NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION
US DEPARTMENT OF COMMERCE

A Bibliometric Analysis of Articles Supported by NOAA's Office of Ocean Exploration and Research

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NOAA Central Library
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ABOUT THIS REPORT

This report presents a summary-level bibliometric analysis of the known peer-reviewed journal articles produced as a result of ocean exploration missions supported by NOAA's Office of Ocean Exploration and Research. This report was produced using data retrieved from the Web of Science, Science Citation Index Expanded and Social Science Index database on 11 April 2022, covering articles published from 2002 thru 2022. 61 articles known to have resulted from Ocean Exploration-supported explorations had to be omitted from this analysis, either because the articles are still in press or because Web of Science does not index the journals in which the articles were published. 15 of these omitted articles were produced with support from Ocean Exploration's underwater archaeology program.

The bibliometric indicators presented in this report are based on citations from the select group of peer-reviewed journal articles indexed by Web of Science and, as such, do not reflect citations to Ocean Exploration-supported expeditions from peer-reviewed journals not indexed by Web of Science (WoS) or from other sources such as book chapters, conference proceedings, or technical reports.

More information about the methodology used and a full listing of all of the articles evaluated in this report are available upon request to Sarah.Davis@noaa.gov.

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SUMMARY METRICS

Bibliometric Indicator	Value
Number of Publications (p)	1,009
Total Number of Citations Received (c)	33,407
Average Number of Citations per Paper (c/p)	33.11
H- Index	85
Percentage of Publications in the Top 10% for Citation Counts	≈14.76%

Table 1: Common bibliometric indicators calculated for publications supported by Ocean Exploration. An H-Index of 85 indicates that this group of 1,009 publications includes 85 articles that have each received 85 or more citations. For more details on the H-Index, see Hirsch (2005). For more details about the Percentage of Publications in the Top 10% for Citation Counts, see page 14.

PUBLICATION ANALYSIS

The following figures analyze the number of publications produced as a result of Ocean Exploration-supported expeditions. For clarity, the figures showing the number of publications per subject, author, journal, institution, and funding agency only list the top 10 results in each category.

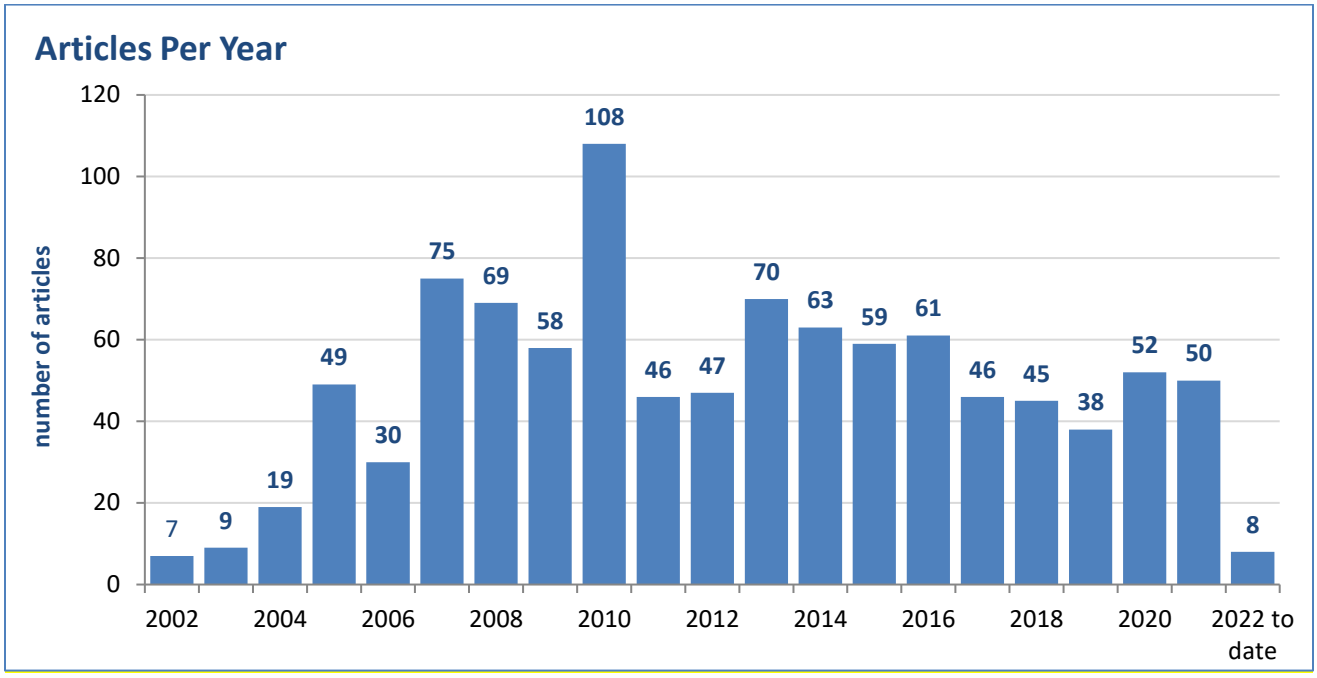

Figure 1: Non-cumulative number of Ocean Exploration-supported peer-reviewed articles produced per year. On average, 50 articles resulting from Ocean Exploration funding or funded expeditions are published annually.

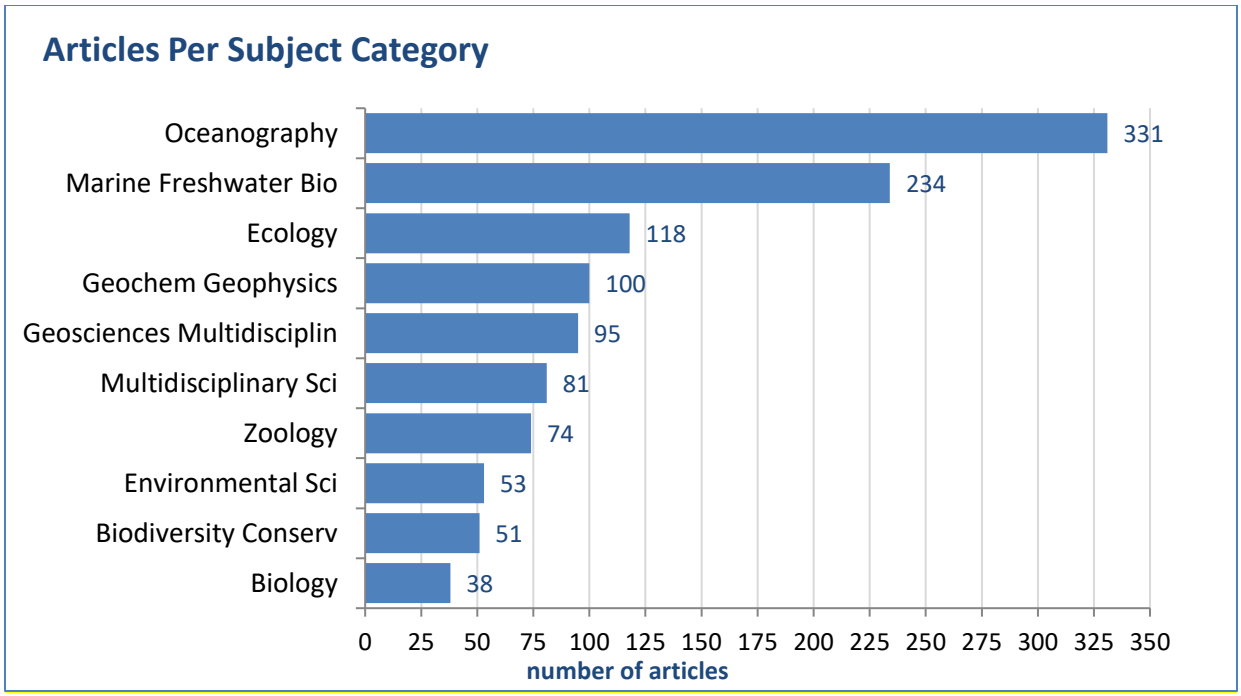

Figure 2: Ocean Exploration-supported peer-reviewed articles have been published in 62 subject categories, of which the top 10 by number of publications are shown here. Articles are assigned to subject categories by WoS based on the journal in which the article appeared. These subject categories are not mutually exclusive.

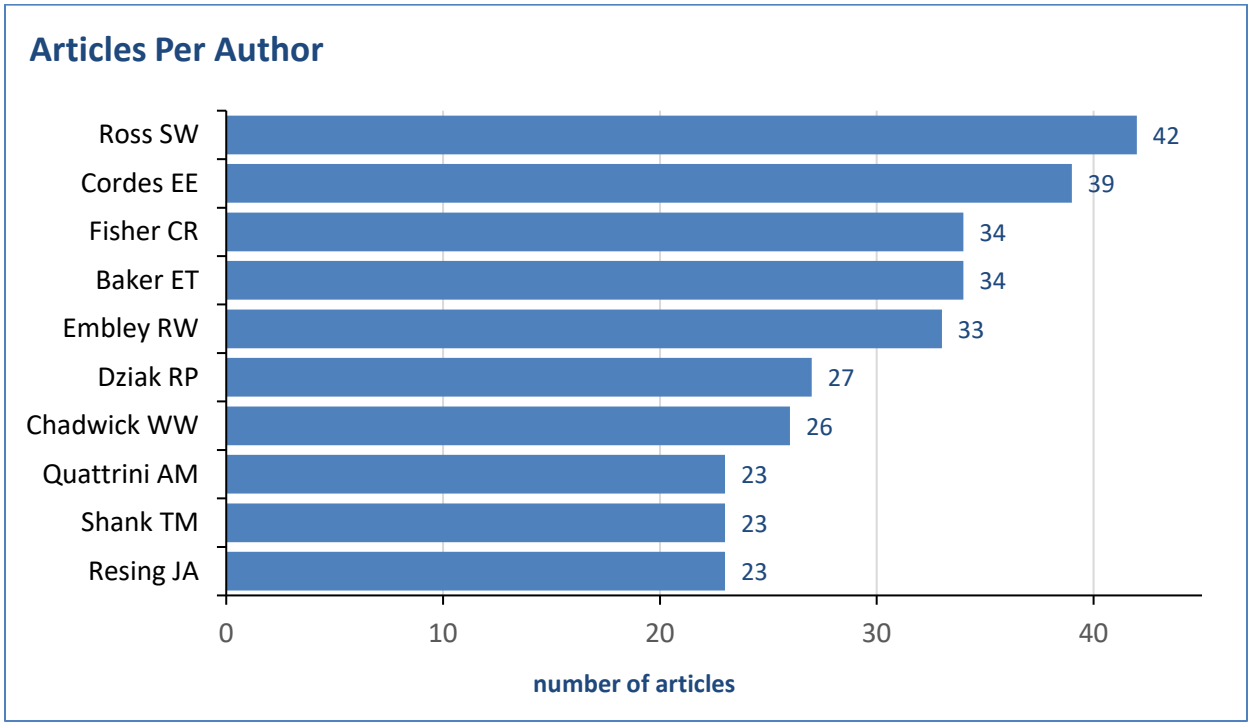

Figure 3: Number of Ocean Exploration-supported peer-reviewed articles produced per author.

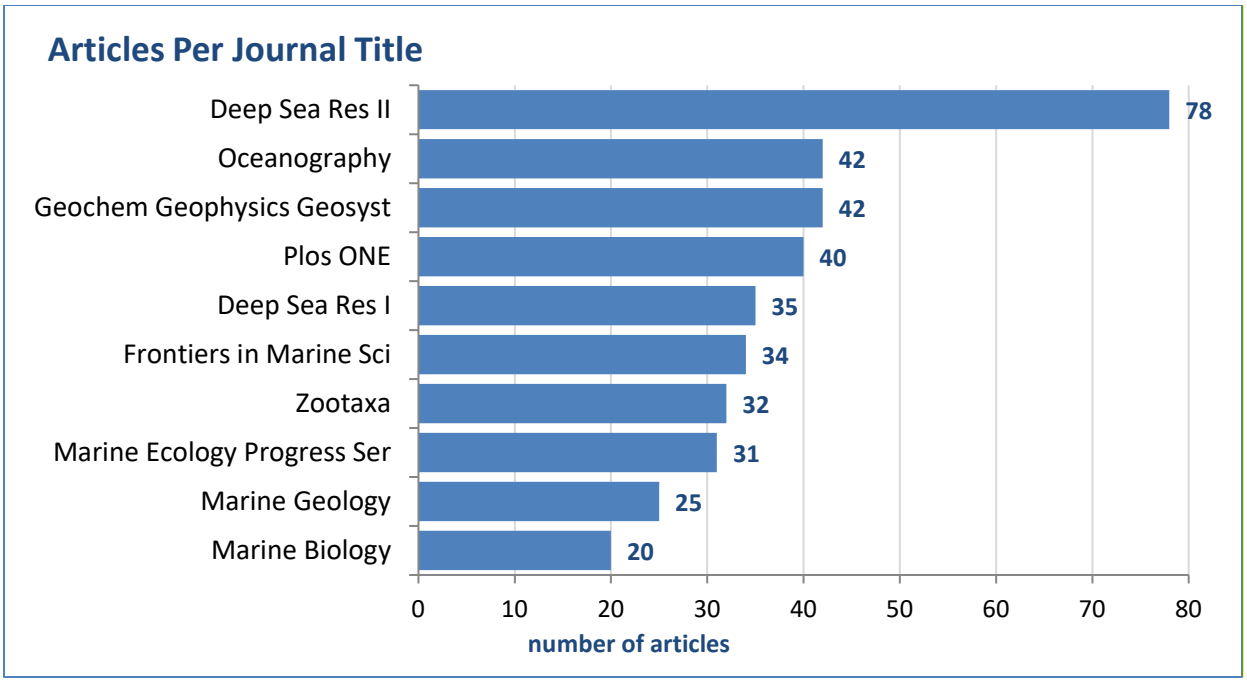

Figure 4: Ocean Exploration-supported peer-reviewed articles have appeared in 227 distinct journal titles, of which the top 10 by number of publication are shown here. Journal special issues dedicated to Ocean Exploration-supported explorations include: Deep-Sea Research Part II 57(1-2), 57(21-23), and 57(24-26); Journal of Geophysical Research – Solid Earth 113 (B8); Oceanography 20(4), 25(S1), and 26(S1); and Polar Biology 28(3).

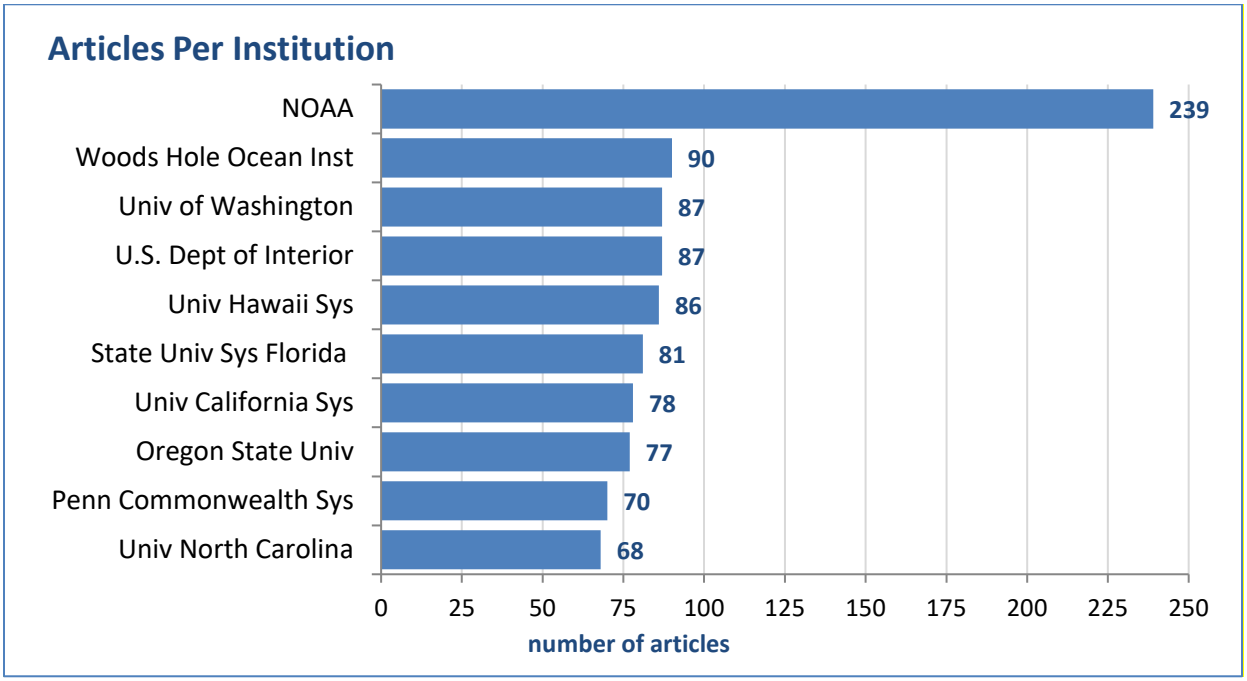

Figure 5: Number of Ocean Exploration-supported peer-reviewed articles per institution. Articles are counted for an institution if at least one of the article's authors lists that institution as his/her affiliation. Calculated using the Web of Science Affiliations feature (formerly referred to as Organizations-Enhanced).

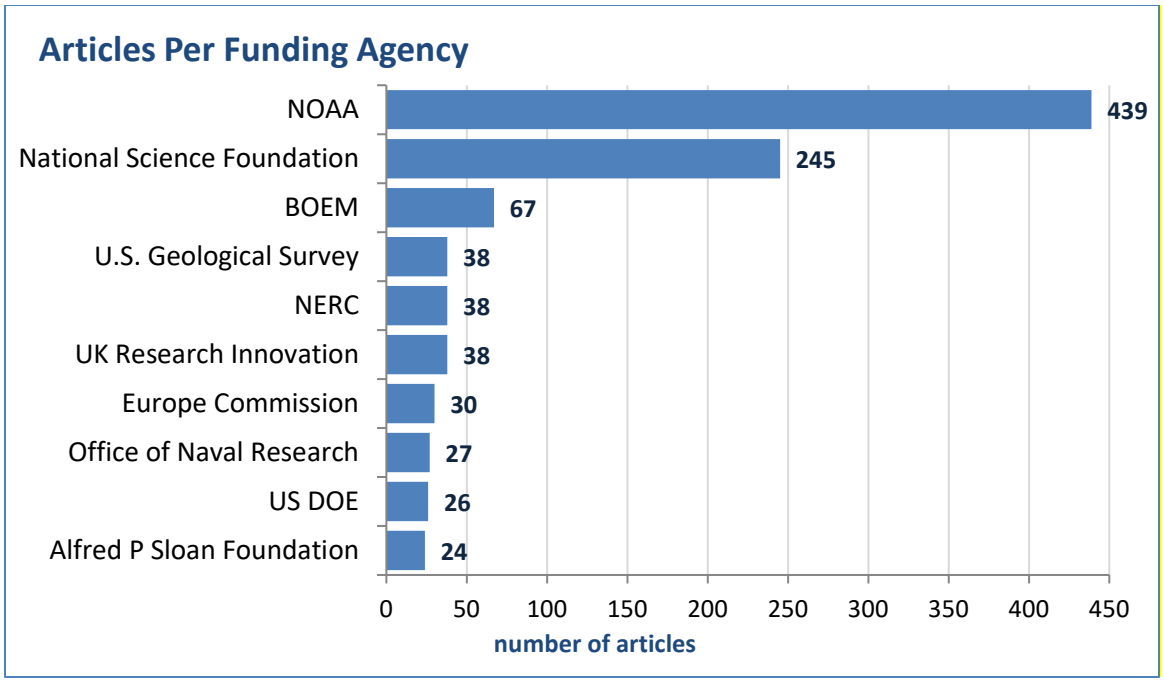

Figure 6: Number of publications co-funded by Ocean Exploration and other agencies and foundations. Data for this figure were derived from an analysis of the 'Acknowledgements' texts of 730 articles (72% of the 1,009 articles analyzed in this report) that were published from 2008 to the present for which this information is available.

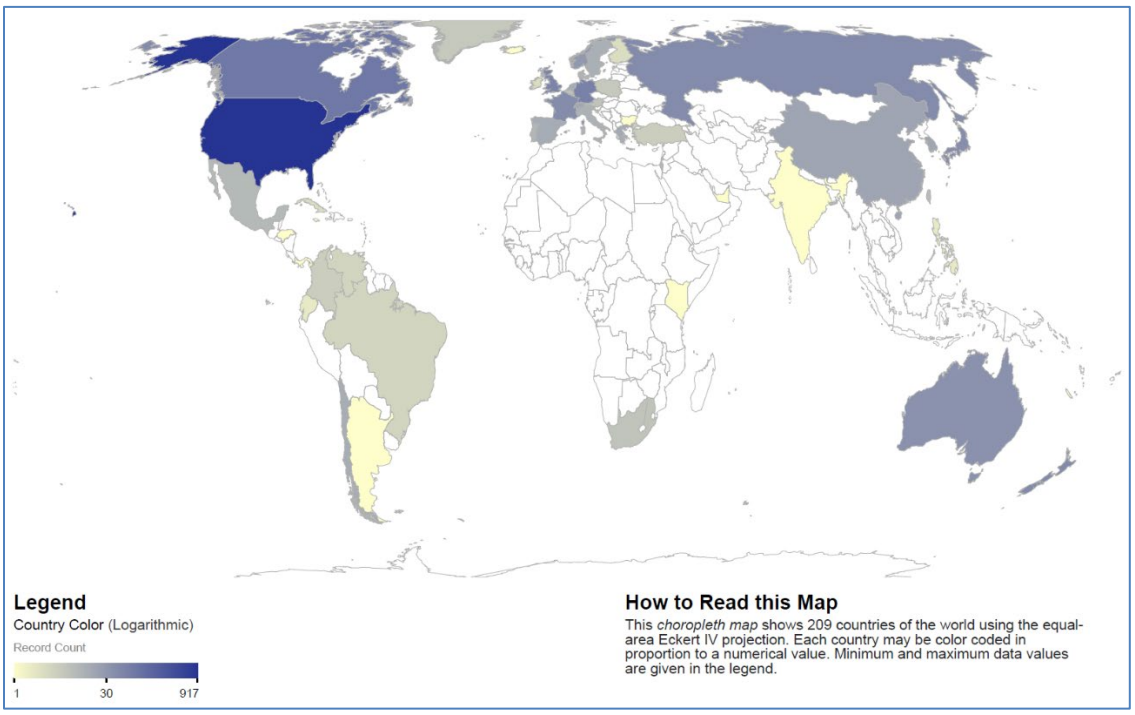

Figure 7: Map depicting the international publication of Ocean Exploration-supported articles. Countries are colored based on the number of Ocean Exploration-supported articles with at least one author from each country. Map created in InCites with Web of Science Data.

CITATION COUNT ANALYSIS

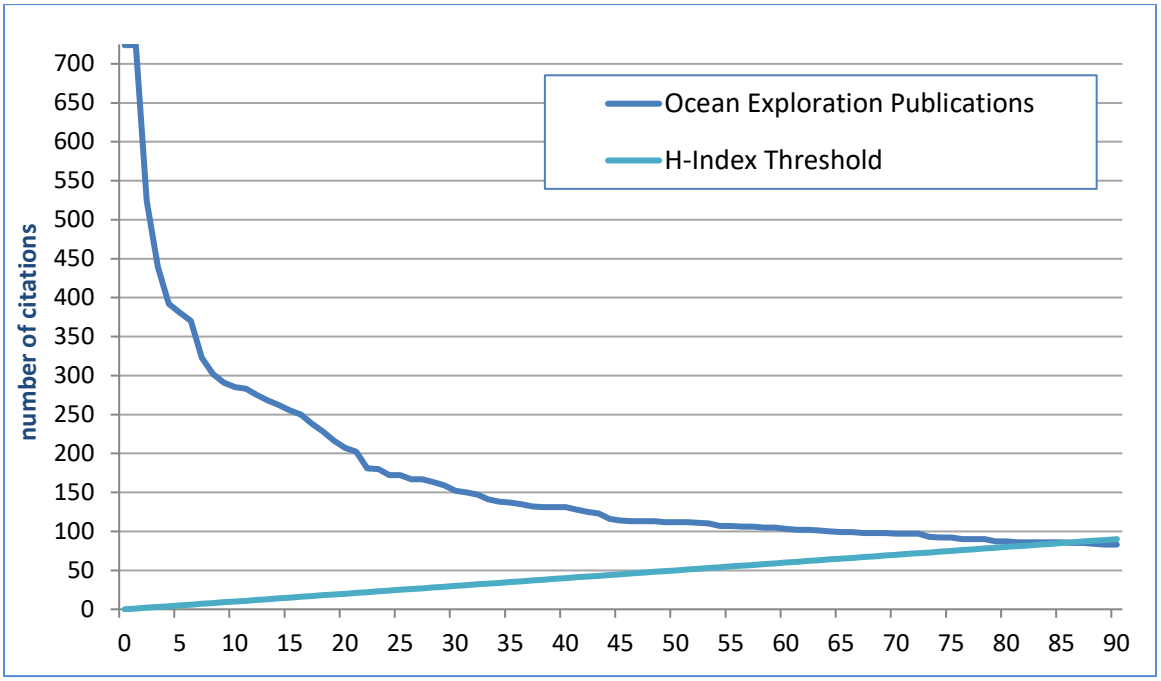

Figure 8: Distribution curve showing the citation counts of the 90 most highly cited publications supported by Ocean Exploration. The straight line indicates the H-Index threshold (slope: y = x). The intersect point of the two curves (x =85) is the H-Index of Ocean Exploration articles.

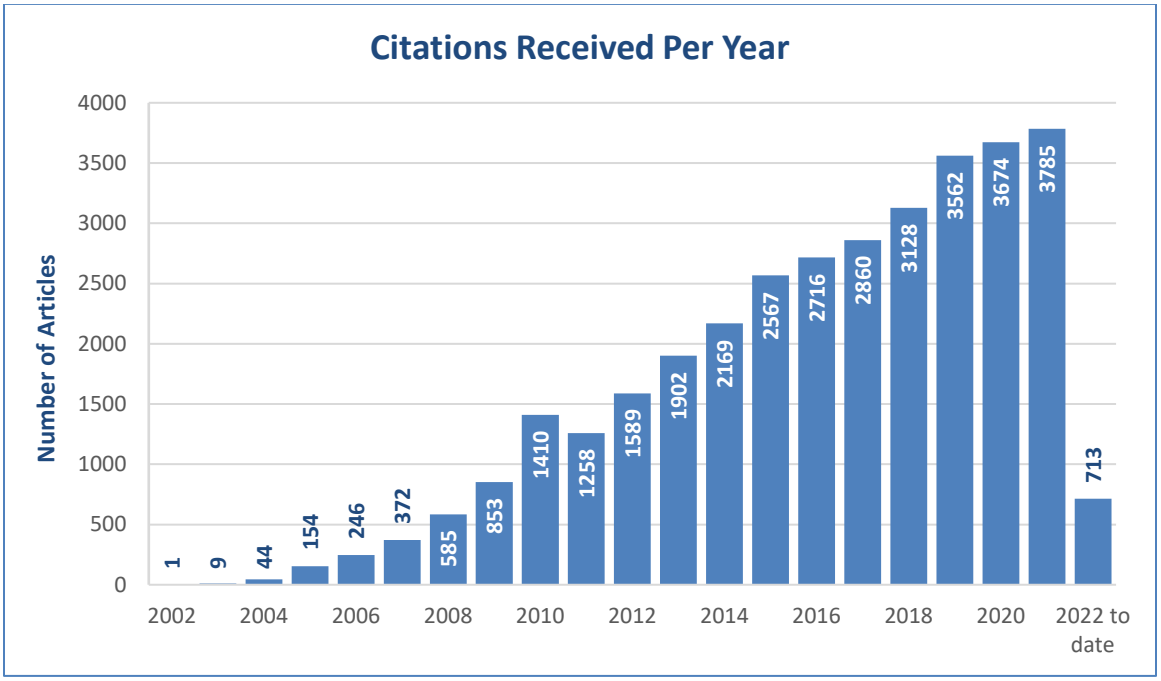

Figure 9: Non-cumulative number of citations received by all 1,009 Ocean Exploration-supported articles per year.

CITING ARTICLE ANALYSIS

The following tables analyze the 20,943 publications that have cited Ocean Exploration-supported articles in an attempt to indicate how these articles are used by the research community. These tables include self-citations (Ocean Exploration articles citing other Ocean Exploration articles). For brevity, each table only includes the top 10 results in each category.

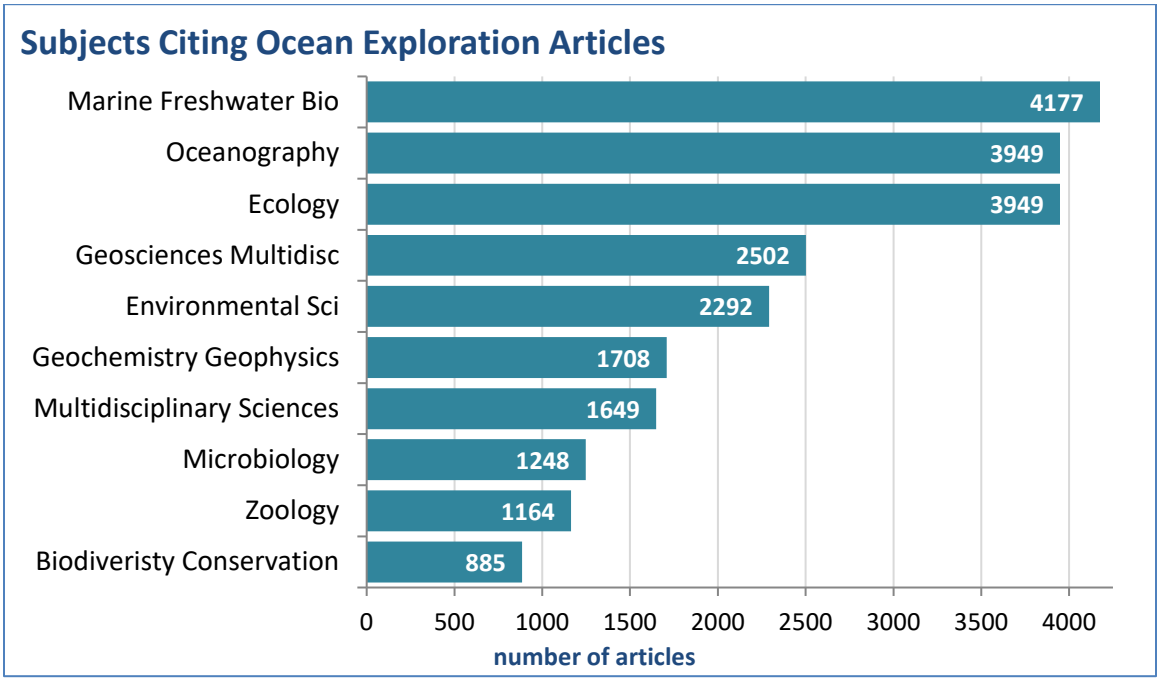

Figure 10: Number of publications per WoS-defined subject category for all publications citing Ocean Exploration-supported articles. These subject categories are not mutually exclusive.

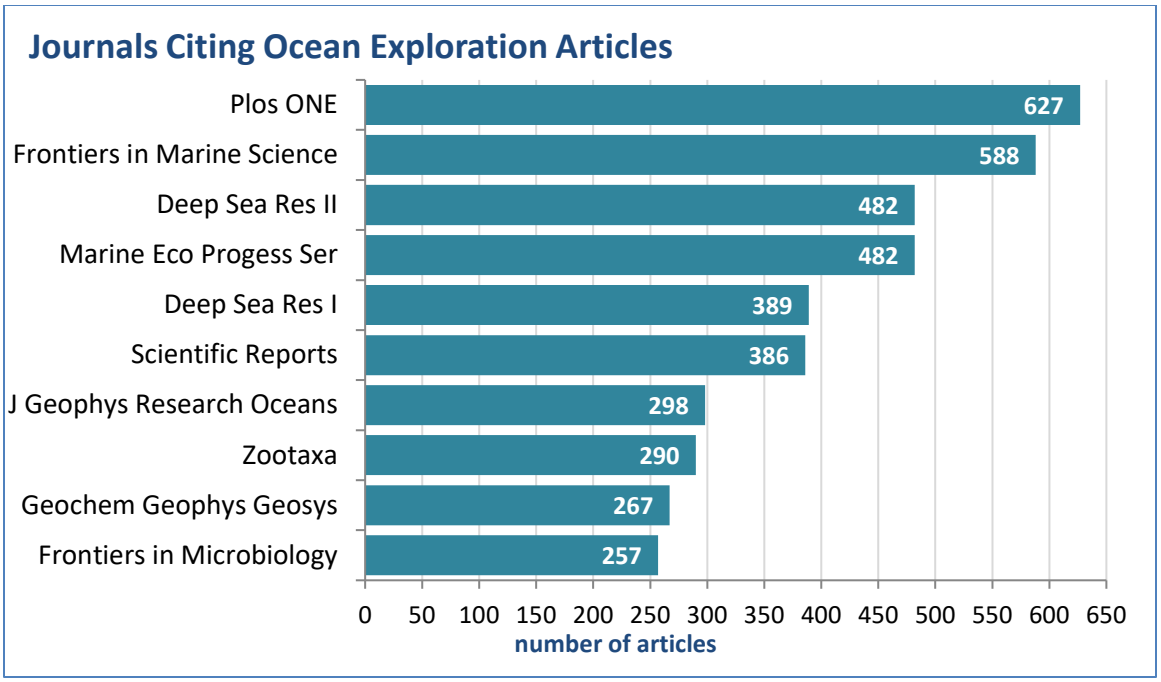

Figure 11: Number of publications per journal for all publications citing Ocean Exploration-supported articles.

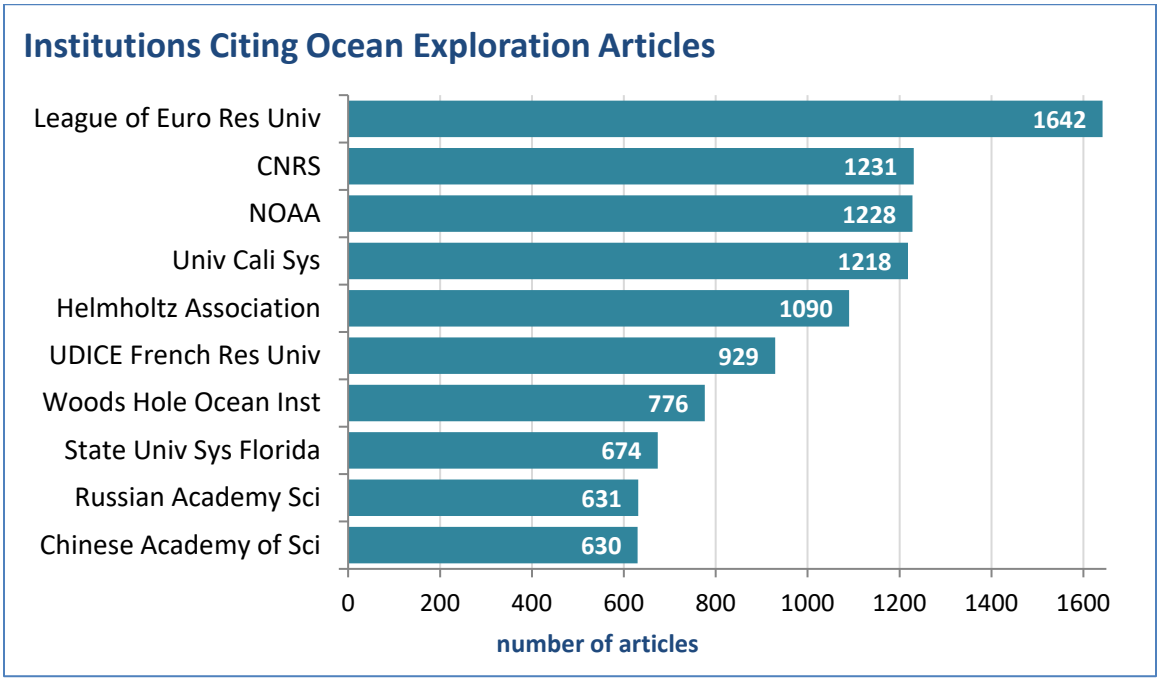

Figure 12: Number of publications per institution for all publications citing Ocean Exploration-supported articles. Publications are counted for an institution if at least one of the publication's authors lists that institution as their affiliation.

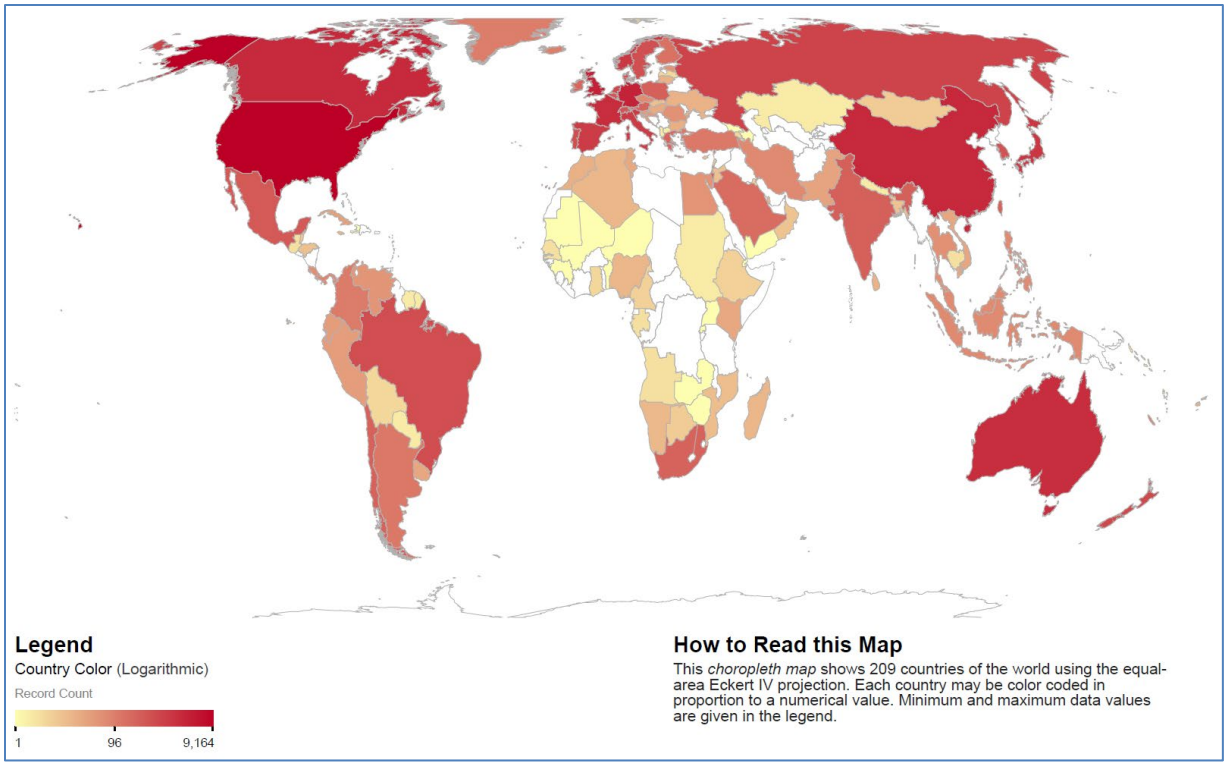

Figure 13: Map depicting the international publication of articles citing Ocean Exploration-supported articles. Countries are colored based on the number of articles with at least one author from each country. Map created in InCites with Web of Science Data.

BIBLIOMETRIC MAPPING

Bibliometric maps attempt to create visual representations of the structure of scientific research by analyzing networks (Borner and others 2007) of scientific publications. Depending on the level of analysis, bibliometric maps attempt to show the relationships between different lines of research on a single topic, between sub-disciplines within a field, and between major disciplines. Such maps can be constructed depicting co-authorship networks (Newman 2001), article citation networks (Boyack and Klavans 2010), or article keyword networks (Mane and Borner 2004). For an extensive survey of the field, see Borner and others (2003).

The following maps depict co-authorship, and word co-occurrence networks derived from Ocean Exploration-supported journal articles indexed in Web of Science. These maps were generated using the Science of Science Tool (Sci2 Team 2009). Higher resolution images of these maps are available upon request.

Co-Authorship Network

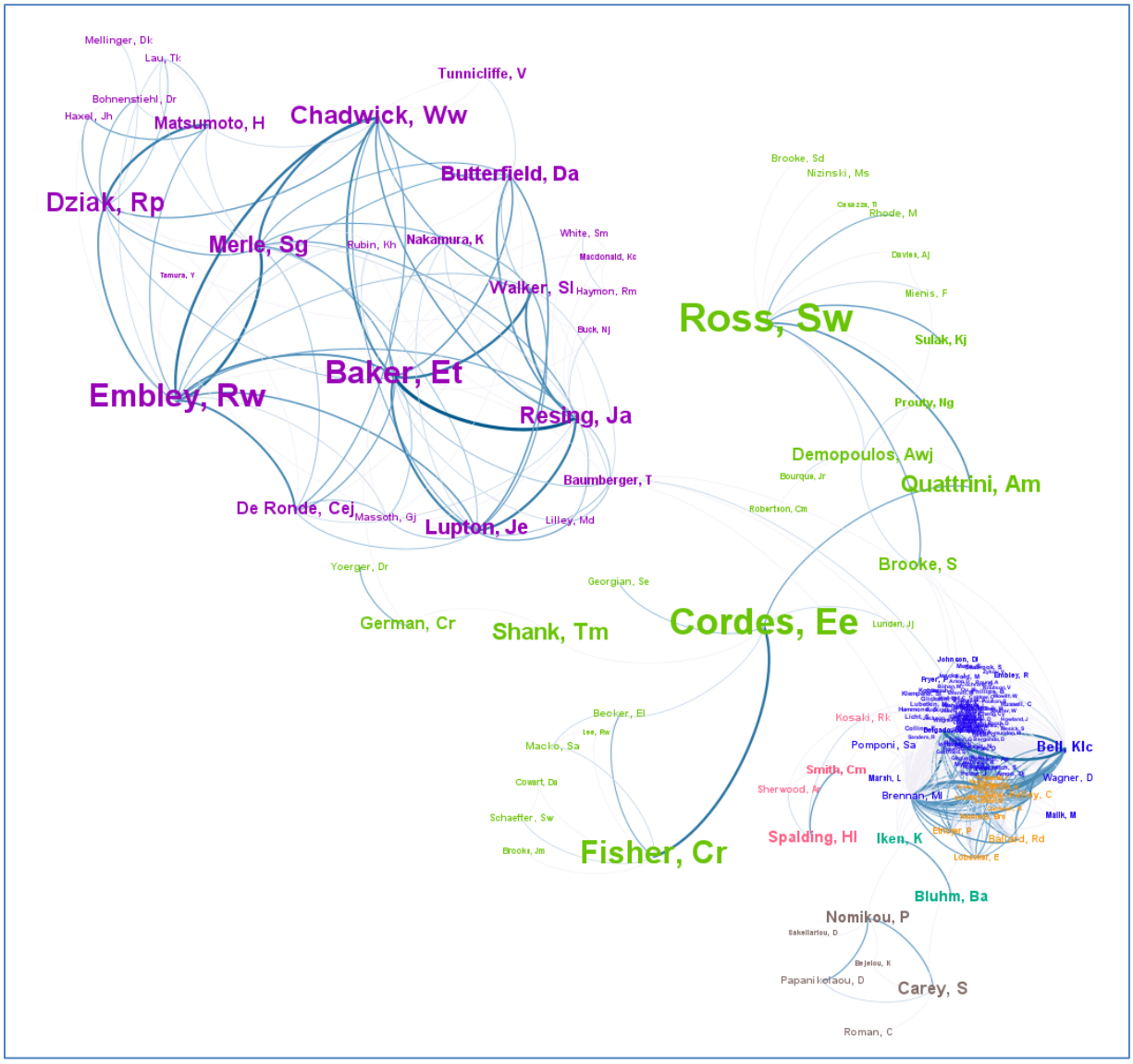

Figure 14: Bibliometric map of the largest connected co-authorship network of authors of Ocean Exploration-supported research. Author names were manually standardized to eliminate misspellings and name variants (e.g. Cordes E and Cordes Ee) were merged prior to creating this network. In this map, name size indicates the number of Ocean Exploration-supported publications by that author; values range from 1 to 42 publications. Name colors indicate communities of authors who tend to write articles together as identified by the community detection algorithm of Blondel and others (2008). Line size and darkness indicate the number of co-authored works between the connected authors; values range from 4 to 21. This map depicts 853 co-author relationships between 189 authors of Ocean Exploration-supported articles. For clarity, lines with a weight of less than 4 were removed and only the largest connected component of the network is shown.

Word Co-Occurrence Network

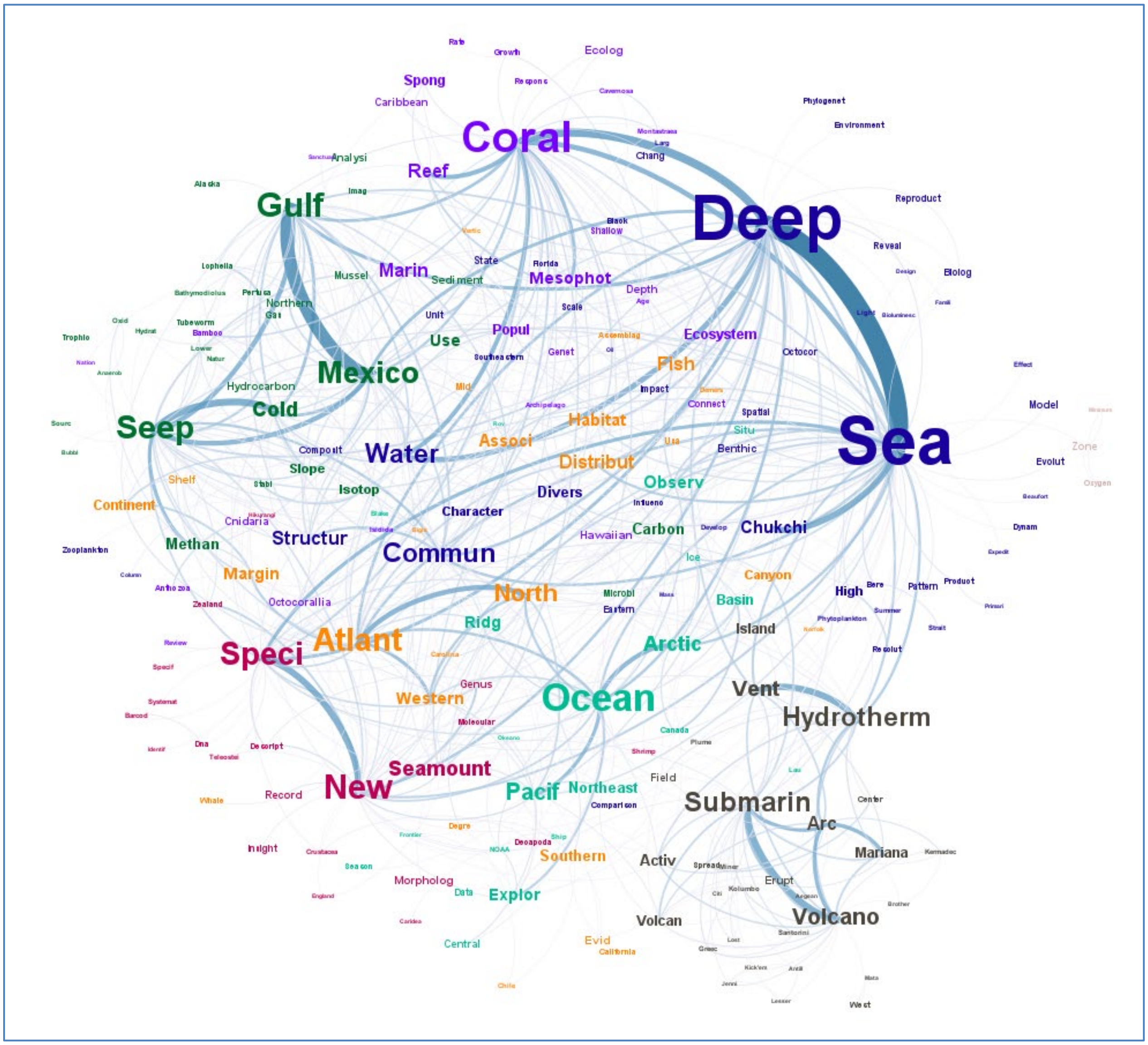

Figure 15: Word co-occurrence network map of the 217 words most commonly co-occurring in the titles of Ocean Exploration-supported journal articles. Words were truncated (i.e. word endings like '-es', '-al', and '-ity' were removed) to increase word matching accuracy and stopwords (words that carry little meaning like "and", "the", and "if") were deleted prior to creating the network. In the map, word size indicates the number of article titles in which the word appears; these values range from 5 articles to 207 articles. Words are colored based on the results of the community detection algorithm of Blondel and others (2008) to indicate groups of words that tend to appear together in article titles. Lines represent article titles in which the connected words both appear, with line size and darkness indicating the number of articles in which the two connected words both occur. For clarity, lines with a weight of less than 5 were removed and only the largest connected component of the network is shown.

CITATION PERFORMANCE EVALUATION

Bibliometric researchers have recently agreed that paper citation counts ought to be evaluated using percentiles rather than averages. In this method, a paper is assigned a percentile rank (top 1%, top 10%, etc.) based on how its citation count compares to that of all other papers in a given set. Sets of papers, such as those by an author or by a research group, are evaluated by calculating the percentage of those papers that have citation counts that rank in a certain percentile (or set of percentiles) when compared to a similar set of papers. In practice, researchers have tended to focus on the percentage of papers in a set with citation counts ranking in the top 10% of all papers in the same database that were published in the same year and subject category. For more information about this approach, see (Bornmann and others 2012; Leydesdorff and others 2011; National Science Board 2012; Waltman and others 2012).

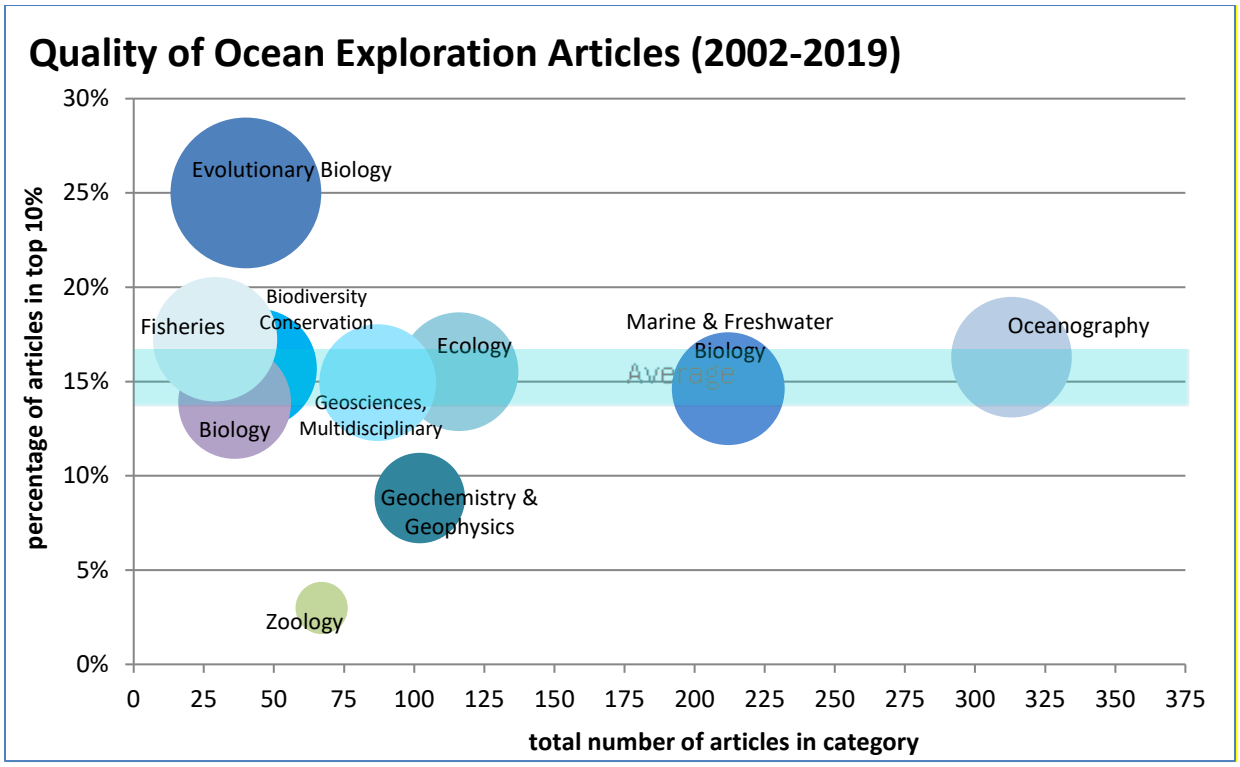

Figure 16: Bubble chart showing the percentage of Ocean Exploration-supported publications in ten subject categories that had citation counts ranking in the top 10% of all publications in WoS that were published in the same categories during the same years (2002-2019). Bubble size indicates the percentage of Ocean Exploration-supported publications in each subject area that had citation counts in the top 10% of all publications in that subject area and year of publication. The ten subject categories shown here are those in which Ocean Exploration-supported explorations were most often published (from Figure 2). Approximately 86% of the articles published during 2002-2019 that are analyzed in this report are included in one or more of these ten subject categories. The 'Multidisciplinary Sciences' subject category, which includes publications in Nature and Science, was omitted from this analysis because these articles could not be analyzed according to the same standards as the other subject categories. Calculated in InCites.

RECENT HIGHLY CITED ARTICLES

The following lists highlight recently published Ocean Exploration-supported articles that have received enough citations for them to rank in the top 10% for citation counts out of all publications in WoS in their respective subject categories. Because articles typically require at least 2-3 years to accumulate enough citations for article-level bibliometric indicators to be reliable (Abramo and others 2012; Costas and others 2011), only articles published in 2020, 2019 and 2018 are listed.

2020

Amon, D. J., Kennedy, B. R. C., Cantwel, K., Suhre, K., Glickson, D., Shank, T. M., & Rotjan, R. D. (2020). Deep-Sea Debris in the Central and Western Pacific Ocean [Article]. *Frontiers in Marine Science*, *7*, 15. https://doi.org/10.3389/fmars.2020.00369

Davis, G. E., Baumgartner, M. F., Corkeron, P. J., et al. (2020). Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data [Article]. *Global Change Biology*, *26*(9), 4812-4840. https://doi.org/10.1111/gcb.15191

Hatch, A. S., Liew, H., Hourdez, S., & Rouse, G. W. (2020). Hungry scale worms: Phylogenetics of Peinaleopolynoe (Polynoidae, Annelida), with four new species [Article]. *Zookeys*(932), 27-74. https://doi.org/10.3897/zookeys.932.48532

McAllister, S. M., Polson, S. W., Butterfield, D. A., Glazer, B. T., Sylvan, J. B., & Chan, C. S. (2020). Validating the Cyc2 Neutrophilic Iron Oxidation Pathway Using Meta-omics of Zetaproteobacteria Iron Mats at Marine Hydrothermal Vents [Article]. *Msystems*, *5*(1), 17, Article e00553-19. https://doi.org/10.1128/mSystems.00553-19

Nayak, A. R., & Twardowski, M. S. (2020). "Breaking" news for the ocean's carbon budget [Editorial Material]. *Science*, *367*(6479), 738-739. https://doi.org/10.1126/science.aba7109

Robertson, C. M., Demopoulos, A. W. J., Bourque, J. R., Mienis, F., Duineveld, G. C. A., Lavaleye, M. S. S., Koivisto, R. K. K., Brooke, S. D., Ross, S. W., Rhode, M., & Davies, A. J. (2020). Submarine canyons influence macrofaunal diversity and density patterns in the deep-sea benthos [Article]. *Deep-Sea Research Part I-Oceanographic Research Papers*, *159*, 15, Article 103249. https://doi.org/10.1016/j.dsr.2020.103249

Ruppel, C. D., & Waite, W. F. (2020). Timescales and Processes of Methane Hydrate Formation and Breakdown, With Application to Geologic Systems [Article]. *Journal of Geophysical Research-Solid Earth*, *125*(8), 43, Article e2018JB016459. https://doi.org/10.1029/2018jb016459

2019

Kennedy, B. R. C., Cantwell, K., Malik, M., Kelley, C., Potter, J., Elliott, K., . . . Rotjan, R. D. (2019). The Unknown and the Unexplored: Insights Into the Pacific Deep-Sea Following NOAA CAPSTONE Expeditions. *Frontiers in Marine Science, 6*, Unsp 480. doi:10.3389/fmars.2019.00480

2018

Djurhuus, A., Pitz, K., Sawaya, N. A., Rojas-Marquez, J., Michaud, B., Montes, E., . . . Breitbart, M. (2018). Evaluation of marine zooplankton community structure through environmental DNA metabarcoding. *Limnology and Oceanography-Methods, 16*(4), 209-221. doi:10.1002/lom3.10237

Hoer, D. R., Gibson, P. J., Tommerdahl, J. P., Lindquist, N. L., & Martens, C. S. (2018). Consumption of dissolved organic carbon by Caribbean reef sponges. *Limnology and Oceanography, 63*(1), 337-351. doi:10.1002/lno.10634

Moore, S. E., Stabeno, P. J., Grebmeier, J. M., & Okkonen, S. R. (2018). The Arctic Marine Pulses Model: linking annual oceanographic processes to contiguous ecological domains in the Pacific Arctic. *Deep Sea Research Part II: Topical Studies in Oceanography, 152*(SI), 8-21. doi:10.1016/j.dsr2.2016.10.011

Mountjoy, J. J., Howarth, J. D., Orpin, A. R., Barnes, P. M., Bowden, D. A., Rowden, A. A., . . . Kane, T. (2018). Earthquakes drive large-scale submarine canyon development and sediment supply to deep-ocean basins. *Science Advances, 4*(3), 8. doi:10.1126/sciadv.aar3748

Papastamatiou, Y. P., Watanabe, Y. Y., Demsar, U., Leos-Barajas, V., Bradley, D., Langrock, R., . . . Caselle, J. E. (2018). Activity seascapes highlight central place foraging strategies in marine predators that never stop swimming. *Movement Ecology, 6*, 15. doi:10.1186/s40462-018-0127-3

Phillips, B. T., Becker, K. P., Kurumaya, S., Galloway, K. C., Whittredge, G., Vogt, D. M., Teeple, C. B., Rosen, M. H., Pieribone, V. A., Gruber, D. F., & Wood, R. J. (2018). A Dexterous, Glove-Based Teleoperable Low-Power Soft Robotic Arm for Delicate Deep-Sea Biological Exploration. *Scientific Reports*, *8*, Article 14779. https://doi.org/10.1038/s41598-018-33138-y

Studivan, M. S., & Voss, J. D. (2018). Population connectivity among shallow and mesophotic Montastraea cavernosa corals in the Gulf of Mexico identifies potential for refugia. *Coral Reefs, 37*(4), 1183-1196. doi:10.1007/s00338-018-1733-7

APPENDIX 1: RESPONSIBLE USE OF BIBLIOMETRICS

When used alongside other evaluative measures, bibliometrics can be a useful tool for evaluating research. However, all bibliometric indicators have limitations and should not be used out of context or applied without a full understanding of their intended use. No single metric can provide a rounded overview of research performance so responsible use of metrics requires using multiple metrics and providing context for those metrics. It can be helpful to think of a bibliometric analysis as a story where each indicator is a plot point. Additionally, bibliometrics should not be used as the sole basis for decision-making or for evaluating the work of either an individual or group.

Some Pros & Cons of Bibliometrics

Pros

- Quantitative, objective and reproducible
- Easy to understand and easily updated
- Fully scalable - from individual- to country-level

Cons

- Datasets, particularly from standard databases like Web of Science (WOS), may represent only a portion of existing publications
- Most indicators are skewed and are vulnerable to manipulation by authors & publishers. H-index for example highly favors authors with longer careers.
- Indicators don't necessarily mean what we think they mean (e.g. a high citation count may be the result of "negative" citations rather than an indicator of quality)

Further reading on the responsible use of bibliometrics:

Aksnes, D. W., L. Langfeldt, & P. Wouters. 2019. Citations, Citation Indicators, and Research Quality: An Overview of Basic Concepts and Theories. SAGE Open, 9. doi:10.1177/2158244019829575.

Barnes, C. 2017. The h-index debate: An introduction for librarians. The Journal of Academic Librarianship 43:487-494, doi:10.1016/j.acalib.2017.08.013.

Belter, C.W. 2015. Bibliometric indicators: Opportunities and limits. Journal of the Medical Library Association. 103(4):219-221. doi:10.3163/1536-5050.103.4.014.

Clarivate Analytics. 2020. InCites benchmarking & analytics: Responsible use of research metrics. http://clarivate.libguides.com/incites_ba/responsible-use. Accessed 12/16/2020.

Haustein, S., V. Lariviere. 2015. The use of bibliometrics for assessing research: Possibilities, limitations and adverse effects. In: Welpe IM, J. Wollersheim, S. Ringelhan, M. Osterloh, eds. Incentives and performance. Springer, Cham. Pg. 121–139. doi:10.1007/978-3-319-09785-5_8.

Hicks, D., P. Wouters, L. Waltman, S. de Rijcke and I. Rafois. 2015. Bibliometrics: The Leiden Manifesto for research metrics. Nature 520:420-531. doi:10.1038/520429a.

Pendlebury, D.A. 2010. White paper: Using bibliometrics in evaluating research. Thomson Reuters, Philadelphia, PA. https://lib.guides.umd.edu/ld.php?content_id=13278687.

APPENDIX 2: METHOD AND SOURCES

This report provides a bibliometric analysis of publications supported by the NOAA Office of Ocean Exploration and Research from 2022 to January 14, 2022. For our data source, we searched Web of Science for variations of "Office of Ocean Exploration and Research" and Ocean Exploration grant numbers. Because we use the WoS analytical tools for our bibliometric analyses, Ocean Exploration publications that do not appear in WoS have been omitted from the data set. Bibliographic citations and citation data were downloaded from WoS and Clarivate InCites.

Although we have included publication and citation data through January 2022 in our data set, it is generally agreed that publications must be at least two years old for citation reporting to be meaningful. Therefore it should be noted that the citation data for the more recent publications is preliminary and is most likely not indicative of their eventual impact.

Publication and citation data were downloaded from Web of Science and InCites on January 14, 2022. Because of slight differences in indexing schedules and algorithms, citation data can vary slightly between WoS and InCites. The full publication list and data sets are from Sarah.Davis@noaa.gov