) 769-3051	Brian Apsy (Pres)	sss,mb
Tritech International Limited	WesthillBusinessPark,Westhill,Aberdeen, AB326JL,UK	+44 (0)1224 744111	No reply from company	ecs
Reson	300 Lopez Rd, Goleta, CA 9317	(805) 964-6260	Jeff Garlik	mb,ecs
Seabeam	141 Washington St, East Wapole, MA	(508) 660-6000	Hugh Murphy	mb,
Atlas	Sebaldsbrucker HeerstraBe 235 28305 Bremen Germany	+04 21 457-4902	Contact Odom Hydrographics	mb
Simrad	7250 Langtry St Houston TX 77040-6625	(713) 934-8885	Chris Hancock	mb

Table 5.2 Multibeam Tools. Contains a list of systems and corresponding specifications for each model. NA= Not applicable for proposed work. NR= No response from company. NM= No longer in production/distributed.

System	<i>EM 1002</i>	<i>EM 952</i>	<i>EM 3000</i>	<i>EM 1000</i>	<i>EM 950</i>	<i>SEABAT 8101</i>	<i>SEABAT 8124</i>
Specification update	1998	1998	1996	1993	1993	1997	1995
Frequency (kHz)	95	95	300	95	95	240	200
Transducer	160° r=45cm	160° r=45cm	Single or dual	160° r=45cm	160° r=45cm	Single 150°	171° r=8.8cm
Source Level (dB rel Pa/m)	226	226	215	226	225	217	210
Power (kW)	4.5	4.5	0.6	4.5	4.5	1.2	0.5
Pulse length (ms)	0.2/0.7/2	0.2	0.15	0.2/0.7/2	0.2	0.07	0.07
Xmt beamwidth (deg) athwartships*fore-aft	60-200*3.3	60-200*3.3	130*1.5	150/120/60*3.3	150*3.3	170*1.5/3	140*1.5/2.4/10
Transmit steps	1	1	1	1	1	1	1
Beamforming	digital	digital	digital	digital	digital	digital	analog
number of beams	111	111	127	120/96/48 in 2 pings	120 in 2 pings	101	40
Beam spacing (deg)	0.5-1.5	0.5-1.5	0.9	2.5(1.25)	2.5(1.25)	1.5	3
Max ping rate (1/s)	10	10	30	4	4	30	30
Minimum range (m)	2	2	0.3	3	3	0.25	1
Cost (\$US)	NM	NM	\$183,000.00	NA	NA	\$200,00.00	\$95,000.00

Survey Speed (knots)	NM	NM	20	10	NR	30	16
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Table 5.2 Multibeam Tools (continued)

System	<i>SEABAT 9001</i>	<i>ELAC BCC- MK2*</i>	<i>ELAC BCC- MK2**</i>	<i>ELAC BCC- SEE28***</i>	<i>Fansweep 15</i>	<i>Fansweep 20</i>	<i>Fansweep 20</i>
Specification update	1993	1997	1997	1993	1998	1996	1996
Frequency (kHz)	455	50	180	180	200	100	200
Transducer	171° r=8.8cm	dual (53*29cm)	dual (25.5*18cm)	dual (25.5*18cm)	single (35*35 cm)	dual (48*48cm)	dual (35*35cm)
Source Level (dB rel Pa/m)	210	234	217	217	227	227	227
Power (kW)	0.5	2*3.5	2*0.6	2*0.6	2*0.7	2*0.7	2*0.7
Pulse length (ms)	0.07	0.15/0.3/1/3/10	0.15/0.3/1/3	0.3/1/3	0.02	0.06	0.02
Xmt beamwidth (deg) athwartships*fore-aft	100*1.5/2.4/10	150*3	150*3	120*5.2	160*1.2	180*1.2	180*1.2
Transmit steps	1	3(42 beams each)	3(42 beams each)	7(8 beams each)	1	1	1
Beamforming	analog	digital	digital	digital	digital	digital	digital
number of beams	60	126 in 3 pingsx	126 in 3 pings	56 in 7 pings	20-600	20-1440	20-1440
Beam spacing (deg)	1.5	1.25	3.75(1.25)	2.2	?	?	?
Max ping rate (1/s)	15	10	12/25	5	12	12	12
Minimum range (m)	1	5	1	1.8	0.5	0.5	0.5
Cost	\$134,000.00	NR	NR	NR	\$105,894	\$156,723	\$140,385
Survey Speed (knots)	16	NR	NR	NR	16	16	16

* Seabeam 1050

** Seabeam 1180

*** Seabeam 1185

Table 5.2 Multibeam Tools (continued)

System	<i>ISIS 2000</i>	<i>ISIS 100</i>	<i>ECHOSCAN</i>
Specification update	1998	1996	1996
Frequency (kHz)	117,234,58.5, 468	117, 234	200
Transducer	dual (49*19.5cm)	dual (30*13cm)	90o (48.3x26.7cm)
Source Level (dB rel Pa/m)	219	219	225
Power (kW)	1	1	0.1
Pulse length (ms)	0.08	0.08-0.2	0.02
Xmt beamwidth (deg) athwartships*fore-aft	50*1.7	50*1.0	100*2.5
Transmit steps	1	1	1
Beamforming	phase measurements analog	phase measurements analog	none
number of beams	up to 15 pairs	up to 6 pairs	30
Beam spacing (deg)	single beam	single beam	3
Max ping rate (1/s)	2.5	2.5	15
Minimum range (m)	1.0	1.5	2
Cost	\$120,696.00	NR	\$137,600.00
Survey Speed (knots)	16	16	17

Source C. de Mousier 1999

Table 5.3 Side Scan Sonar Tools. List of sidescan sonar equipment and specifications.

Model	<i>Widescan 60</i>	<i>AMS - 36/120S1</i>	<i>Sys09 (SSI Int'l.)</i>	<i>Hydrosweep</i>	<i>Simrad EM - 12</i>	<i>Simrad EM - 100</i>	<i>Simrad EM - 1000</i>
Operator(s)	Commercial applications, SOC	Acoustic Marine Systems, Inc.	Commercial applications	UW, LDEO, Germany, India, others...	SIMRAD A/S, RVS, IFREMER	SIMRAD A/S, Canadian Hydrographic Service ...	SIMRAD A/S, Canadian Hydrographic Service ...
Type	Shallow-tow	Deep-tow	Shallow-tow	Hull-mounted	Hull-mounted	Hull-mounted	Hull-mounted
Depth range	<300 m	<6,000 m	60 - 10,000 m	10 - 10,000 m	10 - 11,000 m	10-700 m	3-1,000 m
Total swath width	37.5 x 400 m	< or = 1,000 m	< 20 km	2 x water depth (less if depth > 7 km)	150° (7.3 x water depth) 90° - 120° for EM-12S	150° (7.3 x water depth)	150° (7.3 x water depth)
Typical navigation error	< 100 m satellite + near-shore reckoning	100 - 1000 m satellite	100 - 1000 m satellite	100 - 1,000 m (satellite positioning)	100 - 1,000 m (satellite positioning)	100 - 1,000 m (satellite positioning)	100 - 1,000 m (satellite positioning)
Frequency (wavelength)	100 kHz/325 kHz	33.3 / 36 kHz	9/10 kHz	15.5 kHz (9.7 cm)	13 kHz (11.5 cm)	95 kHz (1.6 cm)	95 kHz (1.6 cm)
Footprint size (along-x across-track)	~ 0.2 m	< 1 m	0.2 x 0.2 m to 10 x 10 m	134 x 134 m	170 x 170 m	170 x 170 m	170 x 170 m
Output data	Imagery	Imagery	Imagery Bathymetry	Bathymetry + backscattering amplitude	Bathymetry + backscattering amplitude	Bathymetry + backscattering amplitude	Bathymetry + backscattering amplitude
Typical size of daily data	<< 1 Gbyte	< or = 1 Gbyte	> 1 Gbyte	~ 1 Gbyte	Not available	Not available	Not available
Ancillary data	Altitude	Altitude, roll, pitch, yaw	N/A	Heading + roll, pitch	Heading + roll, pitch, yaw	Heading + roll, pitch, yaw	Heading + roll, pitch, yaw
Cost (\$US)	NR	NR	NA	NR	NR	NR	NR

Comments	NR	NR	NA	NR	NR	NR	NR
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Table 5.3 Side Scan Sonar Tools (continued)

Model	<i>GLORIA Mk II</i>	<i>GLORIA - B</i>	<i>TOBI</i>	<i>SeaMARC II/HMR-1</i>	<i>SAR 190 kHz</i>	<i>DSL-120</i>	<i>Jason 200 kHz</i>	<i>EG&G 990S</i>	<i>EG&G Deep-Tow</i>
Operator(s)	SOC, USGS, ...	SOC	SOC	Univ. of Hawaii	IFREMER	WHOI	WHOI	Commercial applications, GPI Kiel	Government & commercial surveys
Type	Shallow-tow	Shallow-tow	Deep-tow	Shallow-tow	Deep-tow	Deep-tow	Deep-tow	Deep-tow	Deep-tow
Depth range	200-11,000m	200-11,000m	< 10,500m	100-11,000m	< 6,200m	< 6,100m	< 6,000m	Pending	< 600 m
Total swath width	up to 60 km (typically 45)	45 km (imagery) 4.5 x depth (bathymetry)	6 km	up to 10 km (typically 10 km)	up to 1.5 km	0.1 to 1 km (typically 1 km)	0.3 km	2 x 400 m	< 1 km
Typical navigation error	100-1000m satellite	100-1000m satellite	50-500m long-baseline	100-1000m satellite	5-10m long-baseline	5-10m long-baseline	0.1-10 m short-or long-baseline	< 100 m satellite + near-shore reckoning	< 100 m satellite + near-shore reckoning
Frequency (wavelength)	6.3 - 6.7 kHz 23.8 - 22.4 cm	6.25 - 6.75 kHz 24 - 22.2 cm	30 - 32 kHz 5 - 4.7 cm	11 - 12 kHz 13.6 - 14.9 cm	170-190 kHz 0.9-0.8 cm	120 kHz 1.25 cm	200 kHz 0.75 cm	Pending	59 kHz
Footprint size (along-x across-track)	175 x 45 to 657 x 45 m	125 x 45 m to 1000 x 45 m	8 x 3.5 m to 43 x 2.1 m	120 x 10 m to 197 x 2 m	0.7 x 0.8 m to 3 x 0.4 m	3.3 x 0.33 m to 13.7 x 0.15 m	0.5 x 0.29 m to 2.4 x 0.15 m	N/A	1/400 of the range
Output data	Imagery	Imagery Bathymetry	Imagery	Imagery Bathymetry	Imagery	Imagery Bathymetry	Imagery Bathymetry	Imagery	Imagery
Typical size of daily data	< 1 Gbyte	~ 5.3 Mbyte	528 Mbyte	< 1 Gbyte	< 1 Gbyte	> 1 Gbyte	~ 100 Mbyte	Paper record	NA
Ancillary data	Heading	Heading + Roll, Pitch, yaw	Heading, depth, speed + Roll, Pitch, yaw	Heading + Roll, Pitch, yaw	Heading, depth, speed	Heading, depth + Roll, Pitch, yaw	Heading, depth + Roll, Pitch, yaw	Pressure, heading, speed, temperature	Speed, depth, temperature
Cost (\$US)	NA	NA	NR	NA	NR	NR	NR	NA	NA

Comments	Older system. No longer used	Older system. No longer used	Used only for deep water	NA	Used only for deep water	Used only for deep water	Used only for deep water	Used only for deep water	Used only for deep water
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Table 5.3 Side Scan Sonar Tools (continued)

Model	<i>EG&G model 272T</i>	<i>[TAMU]2</i>	<i>Klein 590/595</i>	<i>Klein 520</i>	<i>Simrad MS- 992</i>	<i>OKEAN</i>	<i>MAK-1</i>
Operator(s)	Government & commercial surveys	Texas A&M Univ.	Klein Assoc. Massachusetts, U. Kiel, ...	U. Kiel, Klein Assoc., etc.	Commercial, military...	CIS States	CIS States
Type	Shallow-tow	Shallow-tow	Shallow-tow	Shallow-tow	Deep-tow	Shallow-tow	Deep-tow
Depth range	< 1,000m	< 500 m	< 1,000m	< 300 m	< 1,000m	NR	NR
Total swath width	N/A	100 m -30 km	< 600 m (100 kHz) < 400 m (500 kHz)	25 m - 600m	10 m - 800 km	2 x 8,000 m	2 x 1,000 m or 2 x 250 m
Typical navigation error	< 100 m satellite + near-shore reckoning	< 100 m satellite + near-shore reckoning	< 100 m satellite + near-shore reckoning	< 100 m satellite + near-shore reckoning	< 100 m satellite + near-shore reckoning	100-1000 m Satellite	SBL net
Frequency (wavelength)	105 kHz	11/12 kHz 72 kHz	100 kHz 500 kHz	500 kHz	120 kHz 330 kHz	9.5 kHz	30 kHz or 100 kHz
Footprint size (along-x across-track)	N/A	Not Available	N/A	N/A	N/A	100 x 5 m	35 x 0.5 m
Output data	Imagery	Imagery Bathymetry	Imagery	Imagery	Imagery	Imagery	Imagery
Typical size of daily data	< 1 Gbyte	< 1 Gbyte	< 1 Gbyte	< 1 Gbyte	unknown	< or = 350 Mbyte	< or = 1 Gbyte
Ancillary data	N/A	Depth + Roll, Pitch, yaw	N/A	N/A	N/A	N/A	N/A
Cost	\$15,500.00	NR	\$74,770	NM	NA	NR	NR
Comments	100/500kHz Max speed 12.7 knots	NR	1-8 kots survey speed	No longer manufactured	Used only for deep water	NR	Used only for deep water

Source C. de Mousier 1999

Table 5.4 Processing Tools. Contains model, type, cost, description, reference, requirements

Model	Sub-Type	Cost	Description	Tool Ref	Tool Req
<i>Caris-SIPS</i>	Image processing	\$11,285.00	Sonar image processing	David Evans & Associates	training @ \$2500/person or \$6000 for field training
<i>Caris-HIPS</i>	Image processing	\$13,570.00	Hydrographic data processing	David Evans & Associates	training @ \$2500/person or \$6000 for field training
<i>Caris-GIS</i>	Image processing	\$2,300.00	GIS system for hydrographic data	Seafloor Systems	training @ \$2500/person or \$6000 for field training
<i>Caris-Object Manager</i>	Image processing Interactive w/editing features	No response	Create, edit, maintain and output hydro data	Seafloor Systems	training @ \$2500/person or \$6000 for field training
<i>CODA-GeoKit</i>	data interpretation	No response	Online interpretation and reporting of seabed features	No response	DA-100 or DA-200
<i>CODA-TrackPlot</i>	planning & real-time coverage	\$3,192.00	Real-time track and survey coverage information	C & C Technologies	DA-100 or DA-200
<i>CODA-TrackPlotplus</i>	interactive w/ editing features	No response	Real-time track and survey coverage information	No response	DA-100 or DA-200
<i>CODA-Bathy</i>	acquire, display, & record data	Still in development	Acquire, display and record swathe & seismic bathymetry data	DiGimap	DA-100 or DA-200
<i>CODA-Mosaic</i>	Image processing	\$12,792.00	Post Processing	Milford Haven Port Authority	DA-100 or DA-200

Table 5.4 Processing Tools (continued)

Model	Sub-Type	Cost	Description	Tool Ref	Tool Req
<i>CODA-DA100</i>	acquisition and processing	\$35,102.00	TVG, slant range cor, 2 channelwaterfall	C & C Technologies	GPS & sensor input
<i>CODA-DA200</i>	multiple acquisition, display, and interpretation	\$47,992.00	Acquisition sidescan sonar and sub-bottom profiler.	Milford Haven Port Authority	Towfish
<i>Polaris-EOSCAN</i>	Acquisition and processing	\$23,000.00	Data acquisition	U of Rhode Island	Exabyte download capabilities
<i>Triton Elics ISIS</i>	Acquisition and processing	\$67,500.00	data acquisition, display, and mosaic	Fugro West	Data recorder, Towfish, positioning system
<i>Polaris-EOMAP</i>	Image processing	\$9,000.00	Digital Mosaic software	U of Rhode Island	400mhz pentium computer
<i>Polaris-EOSCAN LTE</i>	Acquisition and processing	\$18,000.00	Simplified version of EOSCAN	U of Rhode Island	Used with analog sss systems
<i>Edgetech-260</i>	Data acquisition & Thermal printer	\$36,900.00	Control, printer and acquisition for towvehicle	Moss Landing Laboratories	Data recorder, Towfish, positioning system
<i>Edgetech-Model 560D</i>	Sidescan sonar processor	\$12,500.00	data acquisition, display and control	Seafloor Systems	Towfish, positioning system
<i>Edgetech-DF-1000</i>	Digital Control Interface	\$7,500.00	data acquisition, display and control	Seafloor Systems	Towfish, positioning

Table 5.4 Processing Tools (continued)

Model	Sub-Type	Cost	Description	Tool Ref	Tool Req
<i>Edgetech-MIDAS</i>	Data acquisition for DF-1000 fish	No response	data fusion	Racal pelagos	Towfish
<i>Datasonics-SIS-1500 Chirp Side Scan System</i>	Sidescan acquisition/processing	\$55,800.00	dsp of backscatter,mosaic upgrade available	Ocean Inovations	Towvehicle
<i>Datasonics-SIS-1000 Seafloor Imaging System</i>	Sidescan/sub-bottom acquisition/process	\$91,600.00	dsp w/Chirpscan3 software	Ocean Inovations	Towvehicle

Table 5.5 Seabed Classification Tools

Company	<i>Marine MicroSystems</i>	<i>Quester Tangent Inc</i>
Address	Offshore House, Clymore Dr, Bridge of Don, Aberdeen AB 23 8GD Scotland UK	99-9865 West Saanich Rd, Sidney BC Canada V8L5Y8
Phone	1-800-460-5789	250-656-6677
Contact	John Tamplin (503) 356-8717	Chris Elliot
Model	Roxann	QTC View
Reference	Rikk Kvitek Cal State University Monterey Bay	Robert McConnaughey NMFS Alaska Fisheries Science Center
Cost	\$18,400.00	\$15,000.00
Description	software and processor	software and processor
Tool Requirements	486 DX 33, 200Mb Hard Disk, 4 Mb Ram, 4 RS232 ports, 0.5 Mb SVGA video card, 1 parallel port, for 15-210kHz, min depth of 0.5m max 1500m	486 DX2-66, 8 Mb RAM, Windows 3.1 or 95, one dedicated serial port, Rs 232 port, GPS NMEA 0183 standard, for freq of 22- 250kHz
Comments	Difficult to contact, Main office located in UK.	On-site assistance \$697/day, phone \$75/hr
Classifying values	E1 and E2	Q1, Q2, and Q3

Table 5.6 Electro-Optical Tools. Contains manufacturer, address, phone number and contact. Also, contains description of equipment, resolution, requirements, user, type of data output, and cost.

Tool	<i>LIDAR</i>	<i>Laser Line Scan</i>	<i>CASI</i>	<i>Satellite</i>
Manufacturer	NOAA, NASA	Raytheon	ITRES Research Limited	NOAA, Weather Service, Military
Address	2234 South Hobson Ave. Charleston SC 29405	141 Spring St Lexington MA 02421	Ste 155 East Atrium 37 Ave N.E. Calgary, Alberta Canada T1Y	NOAA NESDIS OSDPD E/SP, RM 1069, FB4 5200 Auth Road Suitland, MD 20746-4304
Phone	(843) 740-1200	(781) 862-6600	(403) 250-9944	(301) 457.5120
Contact	William Krabill	B.W. Coles	Jeff Lilycrop	Gary Davis
Description	airborne imaging system	Scanning laser to produce GB images	airborne imaging system	TM, multispectral images at various resolution
Resolution	10-15 cm	<1 m	1-10 m at 288 spectral bands, 15m depth	1-30m
Requirements	aircraft	Processing software	Aircraft, 20 GB storage capacity	Access to data and proper GIS analytical software
User	NOAA, NASA, USGS	Scientific Application International Corporation	Tres research Limited	Various, govt, agriculture, environmental monitoring firms
Data Output	>1G	>5G	>5G dependant on survey area	variable
Cost	\$8,000.00-\$10,000.00 per square mile	Rental or purchase of data only. No response from SAIC on cost estimates.	\$8,000.00-\$10,000.00 per square mile	Purchase of data only. Price variable. Depends on coverage and resolution

Table 5.7 Survey Equipment Providers. Lists companies, contacts phone numbers and comments. Includes price of Side Scan Sonar, Single Beam Bathymetric and Processing equipment based upon daily (d), weekly (w), and monthly (m) rates.

<i>Company</i>	<i>Contact</i>	<i>Phone</i>	<i>SSS Rates</i>	<i>Bathy Rates</i>	<i>Processing Rates</i>	<i>Comments</i>
Rentmar	Chris Sabo	410-990-0566	No response	No response	No response	Low prices but questionable support/service. Sell and rent of equipment
Ashtead	Chris Flynn	281-398-9533	\$550(d) \$3465(w) \$13,200(m)	\$95(d) \$599(w) \$2,280(m)	N/A	no min rental duration, rental period is "door to door", equip must be insured by renter. Reson 8101 \$900(d), \$5670(w) \$21,600(m) support \$500/day + exp, can provide all levels of tech assistance, reduced rate for 2-3 wk term, on call 24 hr
McQuest	Darren Keyes	905-639-0931	\$470(d), \$2491(w) \$8695(m)	\$75(d), \$397(w), \$1387(m)	\$120(d), \$636(w), \$2220(m)	Minimum rental 3-4 days, Support \$450/day + exp
GSE Rentals	Alan Cameron	+441224-771247	\$280(d), \$1960(w), \$7680(m)	\$120(d), \$840(w), \$3120(m)	N/A	On call 24hr, Do not pay for shipping time. All levels of support: installation to survey. SeaBat \$1080(d), \$7560(w), \$28800(m)
ORE	Carl Shue	281-879-727	No response	No response	No response	No response
Sonar Equipment	Les Ford	+441493-443363	\$1520(d), \$10,640(w))\$45,600(m))	\$288(d), \$2016(w), \$8,640(m)	N/A	Difficult to contact Freight is an extra %15

Table 5.8 University Contact List. Contains the university, contact, phone, survey capabilities and comments.

<i>University</i>	<i>Contact</i>	<i>Phone</i>	<i>Survey Capabilities</i>		<i>Comments</i>
			Full	Limited	
CSU Bakersfield	Rob Negrini	(661) 664-3027			no experience
CSU Chico	Vic Fischer	(530) 898-5266		X	no equip, limited GIS capability, hasn't done work before
CSU Fresno	Stephen Lewis	(209) 278-6956	X		no rapid response, leases or rents equip
CSU Fullerton	John Foster	(714) 278-7096			no experience
CSU Hayward	Calvin lee	(510) 885-3088		X	seismic, sss interp exp, use of MLML facilities
CSU Humboldt	Jeff Borgeld	(707) 826-3328		X	expertise, but no equip or GIS capability.
CSU Long Beach	Robert (Dan) Francis	(562) 985-4929		X	seismic survey, analog only, no GIS
CSU Los Angeles	Ivan Colburn	(323) 343-2413			no experience
CSU Monterey Bay	Rikk Kvitek	(831) 582-3529	X		rapid response ability
Moss Landing Marine Laboratories	Gary Greene	(831) 633-7264	X		rapid response ability
CSU Northridge	Peter Fischer	(818) 677-3574			No response
CSU Pomona	John Klasik	(909) 869-3454			no experience
CSU Sacramento	Diane Carlson	(916) 278-6382			no experience
CSU San Bernadino	Sally McGill	(909) 880-5347			no experience
CSU San Diego	Clive Dorman	(619) 594-5707			no experience
CSU San Francisco	Karen Grove	(415) 338-2061			no experience
CSU San Jose	Don Reed	(408) 924-5036	X		limited inshore exp, no equip, non-rapid response, limited GIS capability
CSU Sonoma	Tom Anderson	(707) 664-2176			no experience

Table 5.8 University Contact List (continued)

<i>University</i>	<i>Contact</i>	<i>Phone</i>	<i>Survey Capabilities</i>		<i>Comments</i>
			Full	Limited	
CSU Stanislaus	Mario Giaramita	(209) 667-3090			no experience
CSU San Luis Obispo	Mark Moline	(805) 756-2948			no experience
CSU Channel Islands	J. Handel Evans	(805) 383-8400			no experience
CSU Dominguez Hills	David Sigurdson	(310) 243-3316			no experience
CSU San Marcos	Dick Bray	(760) 750-4175			no experience
UC Berkeley	William Dietrich	(510) 642-2633			No response
UC Riverside	Carole Carpenter	(909) 787-3435			no experience
UC San Diego	Christian Mousier de	(619) 534-6322		X	min depth 10-20m, extensive experience, suited for deeper water only, rapid response capability
UC San Francisco	na	na			no experience, no dept; medical institution
UC Santa Barbara	Bruce Luyendyk	(805) 893-2827			No response
UC Santa Cruz	J. Casey Moore	(831) 459-2574		X	experience, no equip, no exp inshore
SCMI	Rick Piper	(310) 519-3172		X	equip & vessels but no experienced personnel. Teaching
UC Davis	Jim McClain	(530) 752-7093		X	limited inshore exp, no equip, non-rapid response
UC Irvine	Ellen Druffel	(949) 824-2116			no experience
UC Los Angeles	Frank Kyte	(310) 825-2015			No response
Summary	34 Universities contacted 4 non responses 8 Limited Capabilities 5 Full Survey Capabilities 17 Have No Experience or Capabilities				

Table 5.9 List of universities and with full survey capabilities. Lists capabilities for each university with cost estimates for three scenarios at two resolutions. Capability Symbols: MB= Multibeam, SSS= Side Scan Sonar, SBB= Single Beam Bathymetry, HC= Habitat Classification, GVC= Groundtruth Video/Classification, HI= Habitat Interpretation, GIS=GIS Habitat Vector Polygons, APS= Able to Produce Product from Scheme, R/L= Rent or Lease. Scenario A= 1 mile², 2 m posting, 1 m vertical resolution, Scenario B= 10 mile², 2 m posting, 1 m vertical resolution, Scenario C= 100 mile², 2 m posting, 1 m vertical resolution. Subscript 1=Backscatter resolution 20-50cm, Subscript 2=Backscatter resolution 1-2 m. NR= No response from contact.

<i>University</i>	<i>Capabilities</i>	<i>Scenario A₁</i>	<i>Scenario A₂</i>	<i>Scenario B₁</i>	<i>Scenario B₂</i>	<i>Scenario C₁</i>	<i>Scenario C₂</i>
CSU San Jose	MB, SSS, SBB, HI, GIS, APS, R/L	NR	NR	NR	NR	NR	NR
CSU Monterey Bay	MB (pending), SSS, SBB, HC, GVC, HI, GIS, APS	\$10,000.00	\$6,000.00	\$100,000.00	\$60,000.00	\$1,000,000.00	\$600,000.00
CSU Fresno	MB, SSS, SBB, HI, GIS, APS, R/L	NR	NR	NR	NR	NR	NR
Moss Landing Marine Laboratories	MB, SSS, SBB, HC, GVC, HI, GIS, APS	\$10,000.00	\$6,000.00	\$100,000.00	\$60,000.00	\$1,000,000.00	\$600,000.00

Table 5.10 Agencies Involved in Habitat Mapping. Contains the agency, contact, phone number, address, related projects, description of work, and tools used.

Agency	<i>Coastal Service Center</i>	<i>USGS</i>	<i>Army Corp Of Engineers</i>	<i>Naval PostGraduate School</i>	<i>NFMS</i>	<i>MBARI</i>	<i>Mineral Management Services</i>
Contact	William Krabill	James Gardner	Lee Estip	James Clynych	Robert McConnaughey	Gerry Hatcher	Daniel Leedy
Phone	301-713-2770	(650) 329-5469	(213) 452-3675	(831) 656-3268	(206) 526-4000	(831) 775-1700	(805) 389-7818
Address	1315 East West Highway Silver Spring, Maryland 20910-3285	U.S. Geological Survey 345 Middlefield Road Menlo Park, California 94025-3591	Waterways Experiment Station, 3909 Falls Ferry Road Vicksburg, Mississippi USA 39180	1 University Circle Monterey, CA 93943	7600 Sand Point Way NE, Seattle WA 98115	7700 Sandholdt Road P.O. Box 628 Moss Landing, CA 95039-0628	Environmental Assesment 770 Paseo Camarillo 2 nd Floor Camarillo CA 93010
Projects	Assesment of Coastal Erosion	Various	SHOALS	Error Sources and Their Mitigation for PPS Shipborne Systems	Fish Habitat Management	Hawaii Mapping Project	Geological and Petroleum management
Description	Evaluation of beach/dune morphology, catastrophic coastal change, and erosion	Coastal Mapping Project	Coastal Mapping Project using fixed wing aircraft	Testing Precise Positioning Serice Novel uses of shipboard high accuracy positioning	Habitat mapping Rockfish fishery management	Deep Water geologic evaluation. Deep water habitat assesment	Inner Channel Islands surveys
Tools	LIDAR	Multibeam, Side Scan Sonar	LIDAR CASI BATHYMETRY	Multibeam Side Scan Sonar Single Beam Bathymetry	Single Beam Bathymetry, QTC View Seabed Classification System	Single Beam Bathymetry, QTC View Seabed Classification System	Single Beam Bathymetry, QTC View Seabed Classification System

Table 5.11. Survey Service Providers. Contains company, contact, phone address web site, comments, references, capabilities, tools used, and bathymetry, substrate, and vertical resolution capabilities. Capability Symbols: MB= Multibeam, SSS= Side Scan Sonar, SBB= Single Beam Bathymetry, HC= Habitat Classification, GVC= Groundtruth Video/Classification, HI= Habitat Interpretation, GIS=GIS Habitat Vector Polygons, APS= Able to Produce Product from Scheme, R/L= Company Rents or Leases equipment. Does not own equipment.

Company	<i>Meridian</i>	<i>Fugro Group</i>	<i>Seabed Explorations</i>	<i>Canadian Seabed Research</i>	<i>Scientific Marine Services Inc</i>	<i>Racal Pelagos</i>
Contact	Tim Janitess	Robin Villa (VP)	Martin Morrison (President)	Patrick Campell	NA	Jerry Wilson
Phone	800-784-6336	(401) 562-8931	(902) 422-3688	(902) 827-4200	(760) 737-3505	(713) 784-4482
Address	1343 Ashton Rd Hanover, Maryland 21076	845 Industry Dr Hartford MA 01856	1675 Bedford Row 2nd Fl Halifax, Nova Scotia Canada B3J1t1	3737 Snowhomish Wy BC L2J3t4 Canada	101 State Place Ste N Escondido CA 92029	3624 Westchase Dr Houston TX 77042
Web site	www.mersci.com	www.fugro.ltd	www.seainc.ca	none	www.scimar.com	www.racal- survey.com
Comments		Extensive experience		LIDAR capabilities	No service available	Extensive experience
Reference	No response	AT&T, MCI	Dept of Fisheries and Oceans	Swiss Air Canadian Air Transportation	US ACE	US ACE NOAA
Capabilities	SSS, SBB, GIS	MB,SSS, SBB, GIS,GVC, HC, HI, APS	MB,SSS, SBB, GIS	SSS, SBB, GIS,GVC, HC, HI, APS	Engineering co. Subcontract's survey work	MB,SSS, SBB, GIS,GVC, HC, HI,
Tools	AMS 60 SSS Triton ISIS Ashtech GPS Remora ROV	Klein Reson ArcView	Klein Caris Simrad ArcView	Klein Triton ISIS ArcView	NA	Reson Klein EG&G ArcView
Bathymetry	No response	<2 m	Variable	Variable	NA	<2 m
Substrate	No response	<1 m	<1 m	<1 m	NA	<1 m
Vertical	No response	<1 m	<1 m	<1 m	NA	<1 m

Table 5.11 Survey Service Providers (continued)

Company	<i>David Evans and Associates</i>	<i>C & C Technologies</i>	<i>Smedvig Technologies</i>	<i>W.L. Williamson & Associates Ltd</i>	<i>ABA Consultants</i>	<i>Office of Coast Survey</i>
Contact	Jon Dasler	Art Kleiner	NA	Nick Lesnikowski	Jim Oakden	William Krabill
Phone	(503) 223-6663	(318) 261-0660	(713) 339-2626	(206) 285-8273	(831) 479-0277	(301) 7 13-2770
Address	2828 S.W. Corbett Ave Portland, Oregon 972011	730 East Kaliste Saloon Road, Lafayette LA 70508	2925 Briarpark Dr Ste 1000 Houston, TX 77042	4200 23rd Ave W. Seattle WA 98199	PO Box 1151 Capitola CA 95010	1315 East West Highway Silver Spring, Maryland 20910-3285 www.noaa.gov
Web site	www.deainc.com	www.cctechnol.com	www.smedtech. com	www.wassoc.com	none	
Comments	Large survey company. Extensive experience and resources	Expereince on West Coast	Oil surveys only. Won't do work.	Large trans-oceanic cable routing. Won't do small surveys	able to work inshore & in kelp beds	Evaluation of beach/dune morphology, catastrophic coastal change, and erosion
Reference	Idaho Power	NOAA MBARI USGS	NA	NA	Cal Trans, CF&G, Moss Landing Harbor District,	No response
Capabilities	MB,SSS, HC, GVC,HI, SBB, APS, GIS	MB,SSS, GIS	NA	SSS	MB,SSS, HC, GVC,HI, SBB, APS, GIS	MB,SSS, SBB, GIS
Tools	Reson Edgetech Caris ArcView	Simrad Coda Edgetech Triton ISIS	Sub bottom profilers	Reson AMS 150	Edgetech 260, Edgetech 272, Hypack, Triton Elics ISIS, Roxann	No response
Bathymetry	1 m	<1 m	NA	NA	1-3 m	No response
Substrate	<1 m	1 m	NA	NA	<1 m	No response
Vertical	Variable	1-3 m	NA	NA	<1 m	No response

Table 5.11 Survey Service Providers (continued)

Company	<i>EMC, Inc</i>	<i>Kenneth Balk & Associates</i>	<i>Science Applications International Corp</i>	<i>Seavisual Consulting Inc.</i>	<i>Hawaii Mapping Research Group</i>	<i>Western Subsea Technology Ltd.</i>
Contact	Mark Mattox	Ray Armstrong	Rod Evans	Terry Sullivan	Bruce Appelgate	Mike Muirhead
Phone	(601) 453-0325	(314) 576-2021	(401) 847-4783	(503) 663-2894	(808) 956-9720	(250) 380-2830
Address	209 Main St Greenwood Miss 38930	1066 Executive Parkway PO Box 419038 St Louis Missouri 63141-9038	211 Third St Newport, RI 02840	29245 South East Stone Road Gresham, OR 97080	University of Hawaii HIG 205 2525 Correa Road HI, 96822	Pacific Marine Technology Center #1- 203 Harbour Rd Victoria BC V9A3S2
Web site	www.emcsurvey.com	www.kba.net	www.saic.com	none	www.soest.hawaii.edu	www.islandnet.com/subsea
Comments	Extremely limited experience and capabilities	Limited shallow work. Large company, extensive experience and resources	LLS and LIDAR capabilities	Very limited capabilities	Specialized for deep water surveys	No response
Reference	None given	US ACOE	US ACOE NOAA	Oregon Dept of Fish and Game	None given	No response
Capabilities	MB,SBB	MB,SSS, SBB, GIS	MB,SSS, SBB, GIS,GVC, HC, HI, APS	MB,GIS	MB,SSS, SBB, GIS	SBB, GIS,GVC, HC, HI,
Tools	Hypack Reson	Roxann Reson Innerspace Hypack ArcInfo	Roxann Reson Innerspace Hypack ArcInfo	Reson	Proprietary research equipment	No response
Bathymetry	Variable	<2 m	<1	1-2 m	No response	No response
Substrate	Unknown	<1 m	<1	Unknown	No response	No response
Vertical	1-3 m	<1 m	<1	2 m	No response	No response

Table 5.11. Survey Service Providers (continued).

Company	<i>Geoprobe</i>	<i>ABS Marine Consultants</i>	<i>McKim & Creed</i>	<i>Atlantic Marine</i>	<i>Clydeside Surveys Limited</i>	<i>Coastal Geoscience Research</i>
Contact	Paul Kronfield	Kit Kuittinen	Tim Cawood	No response	No response	No response
Phone	(713) 974-3205	(707) 987-9567	(901) 251-8282	+44 (0)1273-248800	+44-1475-520394	(250) 380-6866
Address	No response	No response	243 North Front St. Wilmington, NC 28401	Maritime House Basin Road North Hove, East Sussex BN41WR UK	'Rowan' The Lane, Skelmorlie, Ayrshire, PA175AP, UK	2601 Scott St.Victoria B.C. V8R 4J1
Web site	www.geoprobe.com	www.absmarineconsultants.com	www.mckimcreed.com	www.atlanmar.demon.co.uk	www.clydeside-surveys.ltd.uk	www.tdw.doaktown.nb.ca/coastal
Comments	No response	ROV & submersible services	Most likely would subcontract work to SAIC or David Evans & Assoc.	No response	No response	No response
Reference	US ACOE Shell Oil	No response	Stromn Thurman Lake	No response	No response	No response
Capabilities	SSS, GIS	SSS, SBB,GVC	MB,SSS, SBB, GIS	MB,SSS, SBB, GIS	MB,SSS, SBB, GIS	MB,SSS, SBB, GIS
Tools	Edgetech	No response	Eckotrac Reson	No response	No response	No response
Bathymetry	No response	No response	NA	No response	No response	No response
Substrate	No response	No response	NA	No response	No response	No response
Vertical	No response	No response	NA	No response	No response	No response

Table 5.12 Survey Service Providers Quotes. Scenario A= 1 mile², 2 m posting, 1 m vertical resolution, Scenario B= 10 mile², 2 m posting, 1 m vertical resolution, Scenario C= 100 mile², 2 m posting, 1 m vertical resolution. Subscript 1=Backscatter resolution 20-50cm, Subscript 2=Backscatter resolution 1-2 m. Of the 24 private consulting firms contacted only four replied with cost estimates. All requests were made via phone and fax.

Company	<i>C & C Technologies</i>	<i>ABA Consultants</i>	<i>David Evans & Associates</i>	<i>Fugro West</i>
Reference	NOAA MBARI USGS	CF&G, Moss Landing Harbor District,	Idaho Power	AT&T, MCI
Scenario A1	\$87,600.00	\$10,000.00	\$25,000.00	\$18,480.00
Scenario B1	\$384,600.00	\$100,000.00	\$250,000.00	\$108,300.00
Scenario C1	\$3,414,000.00	\$1,000,000.00	\$2,500,000.00	\$1,006,500.00
Scenario A2	\$87,600.00	\$6,000.00	\$20,000.00	\$18,480.00
Scenario B2	\$384,600.00	\$60,000.00	\$200,000.00	\$108,300.00
Scenario C2	\$3,414,000.00	\$600,000.00	\$2,000,000.00	\$1,006,500.00