CANADIAN SURVEY OF ATLANTIC, PACIFIC, ARCTIC, and GREAT LAKES OBSERVING SYSTEMS

Fisheries and Oceans Canada

Pêches et Océans Canada

Canadian Space Agency

Agence spatiale canadienne

Executive Summary

In the summer of 2010, a survey of the Canadian Ocean Observing Systems (OOS) and Observing System (OS) community was carried out by Fisheries and Oceans Canada (DFO) and the Oceans Science and Technology Partnership (OSTP) with the financial support of the Canadian Space Agency (CSA). The survey contacted over 400 organizations and individuals and identified over 65 OOS activities and characterized their users, operations and maturity levels. The results were analyzed and the major issues and trends were discussed:

a) OOS Activities in Canada: OOS activities in Canada have a broad base throughout the country. More than 65 separate OOS activities are underway in every region of Canada bordered by our three oceans and the Great Lakes. The major players in the sector are government, universities, and non-governmental organizations (NGOs). Most (83%) of OS programs have been underway for more than 3 years and have demonstrated operations. Most OOS operations are built upon partnerships with in-kind and financial support from sector stakeholders. The industry role in OOS is as both a user of information and a technology supplier.

b) OOS Regional Focuses: Most Canadian OS are directed to provide specific information needs for either local or regional areas or to meet specific information needs. OS are designed to meet specific objectives and the data and information provided to users are tailored to meet these requirements.

c) Sector Innovation: Canadian OS and industry suppliers are world-leading innovators in the OS sector. There has been significant funding ($100Ms) for OS technology demonstrations and research activities in Canada. This investment has yielded superior Canadian technology and experience in the sector. Canada also has a strategic advantage of access to space based observations. However, much of the proven OS innovation is not being effectively utilized in government operations.

d) OOS Sustainability: Outside of ongoing DFO's fisheries monitoring activities, the majority of OS are viewed as projects by many agencies and organizations. This project approach affects ongoing OOS sustainability through the resulting use and funding uncertainty for operations. Organizations which consider these OS as projects also do not commit to incorporating OS information and data into their regular and ongoing activities.

e) Sector Coordination: Canadian OS activities are typically generated locally or regionally by champion organizations. This has led to the sector developing in a fragmented manner. The upside to this decentralized approach is increased innovation and targeted delivery of specific functions. However even with this de facto approach there is limited effort to coordinate the

sector knowledge and best practices such as data management and data and information exchange. This sector deficiency has likely resulted in loss of efficiencies in terms of resources and downstream valued added benefits to the OS users, suppliers, and the Canadian public.

f) Sector Growth: Given the planning (e.g. US Integrated Ocean Observing System program http://www.ioos.gov/ and the EU Ostend declaration http://www.eurocean2010.eu/declaration/) and ongoing activities in the OS sector worldwide (estimated at US$2.2B annually in 2011) it is clear that the sector will grow significantly.

In parallel with the OOS survey, a preliminary assessment of the environmental, economic, and social value of OOS was carried out. Highlights of this assessment show some positive benefits, the lack of an effective national strategy and governance structure to maximize benefits of investments, and need to measure and communicate the benefits of OOS.

A set of tasks for the Canadian OOS sector were developed to further study the survey data to examine respondent comments, examine how to maximize space based ocean observations for OOS, and to follow-up with survey respondents.

Finally a set of goals for the Canadian OOS sector were developed to initiate national coordination with DFO leadership, utilize innovation for efficiency and productivity, improve OOS sustainability, encourage integration of satellite observations, and utilize innovation for export.

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Purpose of the Survey

The survey was designed to build a knowledge base and inventory of ocean and marine observation systems on Canada's Atlantic, Pacific, Arctic, and Great Lakes coasts and major rivers near these coasts. The compiled survey results are described here for the Canadian oceans and marine community, industry and governments.

This survey was sponsored by Fisheries and Oceans Canada (DFO), Canadian Space Agency (CSA), and Ocean Science and Technology Partnership (OSTP). Seven regional organizations and individuals (see appendices for list) each solicited respondents from their networks. If you wish to find out additional information about this survey please contact the project manager, Sylvain Hurtubise, by email at Sylvain.Hurtubise@dfo-mpo.gc.ca.

Only compiled and analyzed data and information is included in this report. The individual respondent data collected by the survey will not be available to anyone except those involved in compiling and analyzing the data.

All organizations that indicated an interest in receiving the survey results will be provided with an electronic copy of the survey report.

Definition of an OS

This survey concerns the operation and use of ocean and marine observing systems. An observing system is an organized system that collects and provides ocean and maritime data to users on a regular basis. The system can include sensors, system infrastructure, data archive, modeling, data fusion, and data distribution. The OS to be inventoried includes Canada's three oceans, major rivers near the coast such as the St Lawrence, McKenzie, and Fraser rivers as well as nearby watersheds.

The Great Lakes OS includes the 5 Great Lakes, the St. Marys, St. Clair, Detroit and Niagara Rivers and Lake St. Clair.

Note that this definition of OS or OOS is not the same as the OOS used by IOOS in the US or elsewhere.

Survey Results

A total of 423 persons responded to the OOS inventory questionnaire invitation.

1. **The Questionnaire did not require respondents to answer all questions so that the number of responses to each question is variable; however most of the questions have over 150 responses. The discussion of questions usually indicates how many persons answered each question.**
2. **Many questions also allowed responders to provide additional descriptive comments; however this report does not analyze or report these comments.**
3. **All answers are presented as raw data collected. No adjustments or validating of the data has been done.**

The chart below shows the number of responses to each of the 59 questions. It appears that the number of responses drops off during the survey as some of the later questions are more targeted. It is also likely that there is some drop off in response due to survey fatigue. It is likely that 150+ respondents diligently completed the questionnaire with an additional 40+ responders providing less information.

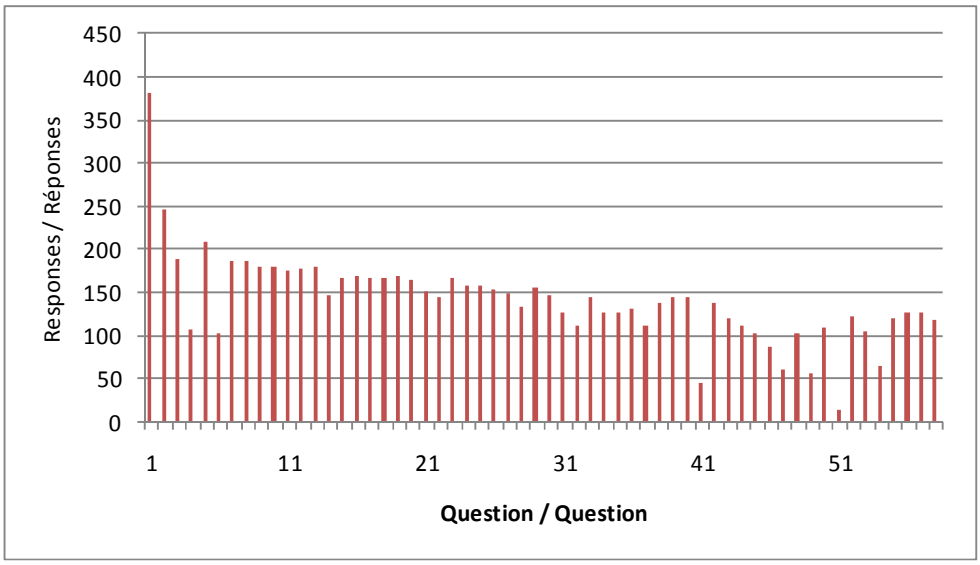

Figure 1. Number of responses to each survey question

A key measure of the survey response is that 127 respondents provided contact coordinates and asked to be provided with a link to the survey results (Q57, Q58). Also 118 respondents requested follow up contact to discuss the survey (Q59).

Description of Respondents

The questionnaire asked (Q1) the responders for a language preference of which 381 responded. The results were French (18%) and English (82%).

If the responder indicated that their organization is not involved with an OOS the survey was terminated. A total of 41 surveys were terminated by this choice. The remainder of the 205 respondents indicated involvement in the OOS sector.

Does your organization contribute to, operate, or use an OS or collect data and information on Canadian waters (as defined in the Introduction)? Est-ce que votre organisation contribue à, exploite, ou utilise un SO ou recueille des données et des informations sur les eaux canadiennes (tel que défini en introduction)?

Answer Options	Response Percent	Response Count
Yes / Oui	74.4%	183
Planned / Prévu	4.5%	11
Would like to but no OS, data, or information available/ Aimerait, mais pas de SO, donnée ou information	3.7%	9
Suspended / Suspendu	0.8%	2
No. This choice ends the survey / Non. Ce choix met fin au questionnaire	16.7%	41
If you answered 'Would like to but no OS available' or 'No' please clarify why your organization does not contribute, operate, use an OS or collect ocean data and information: Si vous avez répondu "Aimerait, mais pas de SO, donnée ou information disponibles" ou "Non", s'il vous plaît expliquer pourquoi votre organisation ne contribue pas, n'exploite pas, n'utilise pas un SO ou ne recueille pas des données ou informations océanographiques ou marines:		28
	answered question	**246**

Figure 2. Organization use of OS

Responder Locations and Statistics by Region

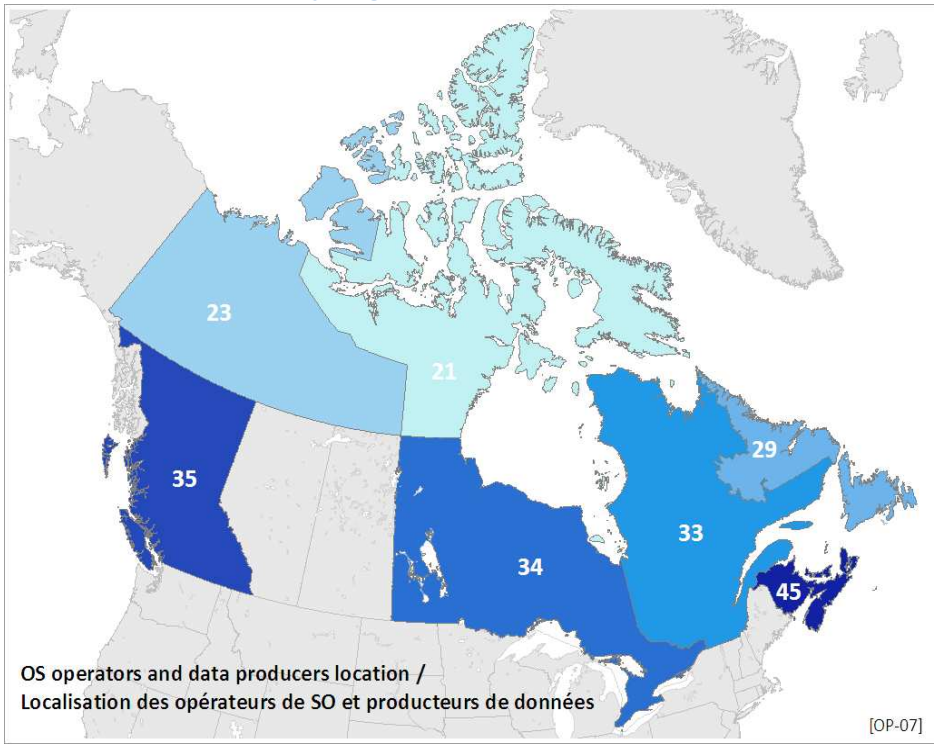

Figure 3. OS location map

Figure 3 shows the total number of locations where the responders are operating OS in each of 7 geographic regions.

Responder Affiliations / Organization Type

Responders were asked (Q5) to indicate what type of organization and functions were carried out by the organization.

Which of the below best describes your organization? (please tick all that apply) / Lequel des types ci-dessous décrit le mieux votre organisation? (s'il vous plaît cocher toutes les cases qui s'appliquent)					
Answer Options	**Research / Recherche**	**Operations / Opérations**	**Services / Services**	**Other / Autre**	**Response Count**
Government / Gouvernement	78	62	45	6	119
Industry / Industrie	18	24	25	6	42
Academic organization / Institution académique	33	6	7	1	34
NGO / ONG	9	3	9	1	14
ENGO / ONGE	7	2	6	0	8
Community	3	2	3	0	8
Individual / Individu	2	0	3	0	4

Figure 4. Organization type

Over 50% of the responders' organization was government. This was followed by industry then academia. Except for industry which provided services, the majority of the responders were focused upon research.

The regional representatives approached Federal and Provincial levels of government and First Nations but no statistics were collected to detail their participation levels in the survey.

OOS End Users

The respondents were asked to identify the OOS end user (Q9).

Please tick all boxes that describe the OS end user: / S'il vous plaît cocher toutes les cases qui décrivent l'utilisateur final du SO:		
Answer Options	**Response Percent**	**Response Count**
Information user / Utilisateur de l'information	74.6%	135
OS operator / Opérateur du SO	48.1%	87
Ocean data archive / Archives des données	45.9%	83
OS subsystem operator / Opérateur du sous-système	13.3%	24
OS system or subsystem supplier / Fournisseur du	14.9%	27
Ocean data supplier / Fournisseur de données	27.1%	49
Ocean data modeler supplier / Modélisateur de	29.3%	53
Ocean data system funder / Bailleur de fonds pour les	14.9%	27
Educator or Teacher / Éducateur ou Enseignant	30.4%	55
Researcher / Chercheur	72.4%	131
Community / Communauté	42.5%	77
Other (please specify) / Autre (préciser s'il vous plaît)		20
	answered question	**181**

Figure 5. OS end user

The OOS end users were identified to be information users and researchers. Secondary users were operators, data archivers, and the community.

OOS Impacts on Community and Rankings

The respondents were queried about the OOS impacts on the community (Q52) and to rank these impacts (Q53).

Please rate the impacts of your OS on the community: / /Évaluer les impacts de votre SO sur la communauté:						
Answer Options	**High Impact / Grand impact**	**Medium Impact / Impact moyen**	**Low Impact / Faible impact**	**Don't know / Ne sait pas**	**N/A**	**Response Count**
Advancing research / Avancement de la recherche	45	42	13	2	14	116
Technology demonstration / Démonstration	32	28	24	7	18	109
Operational efficiencies / L'efficacité opérationnelle	29	35	24	13	12	113
Ocean stewardship / Contrôle et souveraineté des	27	26	17	7	35	112
Coastal stewardship / Contrôle et souveraineté du	26	26	25	6	28	111
Education and outreach / Éducation et sensibilisation	25	42	29	5	11	112
Monitoring region / sector operations / Surveillance	52	35	12	3	14	116
Safety and security / Sûreté et sécurité	29	23	16	14	25	107
Development / Développement	13	40	16	12	18	99
Public information / Information publique	28	43	18	9	13	111
Regulation / policy / Réglementation / politique	18	42	22	10	15	107
Productivity enhancement / Augmentation de la	16	26	16	21	23	102
Other / Autre	2	0	0	4	22	28
Other (please specify) / Autre (préciser s'il vous plaît)						9
					answered question	**123**

Figure 6. OS impact on community

The highest impact score was for regional monitoring followed by advancing research. Ocean and coastal stewardship impact highest scores were under N/A which is interpreted as a low ranking. When asked to provide optional details of the impact there were 66 descriptive responses. These additional responses demonstrate the high diversity of OS uses.

OOS Descriptions

List of OOS Names / Websites

Responders provided the names of 99 OOS with 76 website addresses. Of these the 67 unique OOS and website addresses are tabulated below.

OS Name/ Nom du SO	Website address / Adresse Web
AMEC	shawn.allan@amec.com
Argo	http://www.argo.net
At sea Observer Program, Synoptic survey program, etc....	
Atlantic Zone Monitoring Program	http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/azmp-pmza/index-eng.html
Banque de données hydriques (BDH)	http://www.cehq.gouv.qc.ca/hydrometrie/index.htm
Barrow Strait CATS array	http://www.mar.dfo-mpo.gc.ca/science/ocean/seaice/public.html
BC Shore Station Oceanographic Program	http://www.pac.dfo-mpo.gc.ca/science/oceans/data-donnees/lighthouses-phares/index-eng.htm
Bedford Basin Ocean Monitoring Buoy	http://bbomb.ceotr.ca/
Bedford Institute of Oceanography	http://www.bio.gc.ca/index-eng.htm
Bird Studies Canada	www.bsc-eoc.org
BQMA (Banque de la qualité du milieu aquatique)	
Canada-PEI Water Quality Agreement	several sites (both federal and provincial where data can be downloaded)
Canadian Centre for Ocean Gliders	
Canadian Hydrographic Service	http://www.charts.gc.ca/index-eng.asp
Centre de données sur le patrimoine naturel du Québec	http://www.cdpnq.gouv.qc.ca/
City of Hamilton	www.hamilton.ca
C-NOOFS	www.c-noofs.gc.ca
COINAtlantic	http://coinatlantic.ca
Conservation Authorities	
DFO Gulf Region	http://www.glf.dfo-mpo.gc.ca/Gulf
DFO Operational Remote Sensing	http://www.mar.dfo-mpo.gc.ca/science/ocean/ias/seawifs/seawifs_1.html
Durham Region Coastal Wetland Monitoring Project	www.cloca.ca
Environment Canada - Meteorological Service of Canada	weatheroffice.ec.gc.ca
GEOTOP	www.geotop.ca
health diagnostics	
Great Lakes Observing System	www.glos.us or www.glos.ca
Herring spawn survey	
High Seas Salmon Program	
Ice Information Services	
ISMER	
Lake Erie East Basin Hydroacoustic Survey	
Lambton Area Water Supply System	lawss.org
LAWSS intake	www.lawss.org
Line P Program	http://www.pac.dfo-mpo.gc.ca/science/oceans/data-donnees/line-p/index-eng.htm
multibeam sonar	www.charts.gc.ca
NEPTUNE Canada	www.neptunecanada.ca
NERACOOS	www.neracoos.org
North Pole Environmental Observatory	psc.apl.washington.edu/northpole/
Northwest Arm LOBO	http://lobo.satlantic.com/
NWRI Inland Water Remote Sensing Products	http://www.ec.gc.ca/inre-nwri/Default.asp?lang=En&n=37A22BD5-1
Observatoire Global du Saint-Laurent	http://ogsl.ca
Ocean Networks Canada	www.oceannetworks.ca
Ocean Tracking Network	http://oceantrackingnetwork.org/
Pacific Ocean Shelf Tracking (POST) Project	http://www.postcoml.org
PEI Estuaries Survey	several provincial pages on website
Permanent Water Level Network	http://www-sci.pac.dfo-mpo.gc.ca/Charts/
Permanent Water Level Network (Atlantic)	www.chs-shc.dfo-mpo.gc.ca
Pukaskwa National Park Ecological Integrity Monitoring Program	
Relevés hydrologiques du canada (Québec)	http://www.ec.gc.ca/rhc-wsc/default.asp?lang=Fr&n=4EED50F1-1
Réseau de suivi du milieu aquatique	rsma.qc.ca
activités d'observation en mer en Gaspésie / photo-identification des	www.romm.ca
Saugeen Conservation	www.svca.on.ca
Sault Ste. Marie Region Conservation Authority	www.ssmrca.ca
Sediment trap particle fluxes	
sidescan, Multibeam, Seismic, Single beam, etc	www.csr-marine.com
SmartBay	www.SmartBay.ca
Southern Gulf ecosystem trawl survey	
SW Nova Surface Current Monitoring Network	http://cordc.ucsd.edu/projects/mapping/maps/
Systems	http://www.neracoos.org/
Triaxys Direction wave buoy TAS00160	
U. S. Coast Guard International Ice Patrol	http://www.uscg-iip.org
U. S. Steel Canada Inc	www.ussteelcanada.com
Utilities Kingston	www.utilitieskingston.com
VENUS	www.venus.uvic.ca

Figure 7. List of OOS and websites

Operation Description

The OOS operations mode was identified in Q3. Almost 50% of OOS provided continuous operation and 34% provided regularly scheduled operation.

Choose the most appropriate operation mode used to monitor and observe the ocean: Choisissez le mode d'opération le plus approprié utilisé pour observer et faire le suivi des océans:		
Answer Options	**Response Percent**	**Response Count**
Continuous operation / Opération en continu	49.7%	94
Planned continuous operation / Opération en continu planifiée	7.9%	15
Regularly scheduled operation / Opération régulière planifiée	34.4%	65
Scheduled operation / Opération planifiée	13.2%	25
Occasionally operated as needed / Occasionnellement opéré	18.5%	35
Sporadic (ie. after a storm) / Sporadique (c'est à dire après un	6.9%	13
Other (please specify) / Autre (préciser s'il vous plaît)		21
	answered question	189

Figure 8. OS monitoring modes

For OOS that did not provide continuous operation, 46 (43%) indicated that the OOS operated annually (Q4).

If you did not choose 'Continuous Operation' above, please indicate frequency: Si vous n'avez pas choisi «Opération en continu» ci-dessus, s'il vous plaît indiquer la fréquence:						
Answer Options	**Annual / Annuelle**	**Quarterly / Trimestrielle**	**Monthly / Mensuelle**	**Weekly / Hebdomadai**	**Daily / Quotidienne**	**Response Count**
Scheduled operations / Opération planifiée	46	13	25	12	12	108
					answered question	108

Figure 9. Other Operation Modes

The respondents were asked what water type was observed. Of the respondents, 72% worked in salt water and 57% worked in fresh water. 29% worked in both fresh and salt water (Q8).

What water type is being observed? / Quel milieu aquatique est observé?		
Answer Options	**Response Percent**	**Response Count**
Fresh / Eaux douces	28.3%	53
Salt / Eaux salées	44.4%	83
Both / Les deux	28.9%	54
	answered question	187

Figure 10. Water type

The vast majority (83%) of the OOS have been operating for 3 or more years. There were only 8 (4.5%) respondents who are planning new OOS (Q12).

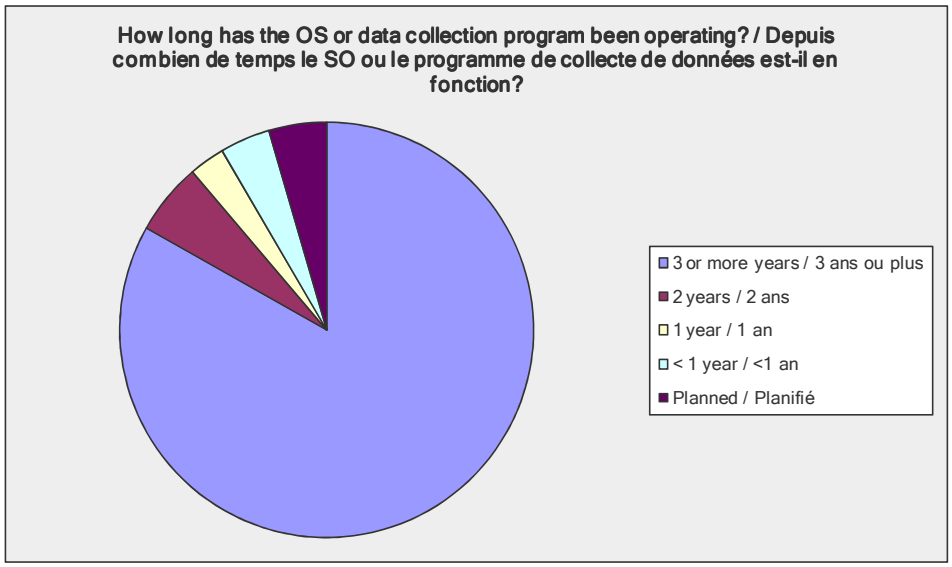

Figure 11. OS Program age

The responders were queried about the type of areas that were being monitored (Q13). The majority of OOS operators and users are monitoring open water and coastal areas but a significant number are monitoring watershed/river and near shore areas.

What type of area is being monitored? / Quel type d'environnement est observé?		
Answer Options	**Response Percent**	**Response Count**
Watershed, rivers close to ocean / Bassin versant,	35.9%	65
Near shore / Près de la rive	45.3%	82
Coastal (bays/harbour/inlet/strait/protected gulf or	58.0%	105
Open water / En eaux libres	61.3%	111
	answered question	**181**

Figure 12. Monitoring area

When asked where the OOS was located, 108 locations were described (Q14). The area coverage of the OOS was also described (Q15). The majority of the OOS coverage is regional.

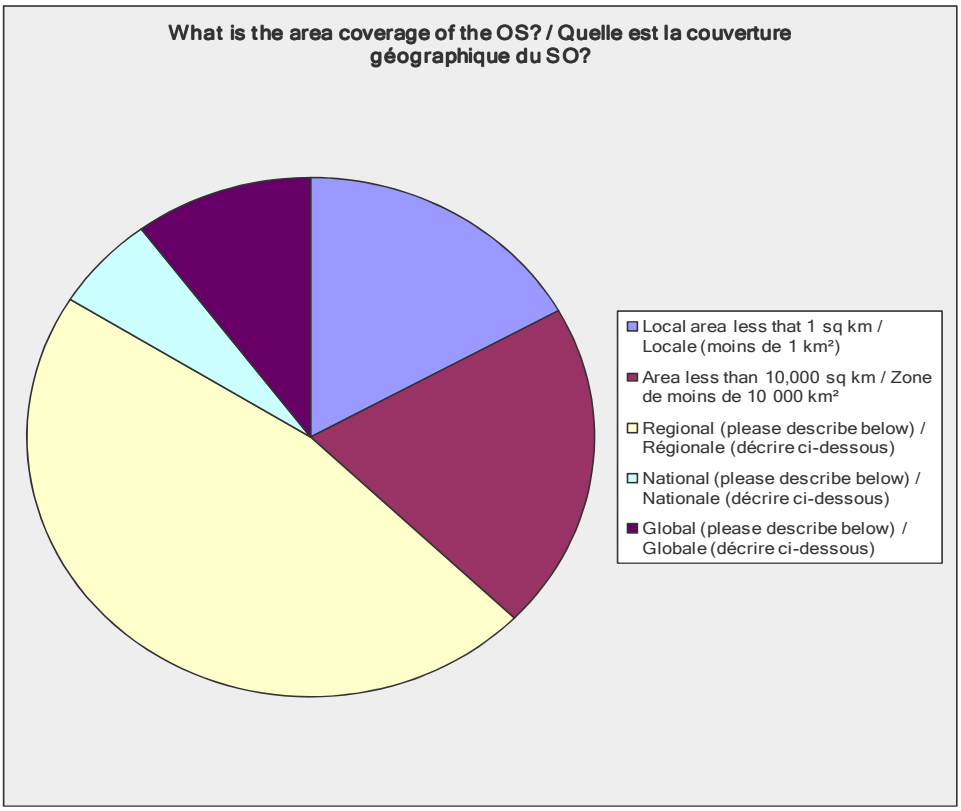

Figure 13. OS Monitoring area size

Why is Data Being Collected – What are the OOS Priorities

The responders were surveyed as to why the data was being collected (Q10). The dominant reason was Research at 76% followed by Operations monitoring at 54% and Fisheries at 47%. Multiple answers were allowed.

Why is the OS / Ocean data being collected? (select all that apply): / Pourquoi le SO / les données océanographiques ou marines sont-elles collectées? (cochez toutes les cases qui s'appliquent):

Answer Options	Response Percent	Response Count
Research / Recherche	76.2%	138
Regulatory monitoring / Suivi réglementaire	42.0%	76
Operations monitoring / Suivi des opérations	53.6%	97
Ocean stewardship / Souveraineté des océans	27.6%	50
Ocean management / Gestion des océans	41.4%	75
Coastal management / Gestion côtière	42.5%	77
Fisheries / Pêches et aquaculture	47.0%	85
Industrial activities / Activités industrielles	31.5%	57
Ocean energy / Énergie	13.3%	24
Tourism & Recreation / Tourisme et Loisirs	17.1%	31
Education and outreach / Éducation et sensibilisation	34.8%	63
Technology demonstration / Démonstration technologique	23.8%	43
Safety & security / Sécurité et sûreté	27.6%	50
Other (please specify) / Autre (préciser s'il vous plaît)		21
	answered question	181

Figure 14. Why is the data being collected?

When asked to rank the three top priorities for the OOS, Research was clearly the top priority (Q11).

Please rank the top three priorities of your OS: / Classer les trois principales priorités de votre SO:

Answer Options	Research / Recherche	Regulatory monitoring / Suivi réglementaire	Operations monitoring / Suivi des opérations	Ocean stewardship / Souveraineté des océans	Ocean management / Gestion des océans	Coastal management / Gestion côtière	Fisheries / Pêches et aquaculture	Industrial activities / Activités industrielles	Ocean energy / Énergie	Tourism & Recreation / Tourisme et Loisirs	Education and outreach / Éducation et sensibilisation	Technology demonstration / Démonstration technologique	Safety & security / Sécurité et sûreté	Response Count
#1 Priority / Priorité # 1	55	27	26	5	7	8	18	5	0	0	4	3	17	175
#2 Priority / Priorité # 2	33	17	25	10	12	14	11	9	1	3	16	8	10	169
#3 Priority / Priorité # 3	27	3	10	12	17	18	12	8	3	5	18	10	8	151

Figure 15. OS priorities

OOS Data Collection and Distribution

Types of Data and Information Collected

General (Q29)

The available data were divided into 5 different types each of which is also colour coded with the rate of acquisition (e.g. continuous collection is blue) and availability. The metrics or statistics used include only respondents from the OS operators and data producers.

The following findings emerge from the graph (Figure 16):

- Processed and archived data are available from the larger number of OS;
- The types of data requiring analysis or manipulation are mainly made available on request;
- Data are more often collected on a continuous basis but that periodic and on demand collection of data is significant.

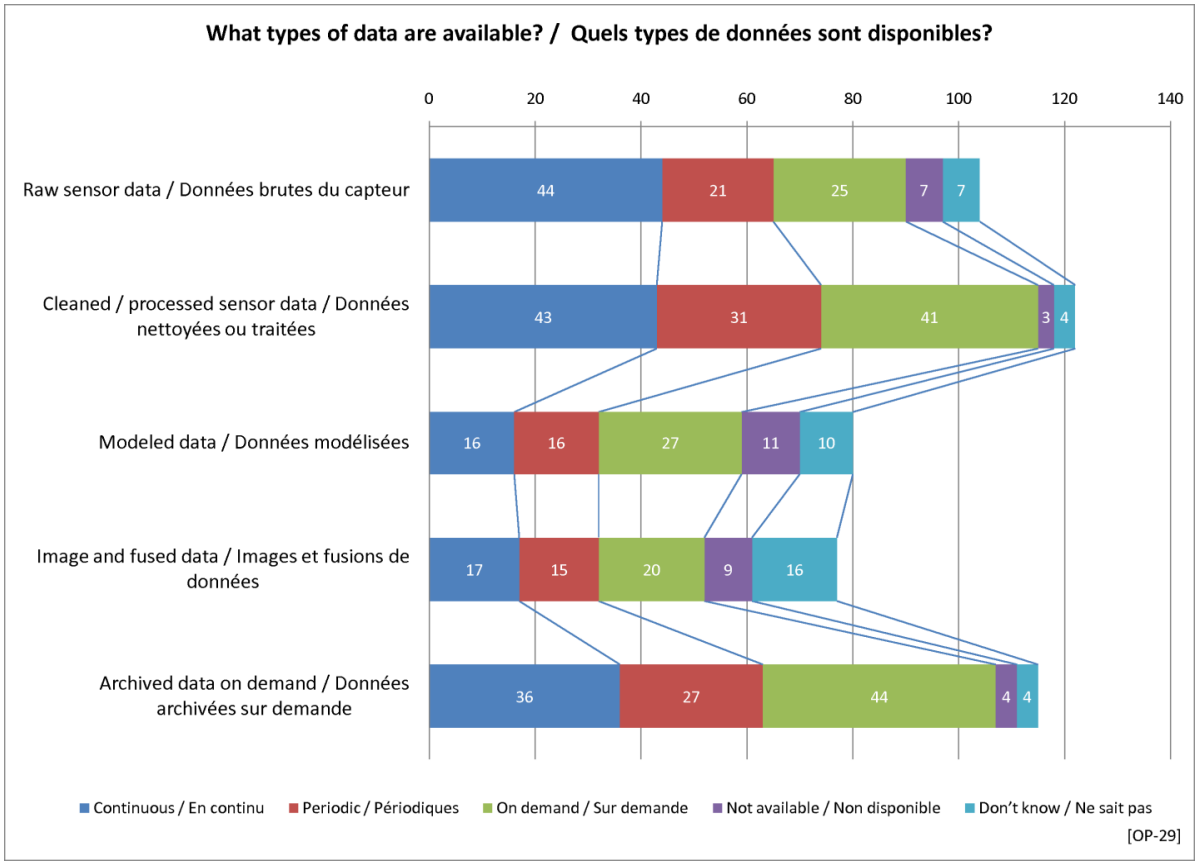

Figure 16. Data types and acquisition rate

Specific Data Types

The specific data types graphic (Figure 17) presents the OS operators and data producers (Q33) answers on the collection or availability of the different marine (aquatic) parameters. Each data type is further identified with the marine zone of collection or of interest (surface, water column and seabed). The

wider availability of data for the physical-chemical parameters of the water column and surface domains can be noted in comparison with the biological parameters and general information about the seabed.

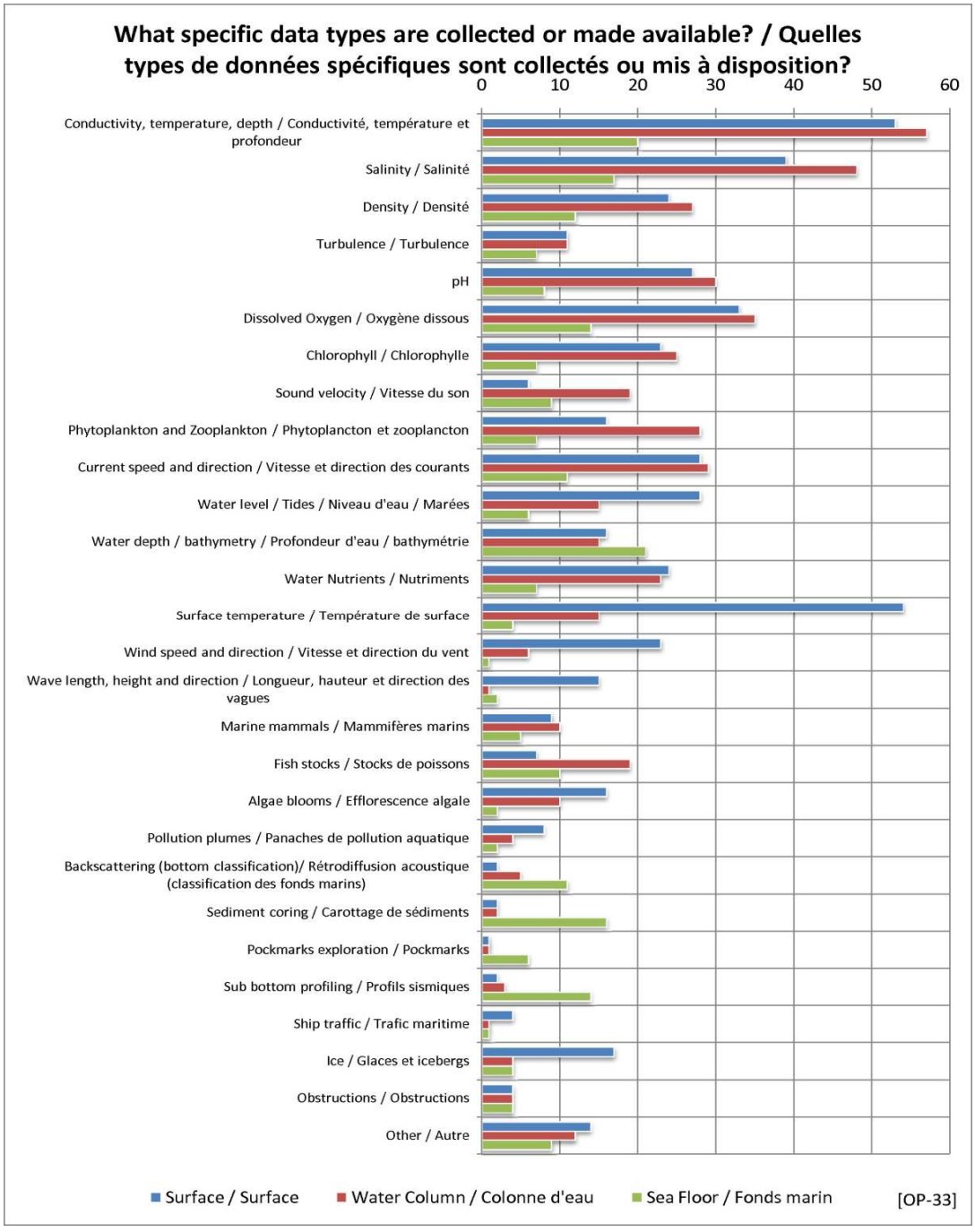

Figure 17. Specific data types

Modeled Data

OS operators and data producers can provide many types of data outputs (Q36). The following graphic (Figure 18) shows the number of responses for each type of model. (N/A is not applicable)

- Hindcasts and nowcasts modeled data output are equally provided. Forecast data is less available.

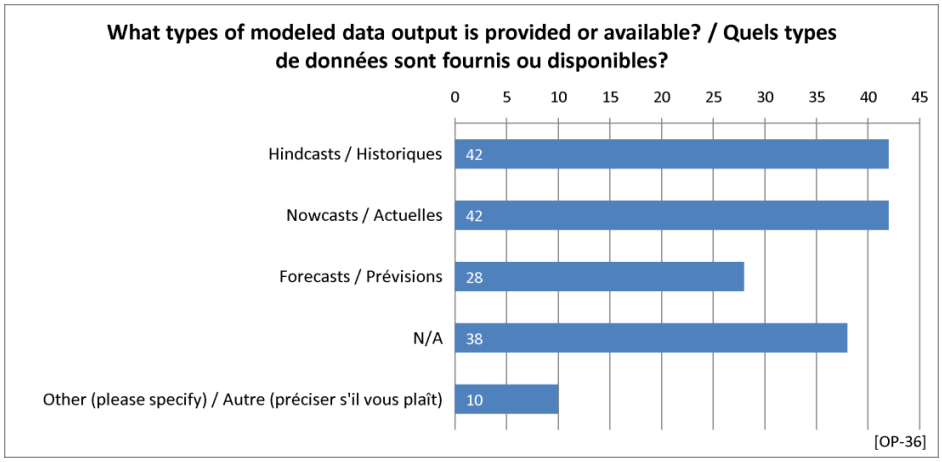

Figure 18. Modeled data

Customized data

Some users may prefer to use customized data for their operations or may need specific analysis or representation of the information (Q40). Nearly 50% of the OS operators and data producers answered they were able to produce custom / specialized output to meet the needs of the data users.

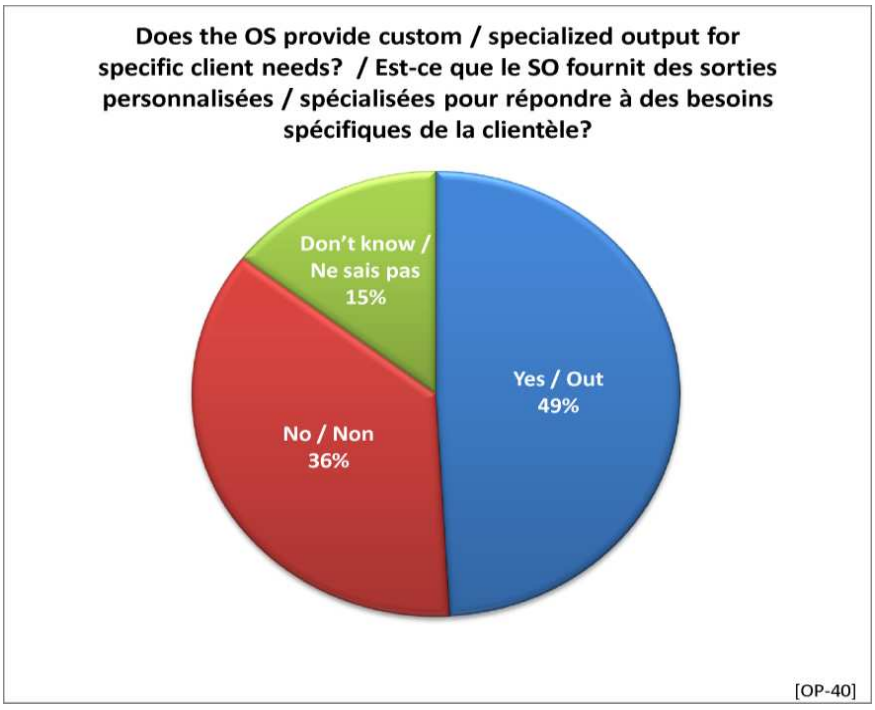

Figure 19. Customized outputs

Acquisition Platforms and Collection Nodes

Various data acquisition platforms are used by operators and producers (Figure 20). Here are the main trends from the survey:

- The traditional platforms that are buoys and ships are the most commonly used (total represents 35% of all platforms);
- Data manually acquired are relatively important;
- There is a marked importance of the use of satellites compared with other remote sensing methods.

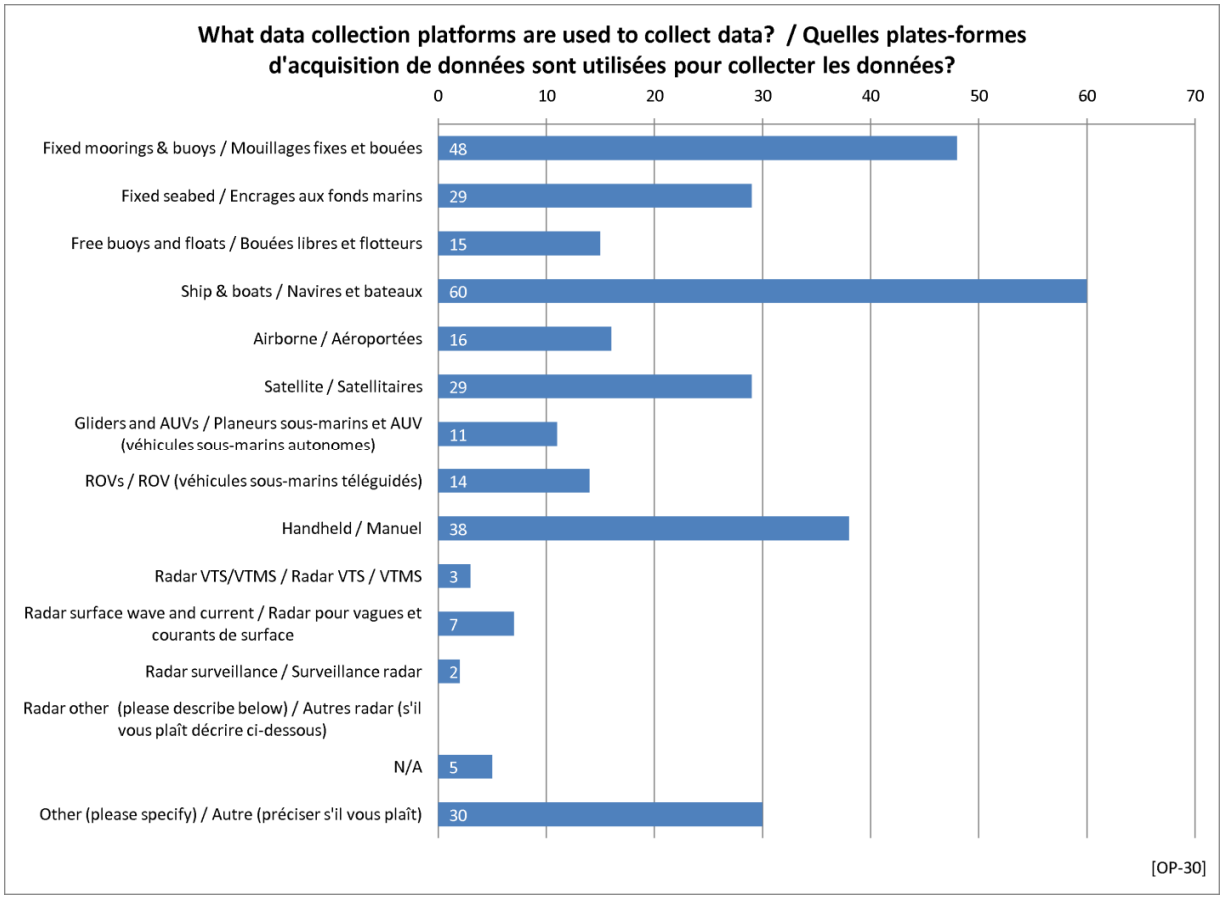

Figure 20. Collection platforms

Airborne Platforms

Nearly 5% of all platforms used by OS operators and data producers are airborne (Q31). The following graphic (Figure 21) shows the airborne platforms used for data acquisition by the OS operators and data producers.

These are mainly divided in two mostly used kinds of airborne acquisition platforms; the laser mapping systems (LiDAR or SHOALS) and aerial photography (panchromatic, color, infrared and others);

None of the OS operators and data producers answered for other airborne platforms.

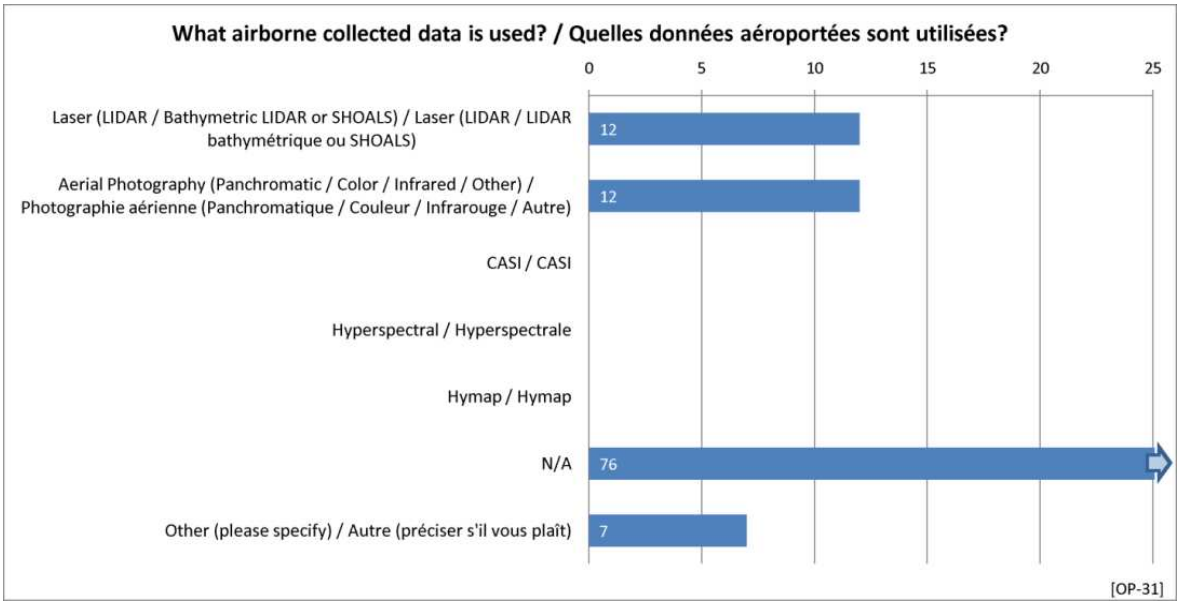

Figure 21. Airborne platform

Satellites

In the objective of showing the trend for the use of remote sensing satellite data, answers from all respondents are represented in the graphic (Figure 22) (Q32).

Only 35 respondents (31%) of the question indicated that they use satellite data, with each satellite user using data from an average of 4.2 satellites;

Radarsat I and II satellites data are of greatest use by respondents (16 selections - 7% - and 19 selections - 9% - respectively);

Next come the MODIS and ENVISAT platforms mainly used for atmospheric and sea surface information (16 selections - 7% - and 13 selections - 6% - respectively).

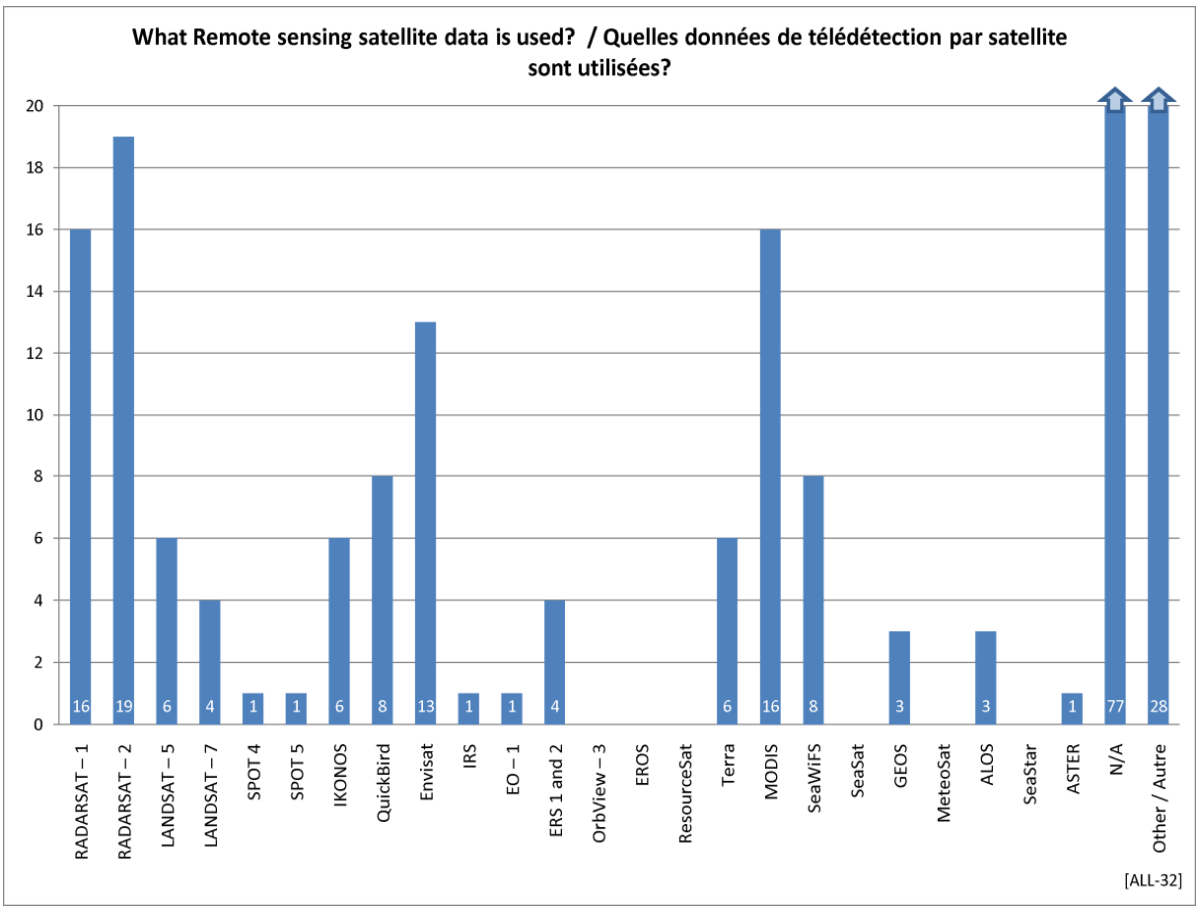

Figure 22. Remote sensing satellite data

Data collection nodes

An OS may have a structure consisting of a single point or multiple nodes of data collection to cover a specific zone (Q35). The next graphic (Figure 23) illustrates the actual number of nodes given by the OS operators and data producers. It also presents the anticipated number of nodes in two years by the respondents.

The anticipated number of nodes in two years is decreasing in all categories. This could mean that OS operators and data producers are on a short term management (budget) or they know that the funds to sustain and develop the infrastructures will be reduced. It could also mean that they sense that there will be a decrease in the interest/need to access the data they are producing/providing or that technology is improving and fewer nodes are required.

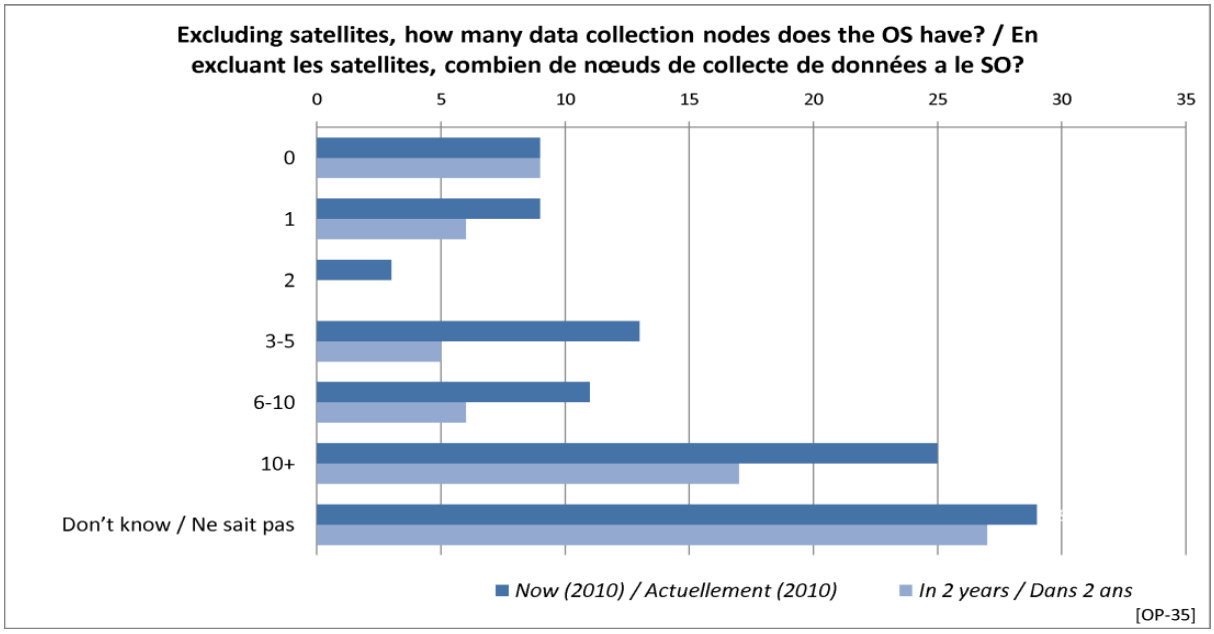

Figure 23. Data collection nodes

Data and Information Cycle

Data transmission to shore

Once a data/parameter/image is taken from a sensor or other collection system, it is transmitted or transferred to a base station to be processed/distributed (Q34). The following graphic (Figure 24) presents the different means of data transmission/transfer to shore with the responses from the OS operators and data producers.

By far, the dominant means of transmission is a direct data transfer by hand or from the device memory.

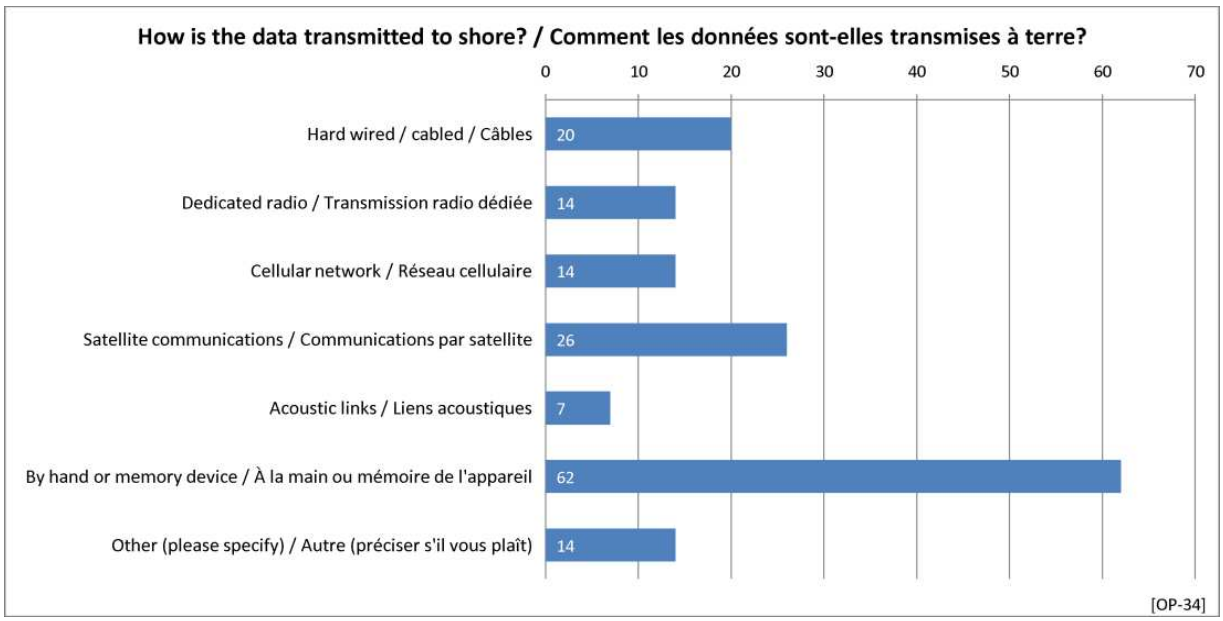

Figure 24. Data transmission to shore

Data Dissemination and Distribution

Dissemination and distribution of data products by the OS operators and data producers to the users is done through several methods presented in the next graphic (Q24). About the same portion of the data products are distributed through the OS website or web services and by direct requests to OS operator.

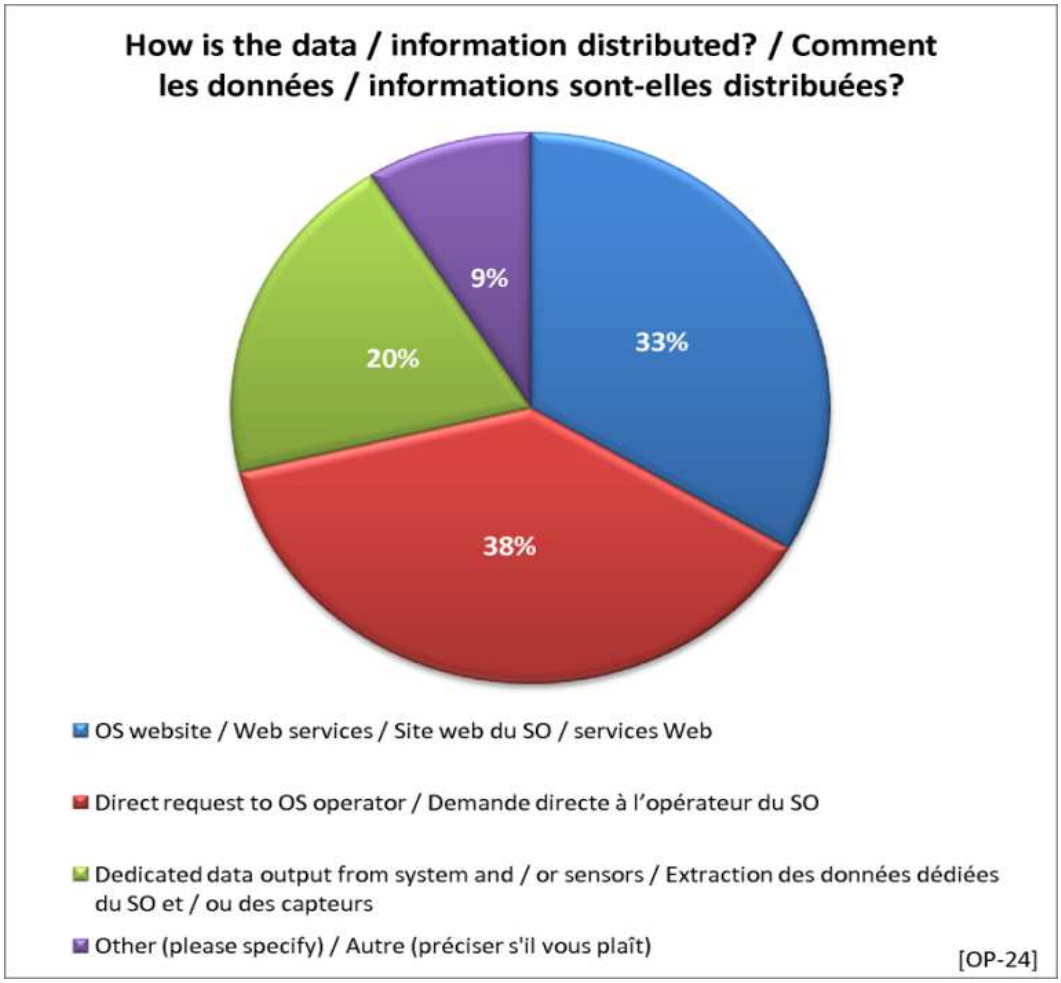

Figure 25. Data distribution

Data Access Methods

In the preceding paragraph we saw the dissemination and distribution methods (the OS offer). In the following graphic (Figure 26) using the same representation, we will see the actual methods used to access the data by the users (the actual demand) using the answers given by the OS operators and data producers (Q25).

The access by direct requests to OS operators is a bit higher than what was shown on the distribution graphic, while the access through the website or web services a bit lower.

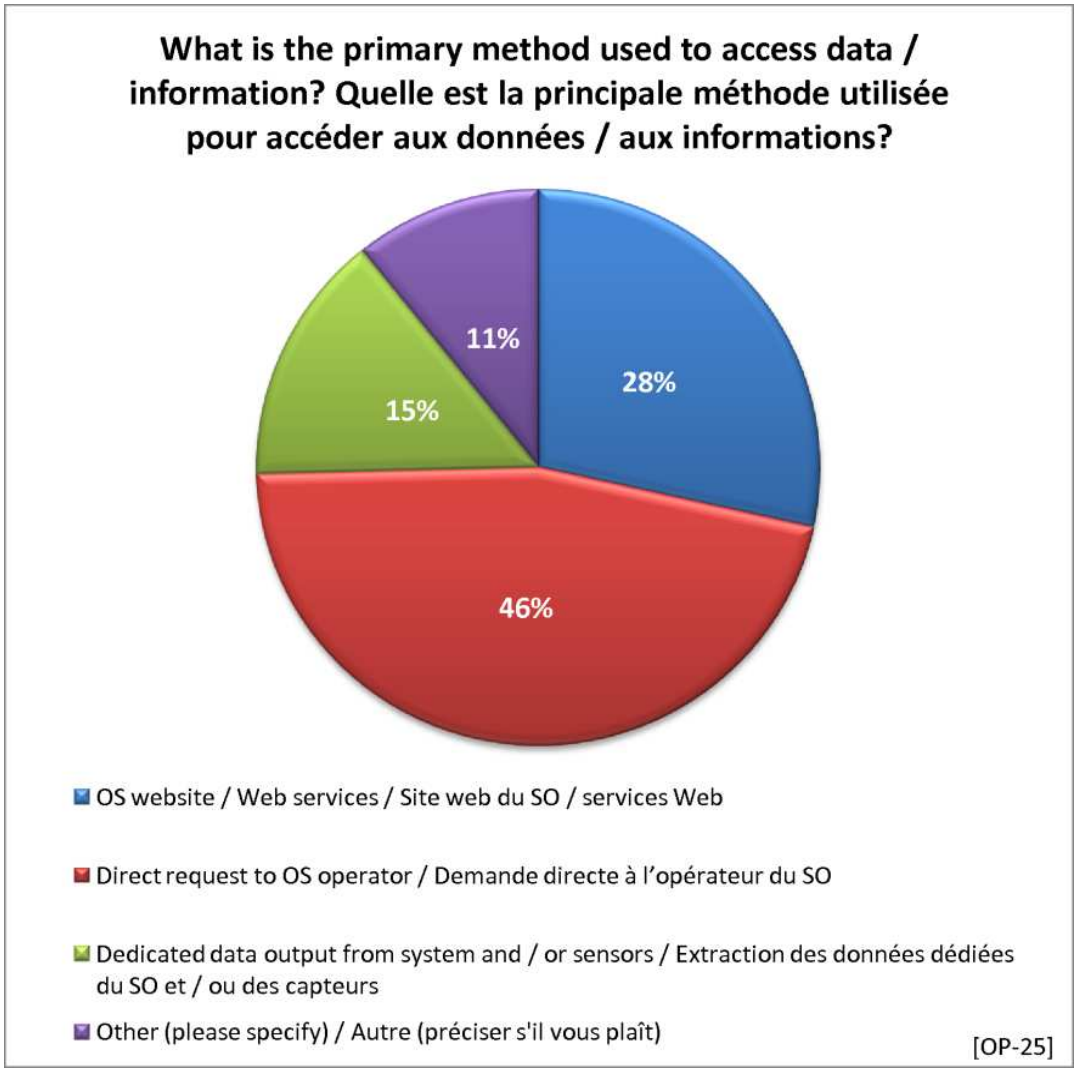

Figure 26. Data access

Data Access Costs

The access to the data products from the OS operators or data producers sometimes has a price tag (either in money, agreement or in kind) (Q26). The next graphic (Figure 27) shows the proportion of the different types of access costs.

- More than 50% of the products are given access on free basis;
- Only a little less than 5% of the access given by the OS operators or data producers has a user fee;
- Nearly 10% of the information has a closed private access.

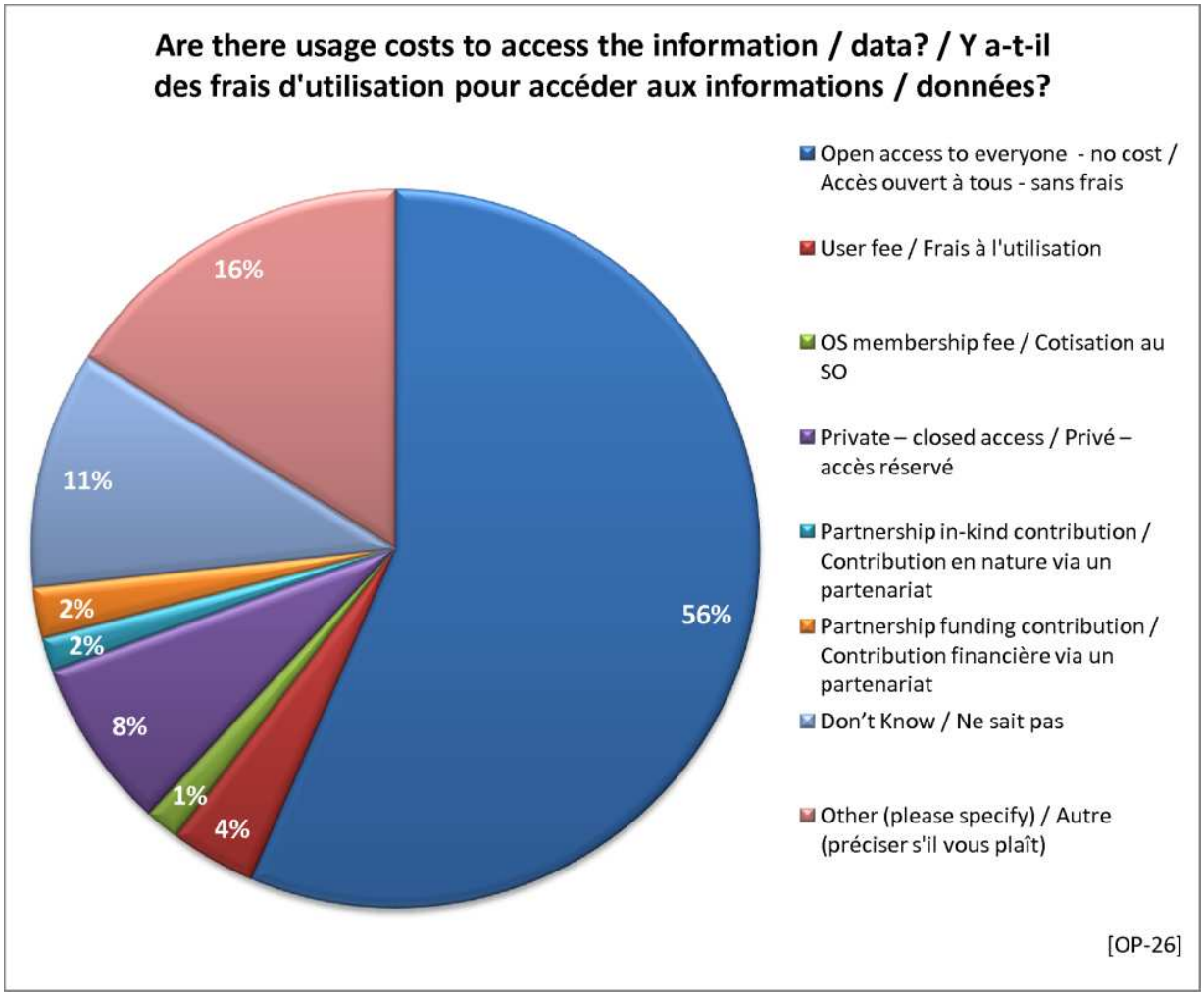

Figure 27. Usage costs

Other Access to Data

Only 2% of the OS operators and data producers would restrict access to data. This implies that 98% of OS already do provide access to data or would be willing (under an appropriate agreement) to provide access to data. (Q27).

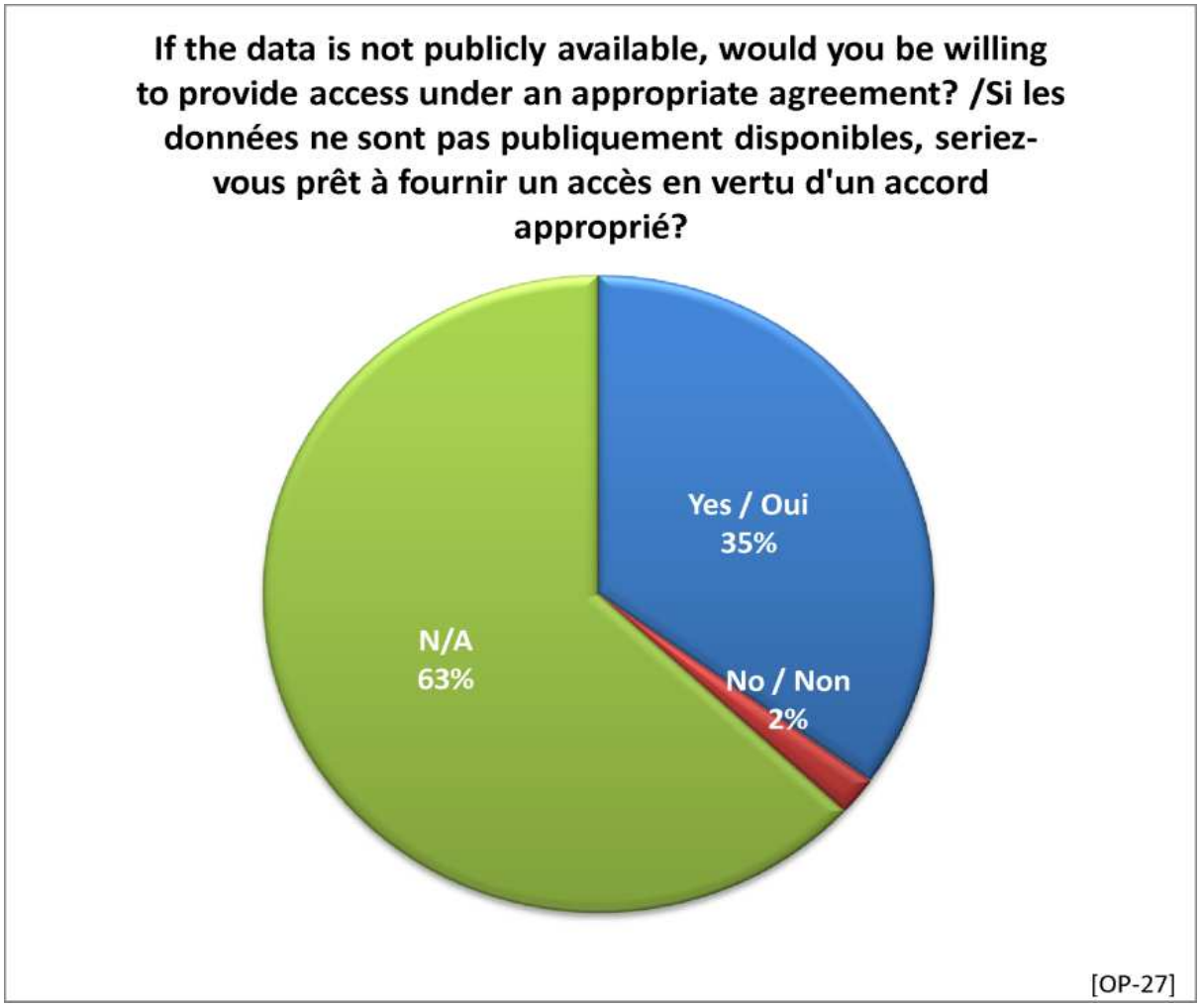

Figure 28. Access agreement

Usage and Awareness Metrics

Metrics or statistics on the usage and awareness can be collected to give a measure of OS usage and awareness (Q28). There are many ways to collect metrics and statistics as shown in the following graphic (Figure 29).

- Many OS operators collect statistics on website hits and data volume). However about the same number of respondents were not aware of any metrics or awareness metrics being collected.
- OS outreach though broadcast media, printed matter, and the internet communications metrics are of less importance to most OS.

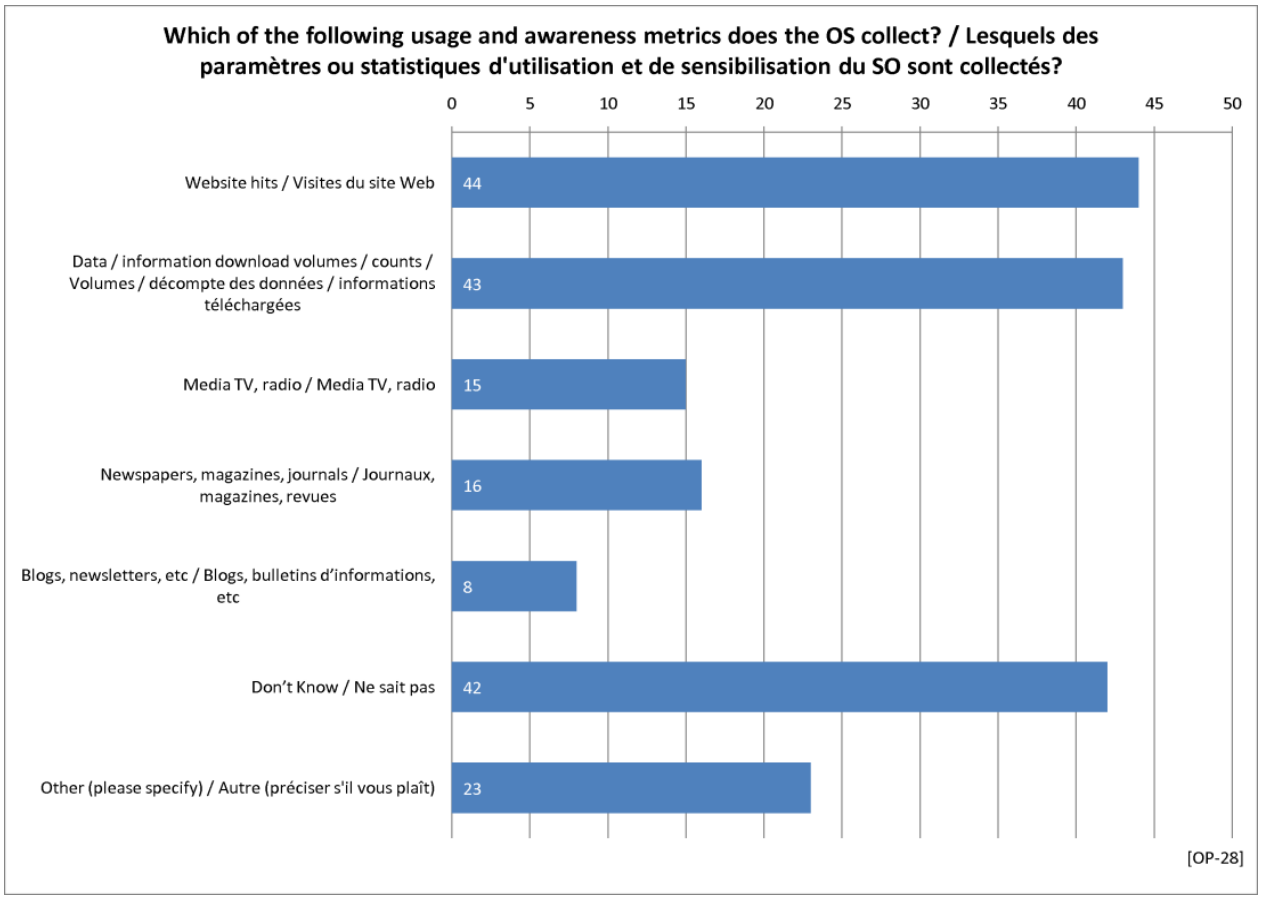

Figure 29. Usage and awareness metrics

Data Standards

Data Availability

Data standards exist to enable exchange of information, reproduce data collection and facilitate data interoperability. The survey answers from the OS operators and data producers were mostly positive about the availability of standardized data (Q38).

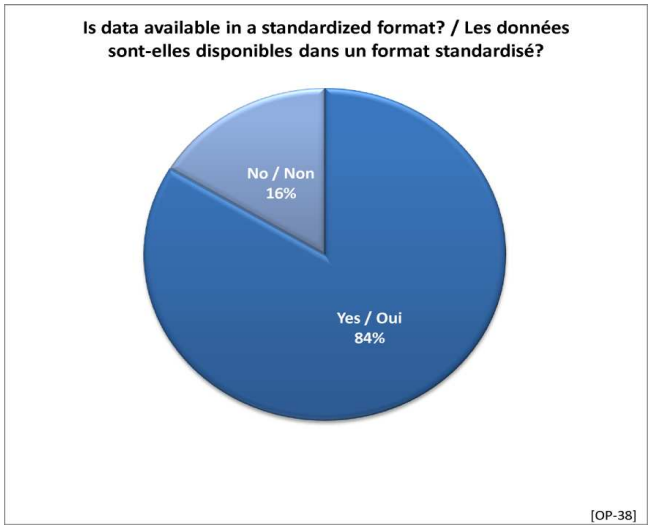

Figure 30. Availability of standardized data

Metadata

The metadata corresponds to the information about the data (means of creation of the data, time and date, author, purpose, standards used, etc.). The survey shows that 60% of the OS operators and data producers are making available the metadata about their products (Q39).

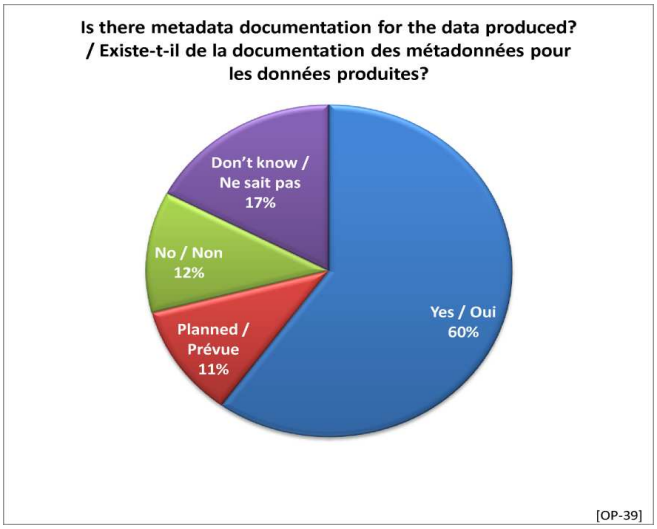

Figure 31. Metadata availability

OSS Planning, Governance, and Coordination

Questions 16 through 20 were incorporated in the survey to provide insight of the OOS planning and governance functions. The results in the graphs below are for OOS operators and data suppliers.

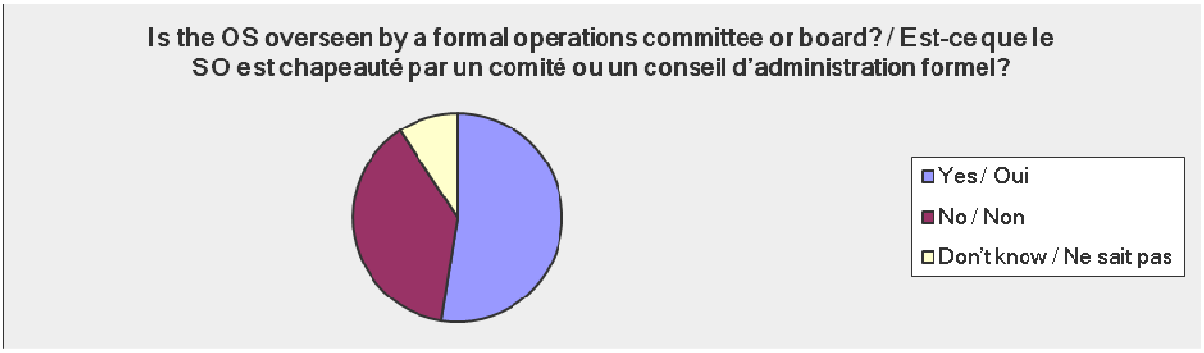

Figure 32. Operations committee or Board

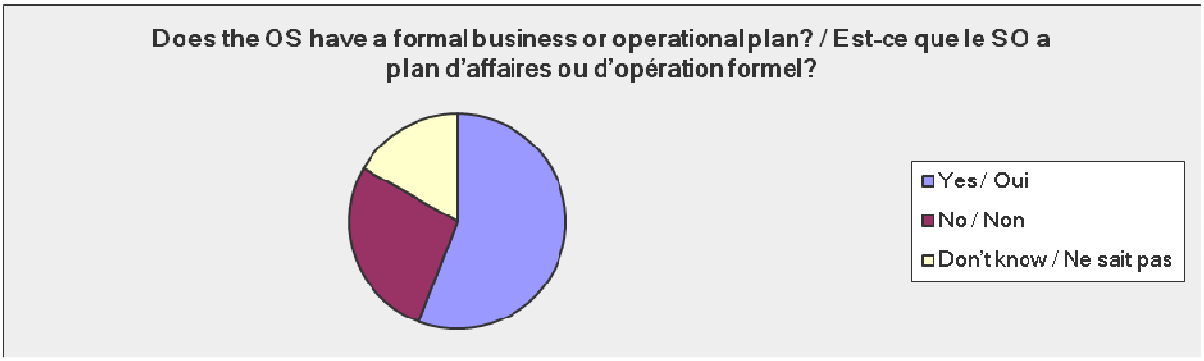

Figure 33. Business or operations planning

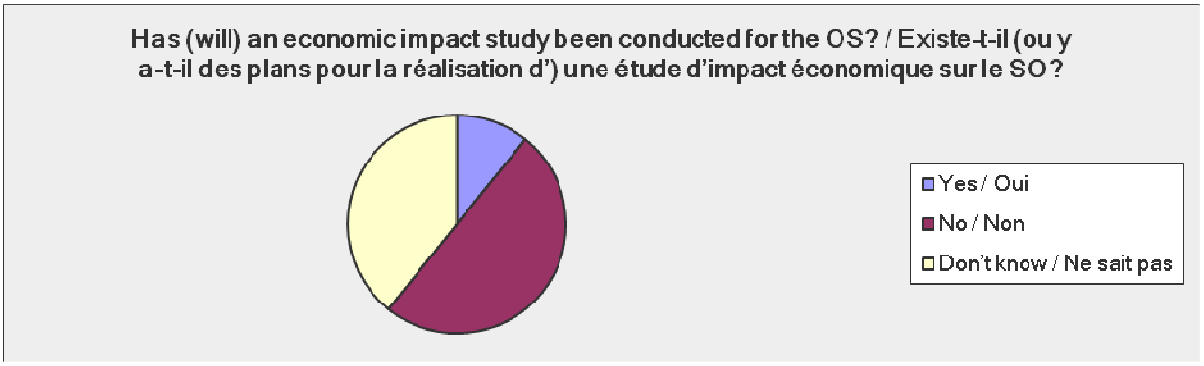

Figure 34. Economic impact study

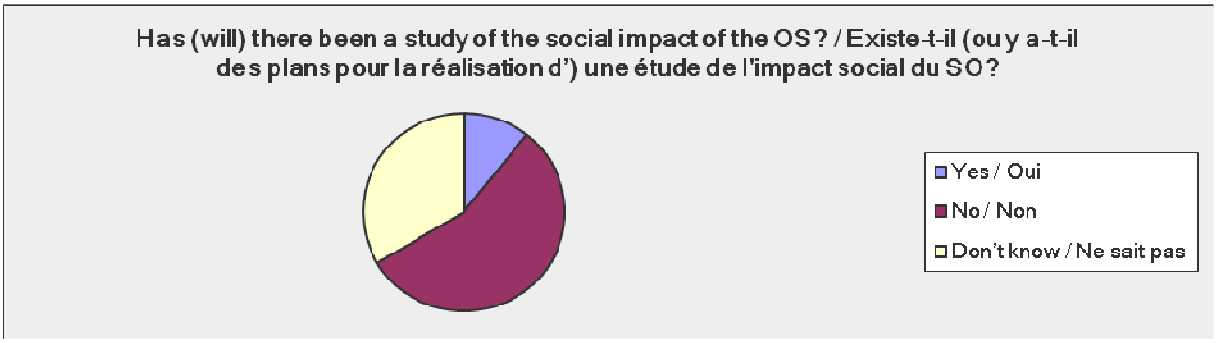

Figure 35. Social impact study

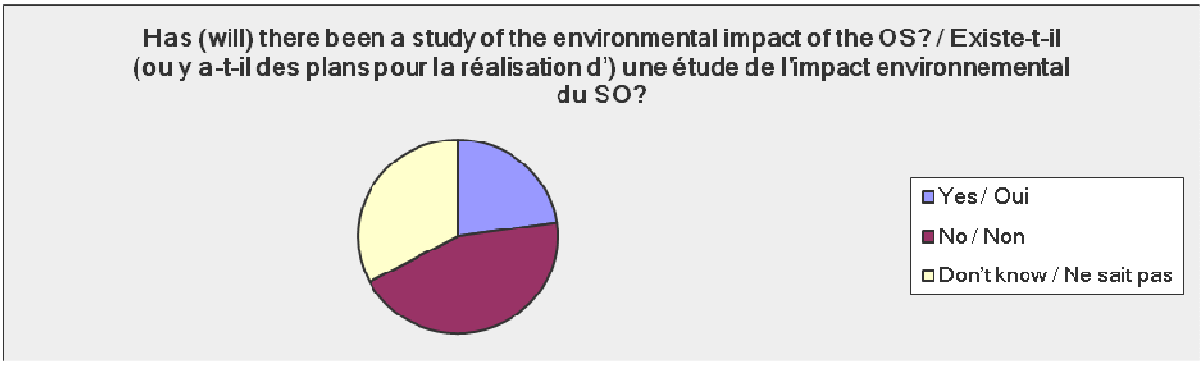

Figure 36. Environmental impact study

The data from the questions about governance and planning are summarized in the table below:

OOS Governance and Planning / Gouvernance et planification des SOO	Responses / Réponses	% Yes / Oui	Yes / Oui	No / Non	Don't Know / Ne sait pas	Plan Available / Planification disponible	% Available / Disponible
Business or Operations Plan / Plan d'affaires ou d'activités	120	56%	67	33	20	50	75%
Formal Board or Operations Committee / Conseil d'administration ou comité d'action	120	53%	63	46	11		
Economic Impact Study / Études d'impact économique	120	11%	13	60	47	11	85%
Social Impact Study / Étude d'impact social	122	11%	13	68	41	12	92%
Environmental Impact Study / Étude d'impact environnemental	119	23%	27	53	39	11	41%

Figure 37. OOS governance and planning responses from responders who were operators or data suppliers

Approximately 55% of the OOS have a formal plan and operations board or committee. Only 11% of the OOS have or intend to carry out economic or social impact studies. Only 23% of the OOS have or intend to carry out environmental impact studies. Significantly the majority of the OOS that have studies and plans are willing to share information.

Support and Finance

The importance of government and non-government support for OOS was measured as two independent questions.

Importance of Government Support (Q21)

Please rate the importance of the types of government support (cash and in-kind services) received for your OS in 2009: / Évaluer l'importance des types de soutien gouvernementaux (en espèces et en nature) reçues pour votre SO en 2009:								
Answer Options	**Not important / Pas important**		**Neutral / Neutre**		**Very important / Très important**	**N/A**	**Rating Average**	**Response Count**
Internal / Internes	8	4	9	12	80	29	4.35	142
Grants / Subventions	20	1	5	16	50	41	3.82	133
Contracts / Contrats	21	6	10	19	23	48	3.22	127
Partners / Partenaires	12	4	5	25	64	23	4.14	133
Operating & Service revenue / Revenus d'exploitation et de services	34	2	4	10	22	57	2.78	129
Other (please specify) / Autres (préciser s'il vous plaît)								19
							answered question	152

Figure 38. Importance of government support

Importance of non-government support (Q22)

Please rate the importance of the types of non-governmental support (cash and in-kind services) received for your OS in 2009: / Évaluer l'importance des types de soutiens non gouvernementaux (en espèces et en nature) reçus pour votre SO en 2009:								
Answer Options	**Not important / Pas important**		**Neutral / Neutre**		**Very important / Très important**	**N/A**	**Rating Average**	**Response Count**
Internal / Internes	25	2	2	7	21	43	2.95	100
Grants / Subventions	25	2	7	2	12	45	2.46	93
Contracts / Contrats	26	5	9	3	8	45	2.25	96
Partners / Partenaires	15	5	5	18	30	28	3.59	101
Operating & Service revenue / Revenus d'exploitation	27	1	6	2	9	46	2.22	91
Other (please specify) / Autres (préciser s'il vous plaît)								10
							answered question	106

Figure 39. Importance of non-government support

Overall the OOS operators and data suppliers consider government support more important than non-government support. In both cases, internal funding and partner support were the most important type of support while contract support was the least important.

Budget Needs and Priorities

When asked about budget needs and priorities (Q43, Q44), the OOS operators and data suppliers indicated that operations funding was the most important need but funding for all categories was indicated as a need (figure 40).

Please indicate the following budget needs: / Indiquer les besoins budgétaires suivants:					
Answer Options	**Major need / Besoin majeur**	**Minor need / Besoin mineur**	**Sufficient / Suffisant**	**Not needed / Non nécessaire**	**Response Count**
Capital / Capital	30	29	13	7	79
Operations / Opérations	64	10	10	3	87
Maintenance / Entretien	32	31	11	6	80
Training / Formation	16	35	18	10	79
Data access / Accès aux données	21	32	18	7	78
Data analysis / Analyse des données	34	23	16	8	81
Development / Développement	27	27	14	10	78
Research / Recherche	32	22	9	13	76

Figure 40. Budget needs

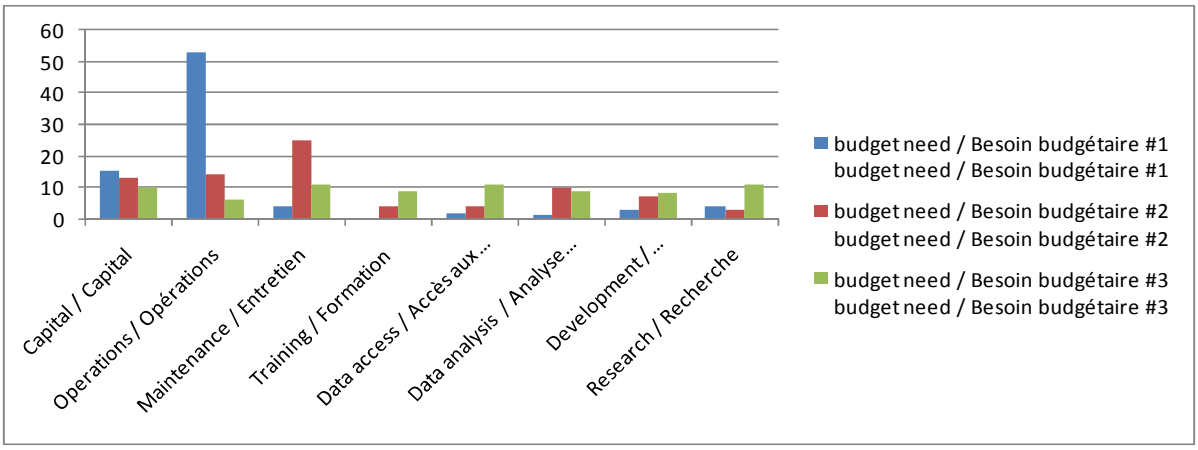

Figure 41. Ranked budget needs

When asked to force rank budget requirements, the #1 need (blue column) was overwhelmingly for operations support. The second ranked need (red column) was clearly for maintenance support (figure 41).

Partnerships and collaboration

When questioned, responders replied overwhelmingly (92%) that they collaborate with other organizations to collect and share data and information. This also agrees with answers (Q21 and Q22) about OOS support where partner support was ranked 1st in non-government support and 2nd in government support

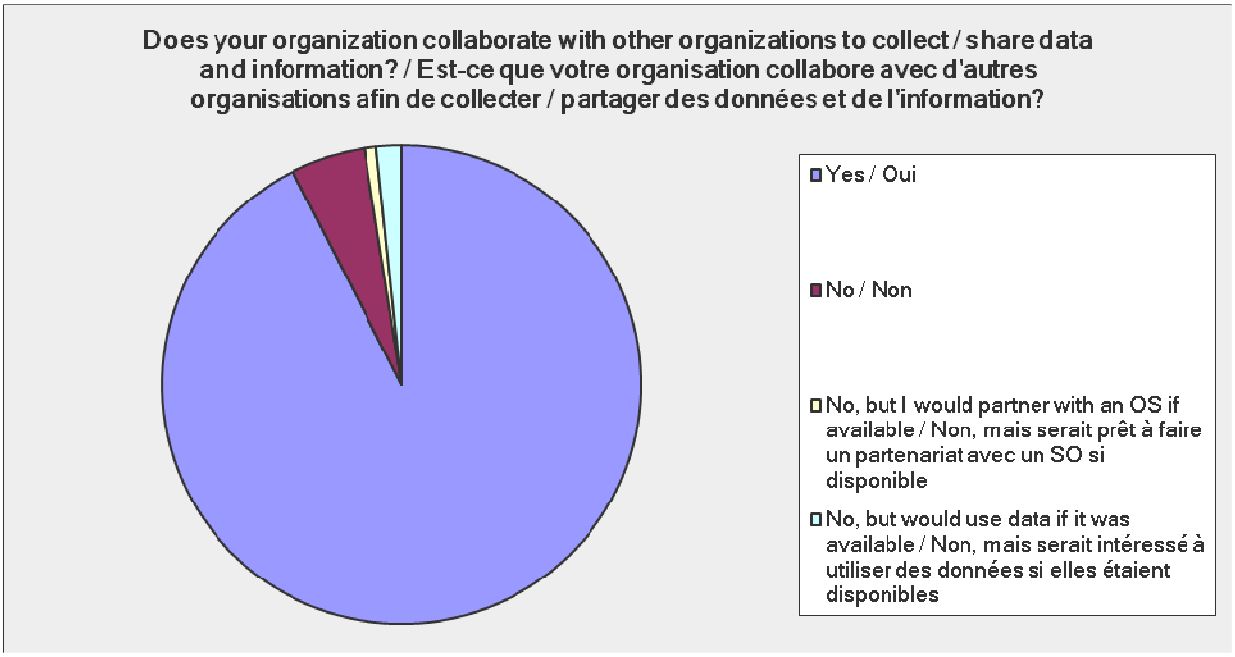

Figure 42. OS collaboration

Linkages to Other OOS

The OOS operators and data suppliers were asked what linkages (Q41) to other OOS they had established. Over 50% indicated that such linkages existed at the international, national, and regional levels. Only 26% indicated linkages at the local level.

Today many OS are linked or feed data to other OS. Please supply the name(s) of the OS linked/interfaced: / Aujourd'hui, de nombreux SO sont liés ou fournissent des données à d'autres SO. S'il vous plaît fournir le(s) nom(s) des SO liés / interfacés:	
Answer Options	**Response Percent**
Local / Local	26.1%
Regional / Régional	52.2%
National / National	50.0%
International / International	50.0%

Figure 43. Linkages to other OS

Outreach Activities

When asked about outreach activities, 47% of OOS operators and data suppliers replied that they have outreach activities (Q28, Q42).

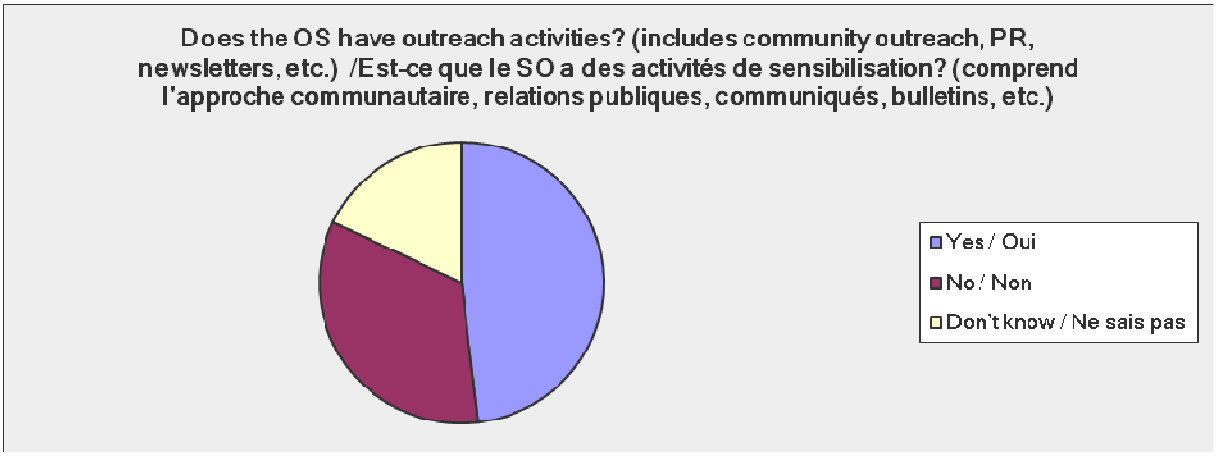

Figure 44. Outreach activities

To quantify outreach activities, the survey then asked operators if they kept metrics for outreach activities. Approximately 45% OOS operators and data suppliers indicated that they are keeping metrics that tracked website hits and downloads. Surprisingly, 51% did not know of any outreach activities. TV and radio media, printed literature, and newsletters outreach activities were only 7%-16%.

Which of the following usage and awareness metrics does the OS collect? / Lesquels des paramètres ou statistiques d'utilisation et de sensibilisation du SO sont collectés?		
Answer Options	**Response Percent**	**Response Count**
Website hits / Visites du site Web	36.6%	49
Data / information download volumes / counts /	37.3%	50
Media TV, radio / Media TV, radio	14.2%	19
Newspapers, magazines, journals / Journaux,	15.7%	21
Blogs, newsletters, etc / Blogs, bulletins	6.7%	9
Don't Know / Ne sait pas	51.5%	69
Other (please specify) / Autre (préciser s'il vous plaît)		28
answered question		134

Figure 45. Awareness metrics

Technological Barriers

The survey also asked respondents to indicate and rank technological barriers of OOS (Q45).

Please rank the technological barriers: / Classer les obstacles technologiques:								
Answer Options	**Sensor technology / Technologie des capteurs**	**Communication technology / Technologie des communications**	**Bandwidth / Bande passante**	**Power / Énergie**	**Maintenance / Entretien**	**Data processing / modeling / Traitement de données / modélisation**	**Training / Formation**	**Response Count**
#1 barrier / Obstacle # 1	16	15	8	5	20	17	7	88
#2 barrier / Obstacle # 2	9	10	10	5	11	20	11	76
#3 barrier / Obstacle # 3	6	5	4	5	16	9	17	62

Figure 46. OS ranked technical barriers

The highest technological barrier was maintenance of the OOS followed by data processing and then training (Q46).

Please provide details about the technological barriers ranked above: / Détailler les barrières technologiques classées ci-dessus:		
Answer Options	**Response Percent**	**Response Count**
Sensor technology / Technologie des capteurs	41.0%	25
Communication technology / Technologie des communications	45.9%	28
Bandwidth / Bande passante	31.1%	19
Power / Énergie	27.9%	17
Maintenance / Entretien	54.1%	33
Data processing / modeling / Traitement de données	52.5%	32
Training / Formation	37.7%	23
Additional barrier(s)/ Obstacles additionnels	14.8%	9

Figure 47. Technical barriers details

The ranking of the technological barriers was confirmed when the respondents entered specific comments about each of the barriers (Q47).

Strategic/Policy/Legal Barriers

The respondents were asked to rank strategic, policy, and legal barriers for the OOS as well as to provide details of the barrier (Q48).

Please rank the strategic/policy/legal barriers for the OS: / Classer les obstacles stratégiques / politiques / juridiques pour le SO:					
Answer Options	**Major barrier / Obstacle**	**Minor barrier / Obstacle**	**Not a barrier / Pas un**	**N/A**	**Response Count**
Regulatory / Réglementation	7	17	35	23	82
Permitting / Permis	2	20	37	23	82
Jurisdictional / Juridictionnelles	4	24	35	19	82
Resources / Ressources	56	13	16	13	98

Figure 48. Ranked strategic / policy / legal barriers

The major barrier identified was the availability of resources. Problems with permits, regulations, and jurisdictional issues were generally not indicated as important barriers.

Please provide details about the strategic/policy/legal barriers ranked above: / les obstacles stratégiques / politiques / juridiques classés ci-dessus:

Answer Options	Response Percent	Response Count
Regulatory / Réglementation	33.9%	19
Permitting / Permis	33.9%	19
Jurisdictional / Juridictionnelles	33.9%	19
Resources / Ressources	82.1%	46
Other / Autre	10.7%	6
answered question		56

Figure 49. Strategic / policy / legal Barriers

The resources barrier was again identified as the most important barrier when the respondents provided details and descriptions of the barriers (Q49).

Human Resources

The survey also questioned the responders about OOS personnel availability of trained personnel (Q50).

Considering availability of personnel for the OS, please indicate the relative availability of qualified / trained personnel for each category: / Compte tenu de la disponibilité du personnel pour le SO, indiquer la disponibilité relative de personnel qualifié / formé pour chaque catégorie:

Answer Options	Very available / Très disponible		Neutral / Neutre		Not available / Non disponible	N/A	Rating Average	Response Count
Development / Développement	16	19	23	22	10	11	2.90	101
Operations / Opérations	30	23	23	19	4	7	2.43	106
Training / Formation	20	23	24	17	6	13	2.62	103
Analysis / Analyse	18	28	20	27	3	9	2.68	105
Research / Recherche	17	25	15	24	6	14	2.74	101
Other / Autre	0	0	2	0	1	15	3.67	18
Other (please specify) / Autre (préciser s'il vous plaît)								3
							answered question	109

Figure 50. Human resources needs

The responses indicate that HR needs for OOS are generally being met in the available employment pool. Only 3-6 of the 100 Respondents in each category indicated that personnel were not available except for the development category where this was 10 respondents.

Survey Data Analysis and Trends

The survey results together with verbal and written submitted comments have been analyzed to obtain a summary of OOS sector trends in Canada. This subjective analysis is intended to be a snapshot of the sector at the time of the survey. Comments have been grouped under the following topics:

1. Overall OOS sector activities in Canada
2. OOS Regional focuses
3. Sector innovation
4. OOS sustainability
5. Sector coordination
6. Sector growth

Overall OOS Activities in Canada

OOS activities in Canada have a **broad base throughout the country**. More than 65 separate OOS activities are underway in every region of Canada bordering on our three oceans and the Great Lakes. The **major players** in the sector are government, universities, and NGOs. Most (83%) of the OS programs have been underway for more than 3 years and have **demonstrated operations**. Most OOS operations are built upon **partnerships** with in-kind and financial support from sector stakeholders. The **industry role** in OOS is as both a user of information and a technology supplier.

In **government**, DFO is the lead agency that carries out many distinct ocean observing activities through its laboratories and through partnerships. Other key government agencies engaged include CSA and Environment Canada although 10+ others also play a role. These agencies provide OS data and information as well as technology and platform assets. OOS activities include regional, national, and international activities for both research and operational monitoring. Examples include the international ARGO program, the national EC weather buoy network, and fisheries monitoring programs. Provincial governments such as NL and BC fund OS and Communities such as those adjacent to SmartBay also play key roles but this support is uneven across the country.

Universities in Canada are leading both small and large OS in NL, NS, QC, and BC. Several high profile OS are operating (VENUS) and others are coming online (NEPTUNE, OTN). Universities are operating these OS as ongoing activities with a strong research focus.

Many other OS are operated by **NGOs and partnerships** between government, communities, universities, and industry. OS such as SmartBay and the St Lawrence Global Observatory (SLGO) are key examples of working partnerships, which are focused on end users.

Industry in Canada is both a user of OS information and a supplier of technology. SmartBay and SLGO are examples of OS that provide real time information for marine industry transportation activities.

Companies such as AXYS Technologies and AMEC supply equipment, systems, and information services to the OS sector in Canada and to the (US$2.2B in 2011) worldwide marketplace.

OOS can play a part in national priorities such as safety and security, water quality, Arctic sovereignty (e.g. http://www.morsearctic.net/), environmental monitoring, United Nations Convention on the Law of the Sea (UNCLOS), as well as providing productivity improvements in industry such as maritime transportation.

OOS Regional Focuses

Most Canadian OS are directed to provide specific information needs for either **local or regional areas** or to meet **specific information needs**. OS are designed to meet specific objectives and the data and information provided to users are tailored to meet these requirements.

Examples of a regional OS include SLGO and SmartBay which provide many **complex information and data** to users. Although marine transportation is one of the major focuses of these two OS, information is also provided to area fishermen, municipalities, recreational, and other users. Stakeholder committees and groups provide advice and help shape these OS operations priorities.

Some OS provide specific information needs such as information for **fisheries management** for salmon, herring, and other species. This type of OS is typically operated by government.

Sector Innovation

Innovation has played a major role in OS design and operations. Typically NGO and Universities utilize much new methodology, processes, equipment, and techniques in their OS. These systems are designed to provide comprehensive data and information and tools for users in new ways.

Canadian OS and industry suppliers are **world-leading innovators** in the OS sector. There has been **significant funding** ($100Ms) for OS **technology demonstrations and research activities** in Canada. This investment has **yielded superior Canadian technology and experience** in the sector.

Canada also could have a strategic advantage of using space-based observations for our oceans and Great Lakes. These observations are available as time series and for various scales. However, the survey shows that most Canadian OS are not utilizing these observations to augment the in situ data.

When government has been an operational partner in OS, it has contributed to and benefited from this innovation. However, much of the proven OS innovation is **not being effectively utilized across government operations**. This is likely due to a variety of factors which include resistance to new methods which might replace or augment existing activities and concerns of budgets being reallocated. This is the typical utilization issue of transforming new technology and methods to ongoing operational activities. There have been **few efforts to examine and quantify potential benefits to government operations**.

OOS Sustainability

Outside of ongoing DFO fisheries monitoring activities, the **majority of OS are viewed as projects** by many agencies and organizations. This project approach affects ongoing OOS sustainability through the resulting **use and funding uncertainty for operations**. Organizations which consider these OS as projects also do not commit to incorporating OS information and data into their regular and ongoing activities. This project mentality to OS is at odds with government implementation of the Oceans Act and implementations of marine protected areas (MPAs). This need not be the case; the Environment Canada national weather buoy program is an example of an OS that has been integrated into ongoing operations.

Many OS, especially those built upon collaboration and partnerships have developed plans and governance models which can / may eventually lead to OS sustainability. However this is unlikely to occur until sufficient awareness of the economic and social benefits are achieved. **Planning to develop awareness of benefits including risk management is crucial to obtaining OOS sustainability**. This process needs to address sector and public awareness through education and outreach activities.

Sector Coordination

Canadian OS activities are typically generated locally or regionally by champion organizations. This has led to the **sector developing in a fragmented manner**. The upside to this decentralized approach is increased innovation and targeted delivery of specific functions. However even with this de facto approach there is limited efforts to coordinate the sector knowledge and best practices such as data management and data and information exchange. In Canada there have been few meetings such as the Ocean Innovation Conference in St. John's (Oct 2010) or sessions at the Oceans conferences (Vancouver, Quebec City) that have focused on the sector. There are **few resources that act as sector knowledge hubs**. Information and data standards and practices are generally unique for each OS. This sector deficiency has likely resulted in **loss of efficiencies in terms of resources and downstream valued added benefits** to the OS users, suppliers, and the Canadian public.

The leading candidate national organizations that could facilitate this national coordination are DFO Oceans, CSA, and NGOs such as OSTP or academic based organizations such as Oceans Network Canada at UVIC. However at present there is no effort underway to initiate this activity.

Outside of Canada, many other nations and regions (US and EU) are coordinating their efforts which will likely result in more effective information and benefits delivery to the public and to industry. For example the GLOS annual general meeting was held in Ontario in 2010.

Sector Growth

Given the planning (e.g. US IOOS program http://www.ioos.gov/ and the EU Ostend declaration http://www.eurocean2010.eu/declaration/) and ongoing activities in the OS sector worldwide (estimated at US$2.2B annually in 2011) it is clear that the sector will grow significantly. Obviously, Canada will require expanded OS activities to keep up with world practices and activities. Initiatives in the US such GLOS (http://glos.us/) in the Great Lakes are underway even though they are not part of Canadian efforts. However, this survey shows little identified growth in Canada (only 4.5% of

respondents are planning OS and the number of data collection nodes is expected to fall). The fragmented and uncoordinated approach occurring in Canada is likely the reason for this contradiction.

Lessons Learned from OOS in Canada: Preliminary Assessment of OOS Value

In parallel with the OOS survey reported here, a preliminary assessment of the environmental, economic, and social value of OOS was carried out. The main objective was to identify actual cases of added value from existing OOS, rather than potential value. The highlights of this short study are presented below.

1. ***Positive Benefits:*** OOS in Canada have demonstrated many positive benefits, although rarely quantified. These include:
   - demonstration of innovative technologies;
   - improving co-ordination and collaboration among diverse data sources;
   - development of export opportunities for expertise and technology;
   - economic and safety efficiencies in transportation;
   - improved access to information;
   - data support for a wide variety of applied and theoretical research efforts to better understand, monitor, and manage the marine environment;

2. ***Need for an Effective National Strategy and Governance Structure to Maximize Benefits of Investments:*** To date, the various OOS activities represent isolated, regional, and often technology driven projects. No national framework exists for developing long term, coordinated objectives and for sharing expertise. This fragmented approach decreases the potential value, at a national level, of the investments made and it decreases Canada's potential effectiveness at the international level. Canada has a rich opportunity to use its unique regional differences to maximize its OOS capabilities and expertise, but to truly capitalize on this requires national coordination, leadership, and accountability.

3. ***Need to Measure and Communicate Benefits of OOS:*** Many of the major efforts, such as Neptune, Venus and Ocean Tracking Network (OTN), and even the American Great Lakes Observatory are in their formative stages. Others such as SmartBay and the St. Lawrence Global Observatory (SLGO) have begun to have an impact; however, even then quantifiable benefits are difficult to estimate. To obtain long-term continuing political, financial, and user support there is a need for all of the OOS efforts to focus more on who the end users are, what do they require, and how well the systems contribute to tangible added value. Many system managers had difficulty identifying specific examples of benefits to individual users. Canada needs to move beyond the published lists of possible benefits and now start to track real economic, environmental, and social impacts.

Potential Further Work Related to this Survey

Follow-on survey work: This survey report has presented the quantifiable data from the survey. However, due to resource limitations, additional work has not been achieved, but should be carried out to properly complete the project.

1. The study committed to share results with survey responders. This must be done as soon as possible. Following the release of the survey results, these people should be canvassed for their thoughts about possible future OOS sector plans.

2. The results of this survey and any further plans should be communicated to the OOS community.

3. This survey has collected valuable information that has not been analyzed thoroughly in this report. In addition to the quantified results, many of the questions have solicited detailed comments from the OOS community. This information could be examined and compiled as a follow-on report.

4. An assessment of how Canadian space based ocean observations can be matched and integrated into OOS information should be carried out. The advantage of extrapolating in situ observations should be examined to determine candidate data. A plan to demonstrate and develop technology will likely be necessary as most OOS currently have no or little capacity to do this.

Recommended Future OOS Industry Development Activities

The analysis of the survey results has shown a number of key OOS activities that should be undertaken for the sector.

1. **Initiate National Coordination:** A national OOS sector strategy should be led and developed by DFO with partners such as OSTP. This strategy will improve sector performance and ensure that Canada is in the leading group of nations using OOS and works effectively with neighboring OOS such as the US IOOS..

2. **Utilize Innovation for Efficiency and Productivity**: A plan to evaluate potential benefits to government operations and industry should be carried out. This evaluation can be a guide to future OOS investments for efficiency and productivity to be able to make the best decisions for Canada's oceans and Great Lakes.

3. **Improve OOS sustainability**: An initiative to assist OOS with the development of strategies, standards, and plans to improve their sustainability is required. Better socioeconomic studies of the OOS are needed to focus OOS on societal requirements and benefits.

4. **Encourage Integration of Satellite Observations in OOS:** Canada has the strategic advantage of government and private sector space based ocean observation assets that should be better utilized for efficiency and productivity.

5. **Utilize Innovation for Export**: Canada should carry out efforts with industry to expand its market share for OOS technology. The Department of Foreign Affairs & International Trade and Industry Canada are candidate agencies to coordinate these efforts with industry.

Appendices

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Questionnaire and Response Summary

See the PDF file of survey questions and response report.