Tethys Management Plan V3

J Whiting, L Hanna, A Copping
Pacific Northwest National Laboratory
November 2015

Introduction

Tethys is an online Knowledge Management System designed to house and organize information and research on environmental effects of marine and wind energy. Developed by Pacific Northwest National Laboratory (PNNL), *Tethys* supports the US Department of Energy Wind and Water Power Technologies Office (WWPTO). *Tethys* also contains information and metadata collected through Annex IV and WREN. Annex IV is an international collaborative project under the auspices the International Energy Agency (IEA) Ocean Energy Systems (OES) focused on collecting, disseminating, and analyzing information and metadata on the environmental effects of marine energy. WREN was established by the IEA Wind Committee to address environmental issues associated with commercial development of land-based wind and offshore wind energy projects. Together, these projects are used by a broad audience that includes: international marine energy technology and project developers, regulatory and resource management agency staff, researchers, and other stakeholders.

Annex IV and WREN focus on facilitating collaboration and communication among the respective marine energy and wind energy communities by utilizing *Tethys* as a commons. Collaborative activities include: hosting webinars and expert forums; maintaining a mailing list and providing updates on new documents and current events; enabling users to create *Tethys* profiles to promote interactions, and to readily communicate among users; updating the *Tethys* stories; and utilizing social media to reach a broader audience.

The purpose of this document is to delineate four management plans for *Tethys* and Annex IV:

1. *Tethys* Collection Plan – Establishes a process to regularly add marine energy, offshore wind (OSW) energy, and land-based wind (LBW) energy content as it becomes available.
2. Annex IV Collection Plan – Establishes a process to update and regularly add Annex IV project site and research study material, with assistance from the Annex IV member nations.
3. Website Performance Measurement Plan – Provides a mechanism to track progress and assure accountability of the *Tethys* project to its programmatic objectives by gaging performance metrics.
4. Outreach Plan – Outlines the primary outreach and communication activities planned with the Annex IV community during *Phase 2* of the project.

This project acts as a primary outreach tool for the DOE Wind and Waterpower Technology Office, in order to support the advancement of the marine and wind energy industries while encouraging responsible stewardship of the environment. Each of the following four plans promotes the primary objectives of *Tethys*, Annex IV, and WREN: to disseminate information and foster community on the environmental effects of marine and wind energy.

Tethys Collection Plan

To ensure the *Tethys* database contains the most current information and research results, the *Tethys* team must actively search for material on a regular basis. This includes both newly published papers and reports, as well as updates of existing documents.

Tethys will require regular addition of content to ensure that:

- New content is captured as it is released;
- Seminal documents that support marine, OSW, and LBW energy are captured; and
- All significant stressor/receptor combinations have ample coverage.

The *Tethys* collection has been assembled by hand-selecting material rather than collecting through large import activities, as is common in many databases. This selection process ensures each entry within *Tethys* is of high quality, and also limits the content to a manageable level. The selection process for hosting material on *Tethys* requires that every piece of content address multiple descriptive fields such as technology type, stressors, and environmental receptors; this strict process ensures consistency and completeness of the entries.

Marine Energy Collection

The marine energy industry is still in the early stages with a limited number of pilot and demonstration projects deployed around the world. With the first commercial arrays under consideration in Europe, there has been considerable research conducted on the potential environmental effects of wave and tidal energy devices. Much of the literature is fairly recent and covers laboratory studies, ancillary industry applications, theoretical research, and monitoring reports on demonstration projects, although peer reviewed papers are becoming available at an increasing rate. As such, the *Tethys* collection contains the vast majority of available marine energy documents, including all seminal documents identified by the marine energy community. Therefore, this collection plan will focus on gathering documents as they are released to the public.

The following activities will be carried out to continue to expand the marine energy content in the Tethys knowledge base:

1. **Subscriptions to websites and mailing lists.** Initial searches of the each of the databases listed below were performed to gather scientific papers for *Tethys*. The most efficient method of ensuring that new papers are noted for addition is through subscriptions that provide daily updates directly to the collection team. The accumulation of these subscriptions results in 1-3 emails per day, which are all scanned for relevant content. *Tethys* additions vary by alert, providing anywhere between 0-5 relevant entries per alert, averaging about 3 articles per week. Our current subscriptions include the following journals:
    a. Scitation – http://scitation.aip.org/
        i. Journal of the Acoustical Society of America
        ii. Journal of Renewable and Sustainable Energy
    b. Science Direct – http://www.sciencedirect.com/
        i. Text Search: MHK, marine energy, environment

ii. Renewable Energy
iii. Ocean & Coastal Management
iv. Marine Pollution Bulletin

c. Seaweb - http://www.seaweb.org/
   i. Habitats and Ecosystems
   ii. Human-Environment Interaction
d. Wiley - http://onlinelibrary.wiley.com/
   i. International Journal of Energy Research
   ii. Wiley Interdisciplinary Reviews: Energy and Environment
   iii. Environmental Progress & Sustainable Energy
e. Plos One – http://www.plosone.org/
   i. Topical search: offshore renewable energy
   ii. Ecology and Environmental Sciences
f. Oxford Journals - http://icesjms.oxfordjournals.org/
   i. ICES Journal of Marine Science
g. MDPI - http://www.mdpi.com/journal/energies
   i. Energies
   ii. Environments
h. Inter-Research - http://www.int-res.com/journals/meps/meps-home/
   i. Marine Ecology Progress Series
i. Royal Society - http://royalsocietypublishing.org/
   i. Biology Letters
   ii. Proceedings A
   iii. Proceedings B
j. Google Scholar - http://scholar.google.com/
   i. Text Search: MHK, marine energy, environment

2. **Professional networking.** Professional contacts (listed below) have been contacted to request scientific papers or reports that pertain to environmental effects of marine energy. Our team actively requests documents from contacts in these organizations on a periodic basis (generally every 6 to 12 months) reminding the contacts of our interest, and asking that they review *Tethys* content to see what might be missing. Currently we receive documents from many of the contacts, often several documents at a time. These partnerships allow for the early identification of documents from sources that are difficult to search with other methods. Additionally, this collaboration ensures that professionals are interacting with *Tethys* as they identify documents, promoting the use of *Tethys* in the professional workplace. The following is a list of partner organizations whose contacts help forward documents of interest:
   a. Annex IV country analysts.
   b. DOE National Laboratories, including Pacific Northwest National Laboratory, Sandia National Laboratories, Oak Ridge National Laboratory, Argonne National Laboratory.
   c. Department of Energy (DOE) WWPTO.
   d. Other federal agencies including BOEM, NOAA, USFWS.
   e. National Marine Renewable Energy Centers (NNMREC, HiNMREC, SENMREC)
   f. Universities engaged in marine energy research, such as University of Washington, Oregon State University, University of Minnesota, University of Maine, Bowling Green University, Florida Atlantic University, University of Hawaii, University of Massachusetts-Dartmouth, University of New Hampshire, Acadia University, University of Edinburgh, Aberdeen University, University of Highlands and Islands, Heriot-Watt University, etc.

g. Coastal and Estuarine Research Federation (CERF) and other marine professional societies.
h. Key consultancies, including: Aquatera Limited, Ecology and Environment, Kleinschmidt, HDR/DTA, Tetra Tech, H.R. Wallingford, etc.
i. Broad inquiries to presenters from relevant conferences.

3. **External database searches.** National and international databases provide significant number of additional documents and content for *Tethys*. The following databases will be mined for relevant material on a quarterly basis. It is important to note that while all these databases contain information related to marine energy developments, not all the information contained is relevant to *Tethys*.
    a. Wave and Tidal Knowledge Network (http://www.waveandtidalknowledgenetwork.com/) – A large European database on environmental effects of marine energy with wide content coverage; documents that do not deal with the environment need to be filtered out.
    b. NNMREC, OSU (http://nnmrec.oregonstate.edu/biblio) – A renewable energy center in the US that performs research on wave energy.
    c. NNMREC, UW (http://depts.washington.edu/nnmrec/documents.html) – A renewable energy center in the US that performs research on tidal energy.
    d. SNMREC (http://coet.fau.edu/research/journals-conferences-reports.html) – A renewable energy center in the US that performs research on marine current energy.
    e. HiNMREC (http://hinmrec.hnei.hawaii.edu/references/) – A renewable energy center in the US that performs research on wave energy and ocean thermal energy conversion.
    f. MHK Tech Papers (http://mhktechpapers.wordpress.com/) – Technical papers with a focus on technology development, economics and resource assessment; documents that do not deal with the environment need to be filtered out.
    g. Ocean Renewable Energy Coalition (http://www.oceanrenewable.com/reports/) – A membership-based organization in the US focused on advancing the marine energy industry.
    h. SOWFIA (http://www.sowfia.eu/index.php?id=23) – Many EU nations contribute to the findings of this research project, exploring the environmental and socio-economic impacts of wave energy.

4. **Suggestions from the *Tethys* community.** Contact information for the collection team is listed on *Tethys*, which allows members of the community to suggest the addition of material to the database. Suggestions are filtered based on the standards of acceptance by the PNNL collection team.

Offshore Wind (OSW) Collection

The OSW industry is maturing rapidly due to technology carry-over from terrestrial wind. Many offshore windfarms in Europe and Asia have been constructed since the first Danish farm was installed in 1991, allowing several decades of research on environmental effects. Although a certain amount of data and information are held as proprietary, there is a considerable body of literature covering environmental effects of windfarms at a commercial scale. *Tethys* focuses on the body of literature pertaining to offshore wind, as most of the terrestrial environmental studies do not apply to offshore applications;

however, there is some overlap between offshore and terrestrial wind studies. This collection plan will focus on identifying documents already in existence while also gathering documents as they are released. Unlike marine energy content, the greatest numbers of papers relevant to OSW environmental effects are found in the academic (scientific) databases and journal entries. While the secondary databases that contain grey literature are also searched (as for marine energy), less emphasis is placed on these sources as there is, as compared to marine energy, less content with an environmental focus.

The following activities will be carried out to continue to expand the OSW content in *Tethys*:

1. **Subscriptions to websites and mailing lists.** Initial searches of the each of the databases listed below were performed to gather scientific papers for *Tethys*. The most efficient method of ensuring that new papers are noted for addition is through subscriptions that provide daily updates directly to the collection team. *Tethys* additions vary by alert, providing anywhere between 0-5 relevant entries per alert, averaging about 1 article per day. Our current subscriptions include the following journals:
    a. Scitation – http://scitation.aip.org/
        i. Journal of the Acoustical Society of America
        ii. Journal of Renewable and Sustainable Energy
    b. Science Direct – http://www.sciencedirect.com/
        i. Text Search: offshore wind energy, environment
        ii. Renewable Energy
        iii. Ocean & Coastal Management
        iv. Marine Pollution Bulletin
    c. Seaweb - http://www.seaweb.org/
        i. Habitats and Ecosystems
        ii. Human-Environment Interaction
    d. Wiley - http://onlinelibrary.wiley.com/
        i. International Journal of Energy Research
        ii. Wiley Interdisciplinary Reviews: Energy and Environment
        iii. Environmental Progress & Sustainable Energy
        iv. Wind Energy
    e. Plos One – http://www.plosone.org/
        i. Topical search: offshore renewable energy
        ii. Ecology and Environmental Sciences
    f. Oxford Journals - http://icesjms.oxfordjournals.org/
        i. ICES Journal of Marine Science
    g. MDPI - http://www.mdpi.com/journal/energies
        i. Energies
        ii. Environments
    h. Inter-Research - http://www.int-res.com/journals/meps/meps-home/
        i. Marine Ecology Progress Series
    i. Royal Society - http://royalsocietypublishing.org/
        i. Biology Letters
        ii. Proceedings A
        iii. Proceedings B
    j. Google Scholar - http://scholar.google.com/
        i. Text Search: offshore wind energy, environment

2. **Professional networking.** Professional contacts (listed below) have been contacted to request scientific papers or reports that pertain to environmental effects of marine energy. Our team actively requests documents from contacts in these organizations on a periodic basis (generally every 6 to 12 months) reminding the contacts of our interest, and asking that they review *Tethys* content to see what might be missing. Currently we receive documents from many of the contacts, often several documents at a time. These partnerships allow for the early identification of documents from sources that are difficult to search with other methods. Additionally, this collaboration ensures that professionals are interacting with *Tethys* as they identify documents, promoting the use of *Tethys* in the professional workplace. The following is a list of partner organizations whose contacts help forward documents of interest:
    a. Task 34 experts
    b. DOE National Laboratories, including Pacific Northwest National Laboratory, National Renewable Energy Laboratory, Sandia National Laboratories, Lawrence Livermore National Laboratory, and Savannah River National Laboratory.
    c. Department of Energy (DOE) WWPTO
    d. Other federal agencies including BOEM, NOAA, USFWS.
    e. Consultants active in OSW research such as Stantec, Pandion/Normandeau
    f. National Marine Renewable Energy Centers (NNMREC)
    g. Other universities engaged in OSW research, such as Oregon State University, Bowling Green University, University of Delaware, Aalborg University, University of Nottingham, etc.
    h. Key consultancies, including: Ecology and Environment, HDR/DTA, Tetra Tech, H.R. Wallingford, etc.
    i. Broad inquiries to presenters from relevant conferences.

3. **External database searches.** National and international databases provide additional documents and content for *Tethys.* Many of the European OSW databases are light on environmental effects content; however we check these databases periodically as environmental reports from some projects are posted. The following databases will be mined for offshore wind related material that can be added to *Tethys* on a quarterly basis. It is important to note that while all these databases contain information related to OSW developments, not all the information contained is relevant to *Tethys*.

    a. The Crown Estate, OSW (http://www.marinedataexchange.co.uk/) – A large European database on environmental effects of offshore wind with wide content coverage; documents that do not deal with the environment need to be filtered out. This site now encompasses COWRIE material.
    b. NREL Wild Database (http://nrelpubs.nrel.gov/Webtop/ws/avianlt/www/web_data/SearchForm) – A large database in the US with publications related to the environmental effects of wind energy, the majority dealing with terrestrial wind; documents with no relevance to offshore wind need to be filtered out.
    c. Good Practice Wind (http://project-gpwind.eu/) – A European collaboration of eight countries to address projects with environmental and community concerns; documents that are not specific to environmental effects need to be filtered out.
    d. University of Maryland (http://www.umces.edu/cbl/wind) – A university in the US that has a strong interest in offshore wind energy; they occasionally publish reports that contain some environmental content.

e. 4C Offshore (http://www.4coffshore.com/windfarms/) – A large international database on project-specific offshore wind farms; environmental information is not a focus of this database, but occasional reports with environmental content are posted.
f. The Wind Power (http://www.thewindpower.net/index.php) – An international database about wind farms, turbines, manufacturers, developers, and operators; environmental information is not a focus of this database, but occasional reports with environmental content are posted.
g. LORC Knowledge (http://www.lorc.dk/offshore-wind-farms-map) – An international database about wind farm engineering specifics; environmental information is not a focus of this database, but occasional reports with environmental content are posted.
h. Offshore Center Danmark (http://www.offshorecenter.dk/offshorewindfarms.asp) – The official Danish database about the status of international wind farms; environmental information is not a focus of this database, but occasional reports with environmental content are posted.
i. Renewable UK (http://www.renewableuk.com/en/renewable-energy/wind-energy/offshore-wind/development-rounds.cfm) – The official UK database about the status of national wind farms; environmental information is not a focus of this database, but occasional reports with environmental content are posted.

4. **Mining the citations of key documents.** References from seminal reports and journal articles will be mined for new content. Additional online searches may be conducted to investigate papers that cite these identified seminal papers.

5. **Suggestions from the *Tethys* community.** Contact information for the collection team is listed on *Tethys*, which allows members of the community to suggest the addition of material to the database. Suggestions are filtered based on the standards of acceptance by the PNNL collection team, only allowing documents that deal with environmental impacts of the offshore technologies covered in *Tethys*.

Land-Based Wind (LBW) Collection

Land-based wind is an established industry within the US and many other countries around the world with an estimated global power production of 369,553 MW at the end of 2014 (GWEC 2015). Over the course of this industry's existence, a considerable amount of research has been published on the potential impacts wind farms may have on surrounding wildlife, mostly focused on bird and bat species, as well as the habitats that support them. Due to the age and maturity of the LBW industry, this collection plan will focus on identifying documents already in existence as well as gathering new articles and reports as they are published. Older documents related to environmental effects of LBW are expected to be present some challenges as they may not be readily available in digital form. In addition to carrying out traditional literature collection methods such as those highlighted in the MRE and OSW collection plans, PNNL will also utilize the network established around the international collaborative project WREN (Working Together to Resolve Environmental Effects of Wind Energy) and work with the National Renewable Energy Laboratory (NREL) to incorporate literature collected for their wind energy database, Wild (Wind-Wildlife Impacts Literature Database).

The following activities will be carried out to continue to expand the LBW content in the Tethys knowledge base:

1. **Requesting content from WREN.** WREN was established by IEA Wind to address environmental issues associated with commercial development of land based and offshore wind energy projects. Analysts from each of the ten member countries (France, Germany, Ireland, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, and the US) have been asked to provide new literature and reports from their respective countries on environmental issues associated with offshore and lab-based wind energy developments. Although this group does not represent all the countries in the world that are utilizing wind resources for energy, they are able to provide unique information and resources that are typically difficult to locate from within the US.

2. **Import new documents added to WILD.** The WILD database contains journal articles, conference papers, reports, books, theses, patents, and more related to offshore wind, land-based wind, power lines, towers (e.g. communication and television), and marine energy. The level of effort varies based on staff availability; NREL currently has one staff member dedicating 15 hours per week to collecting literature. This staff member typically finds content through journal alerts (Google Scholar, Science Direct, PLOS, etc.) and searching references on major reports. Twice a year, WILD sends an excel file to PNNL with all the new LBW content which are integrated into Tethys through.

3. **Subscriptions to websites and mailing lists.** Subscriptions provide direct updates to the collection team, alerting the team of new documents the moment they become available. This list varies from other lists because it does not include offshore-oriented journals. Our current subscriptions include the following journals:
    a. Scitation – http://scitation.aip.org/
        i. Journal of the Acoustical Society of America
        ii. Journal of Renewable and Sustainable Energy
    b. Science Direct – http://www.sciencedirect.com/
        i. Text Search: wind energy, environment
        ii. Renewable Energy
    c. Wiley - http://onlinelibrary.wiley.com/
        i. International Journal of Energy Research
        ii. Wiley Interdisciplinary Reviews: Energy and Environment
        iii. Environmental Progress & Sustainable Energy
        iv. Wind Energy
    d. Plos One – http://www.plosone.org/
        i. Ecology and Environmental Sciences
    e. MDPI - http://www.mdpi.com/journal/energies
        i. Energies
        ii. Environments
    f. Royal Society - http://royalsocietypublishing.org/
        i. Biology Letters
        ii. Proceedings A
        iii. Proceedings B
    g. Google Scholar - http://scholar.google.com/
        i. Text Search: wind energy, environment

4. **Annual Web of Science searches.** Roughly once a year PNNL staff will use Web of Science to search for new peer reviewed articles related to LBW and associated environmental concerns. This approach will ensure that PNNL identifies any new articles that were missed or overlooked by the WILD database or the website subscriptions and mailing lists.

5. **Mining the citations of key documents.** As seminal reports and journal articles are acquired, their associated References will be mined for new content. Additionally, online searches may be conducted to further investigate papers that cite these identified seminal papers.

6. **Professional networking.** Professional contacts will be solicited to inform the collection team of any articles or reports that pertain to LBW energy. While subscriptions will be made to journals with a focus on wind energy and the environment, partners can provide awareness of documents from more traditional science resources. Additionally, this collaboration ensures that professionals are interacting with Tethys as they identify documents, promoting the establishment of Tethys in the professional workplace. The following is a list of close partnership organizations in which contacts will help forward documents of interest:
    a. National Renewable Energy Laboratory (NREL)
    b. Pacific Northwest National Laboratory (PNNL)
    c. Department of Energy (DOE)
    d. National Wind Coordinating Collaborative (NWCC)
    e. American Wind Wildlife Institute (AWWI)
    f. Bats and Wind Energy Cooperative (BWEC)
    g. Conference on Wind Energy and Wildlife Impacts (CWW)

7. **External database searches (quarterly updates).** National and international databases can provide a significant amount of additional content for *Tethys*. The following databases will be mined for LBW-related material that can be added to *Tethys*. It is important to note that while all these databases contain information related to the offshore wind developments, not all the information contained in these databases is relevant to *Tethys*, and may not be accessed as frequently as others.

    a. Good Practice Wind (http://project-gpwind.eu/) – A European collaboration of eight countries to address projects with environmental and community concerns; documents that are too specific need to be filtered out.
    b. 4C Offshore (http://www.4coffshore.com/windfarms/) – A large international database on project-specific offshore wind farms; no environmental information.
    c. The Wind Power (http://www.thewindpower.net/index.php) – An international database about wind farms, turbines, manufacturers, developers, and operators; no environmental information.
    d. LORC Knowledge (http://www.lorc.dk/offshore-wind-farms-map) – An international database about wind farm engineering specifics; no environmental information.
    e. Offshore Center Danmark (http://www.offshorecenter.dk/offshorewindfarms.asp) – The official Danish database about the status of international wind farms; no environmental data.

f. Renewable UK (http://www.renewableuk.com/en/renewable-energy/wind-energy/offshore-wind/development-rounds.cfm) – The official UK database about the status of national wind farms; no environmental data.

8. **Suggestions from the *Tethys* community.** Contact information for the collection team is listed on Tethys, which allows members of the community to suggest the addition of material to the database. Suggestions will be filtered based on the standards of acceptance by the PNNL collection team.

Annex IV Collection Plan

Annex IV will require regular curation of information to ensure that:

- The accessibility of environmental studies and monitoring worldwide continues to expand;
- Connections are made among the international research community in order to support the marine energy industry; and
- There is minimal duplication of research, based on increased communication among researchers.

The marine energy industry is still in the early stages and technology designs and project plans continue to change rapidly. New projects are being developed while many demonstration projects have ended. These changes necessitate aggressive collection and updating of information to ensure the integrity of the collection. Lessons learned from the first phase of Annex IV will be leveraged to create an effective system for data handling. The following activities will be carried out:

1. **Metadata forms (12-18 months after initial form submission, and after consecutive updates).** A country analyst has been designated from each Annex IV member nation. This individual will be responsible for collecting and updating metadata forms within her/his respective nation, and will be contacted on an annual basis by the collection team at PNNL. Designating a country analyst to assist with updating and collecting metadata forms ensures that information from each Annex IV member nation will receive sufficient attention; the PNNL collection team will be able to focus their efforts on collecting US information and managing the overall collection process for the Annex IV and *Tethys* databases.
2. **Organizations.** There is a list of over 1000 organizations involved in marine and wind energy. This list is automatically linked to publications based on authorship, sponsorship, and author affiliations. New organizations are added when documents reference new organizations, or based on feedback from member nations.
3. **Database connections.** Links are made to all databases whose purpose is similar to that of *Tethys*, in an effort to promote connectedness with effective networking. As the collection team becomes aware of other databases, they will be added to *Tethys*.
4. **Regulatory framework (annual updates).** The regulatory material listed for OES nation is not intended to be an exhaustive description of permitting processes, but rather to act as an initial point of entry into the regulatory process for each member nation. The framework is not necessarily fully developed and may continue to change, warranting regular updates. In addition, as new nations join OES, information on their regulatory processes will be added. The Annex IV country analysts will be the main source of information updates and confirmation of the validity of the existing summaries.
5. ***Tethys* Community.** A list of *Tethys* members allows users to find more information about colleagues, including contact information. Any user may op in during registration to be shown on the table, but it requires authentication from PNNL staff in order to prevent spam and ensure quality of information. This page is only viewable by logged in members of *Tethys* in order to prevent bots from stealing their contact information.

Performance Measurement Plan

Performance requirements and metrics have been created to monitor the performance and content within *Tethys*. These requirements and metrics are described below, and provide a mechanism for assuring accountability and functionality of *Tethys*, Annex IV, and WREN.

Expected Outcomes and Performance Requirements

Performance measures can be classified as either ***activity measures***, ***outcome measures***, or ***proxy measures***.

Activity measures track objectives, directly observable events, performance levels, or similar metrics based on direct observation of programmatic activities. In the context of a website, examples of activity measures include the number of visits, pageviews, and other such metrics. While activities can play an important role in managing a program, they typically are only indirectly related to actual programmatic outcomes, and often this relationship is not a clear cause-effect relationship.

Outcome measures attempt to directly measure the impact of the programmatic activity in achieving the programmatic goals. In the case of *Tethys*, outcome measures should track improvements in the accessibility and utilization of environmental information relevant to the marine energy and offshore wind communities.

Proxy measures assess inherently subjective goals such as "accessibility" and "effectiveness of collaborations". These measures are used when a qualitative or quantitative link can be established (or is assumed) between an activity and an outcome. For example, positive feedback from users, increased use of the site, and user comments on documents and blog entries are all indicators of increased access. Initial reporting for *Tethys* will focus on these quantitative metrics with the goal of identifying and incorporating metrics for the more inherently subjective goals of the site (e.g., putting information into context) as we gain user experience. As a consequence, the performance measurement plan will be updated annually.

Software Tools

Our primary means of collecting data about the use of *Tethys* is via analysis in real time using the free analysis tool Google Analytics (http://www.google.com/analytics/). Google analytics offers detailed statistics and visual displays on website traffic and traffic sources, providing a simple interface for exploring and filtering site use data to observe trends. Google Analytics identifies and excludes web crawlers and bots that do not represent real users, allowing the results to reliably provide detailed feedback, which is a significant advantage over other similar analytical tools.

Examples of pertinent information provided by Google Analytics include identification of search terms that led the user to *Tethys* (e.g., "wave energy"); maps displaying users per country; graphical representations of metric trends over time; lists of top referral sites and more. Sifting through all the enormous amounts of available information in Google Analytics in order to identify those with significance to project goals, presents a significant challenge. Google Analytics collects website use information on a real-time basis and stores these data on the cloud.

Activity Measures

The complete list of the metrics that will be collected and reported for *Tethys* is provided below, with discussion of measurements techniques and assumptions, where appropriate:

Metric	Definition	Goal
Total visits	***Activity measure*** – A series of page requests from a specific user (identified by IP address or anonymous cookie) within a sliding 30-minute window.	10% increase on annual basis, to be tracked on a revolving quarterly basis.
Total pageviews	***Activity measure*** – Counts the number of times any page within a website has been accessed by a user; generally considered the most accurate gage of activity.	10% increase average on annual basis, to be tracked on a revolving quarterly basis.
Average pages per visit	***Activity measure*** – Derived measure that indicates how well the site engages users.	No goal, but activity should be tracked on a revolving quarterly basis.
Number of documents indexed	***Outcome measure*** – This number represents the coverage of material, and should continue to grow as new documents are released.	Increase by 25 documents per quarter.
Number of external websites linked to *Tethys*	***Outcome measure*** – The actual number of external links to *Tethys* is a reflection of the site's value as perceived by the community.	No goal, as this is outside of our control, but active outreach may increase the number.
Number of websites linked from *Tethys*	***Outcome measure*** – The actual number of links from *Tethys* reflects the connectedness of the site in reaching out to other sources.	Increase by 10 links per quarter.
Percentage of valid links in *Tethys*	***Outcome measure*** – Experience in operating similar websites suggests that a "decay rate" of approximately 10% per month occurs on external links, as websites are redesigned, go out of business, or content is deleted. Fixing broken links is essential for public appearance.	90% working links at any time.
Increased functionality and usefulness of site	***Proxy measure*** – *Tethys* should constantly be adding and enhancing functionality based on community feedback. ***Direct measure*** – A subset of *Tethys* users will be asked to rate the site with a popup survey. The limited questions on the survey may change over time as responses or specific areas of interest on the site are noted.	Continued improvements annually; determined by annual peer review of 4-6 individuals. Continued improvements in the site, based on responses to spot surveys.
Availability of information useful to users	***Proxy measure*** – This perception is based on how well users can navigate *Tethys*, how clean the information appears, how much information is available, and more. Ratings, comments, and direct feedback may be used as an indicator when available.	The majority of site users are satisfied with the information they retrieved from *Tethys*.

Additional Data to be Collected and Reported

The following metrics include demographic data about users, as well as anecdotal and narrative data that provide qualitative feedback about the performance of *Tethys*:

- **Executive summary.** A brief (2-3 paragraphs, bulleted lists) narrative will be included in each report which summarizes highlights, useful observations, trends, and potential issues that have been discerned from the quantitative data.
- **Top referring sites.** It is also possible to provide lists of the top referring sites, which is the URL of the website that users visited immediately prior to coming into *Tethys*. This is a useful administrative metric because it indicates which sites were particularly effective at leading users to *Tethys*.
- **Top search terms.** In many cases, the referring site information captured also includes information about the query (search terms) used to locate the site in Google or other search engines. This provides a means to see what questions users were asking prior to arriving at *Tethys* and allows us to determine the relevance of the site to those queries, as well as the ability to "fine tune" language used in our content.
- **Top foreign countries (domains).** In an effort to evaluate the extent of international use of *Tethys*, we will determine the top foreign countries using *Tethys* each month along with numbers for each country.

Reporting Frequency

A report will be submitted on a quarterly basis with results for all the metrics and additional data listed above. A short summary will also be provided to identify trends, issues, and anomalies in the reporting data (e.g., spikes or dips in web traffic, changes in search terms used to find *Tethys*, etc.). A customized report generated automatically from Google Analytics will also be included.

An annual summary report will be included as part of our fiscal year-end report that will include a tabulation of the monthly data reported above, as well as a summary of additional analytics. Ad-hoc evaluations of website effectiveness and use derived from user interviews, focus groups, and other methods that are not cost effective or appropriate on an ongoing basis may be discussed when available. A customized report generated automatically from Google Analytics will also be included.

A record of all metrics, quarterly reports, annual reports, and a list of recently added documents will be available on a *Tethys* deliverables page (http://tethys.pnnl.gov/deliverables).