

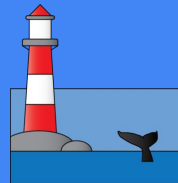
Marine Managed Area Mapping

Experiments in Machine S-122 Data Generation

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Anthropocene Institute



protectedseas

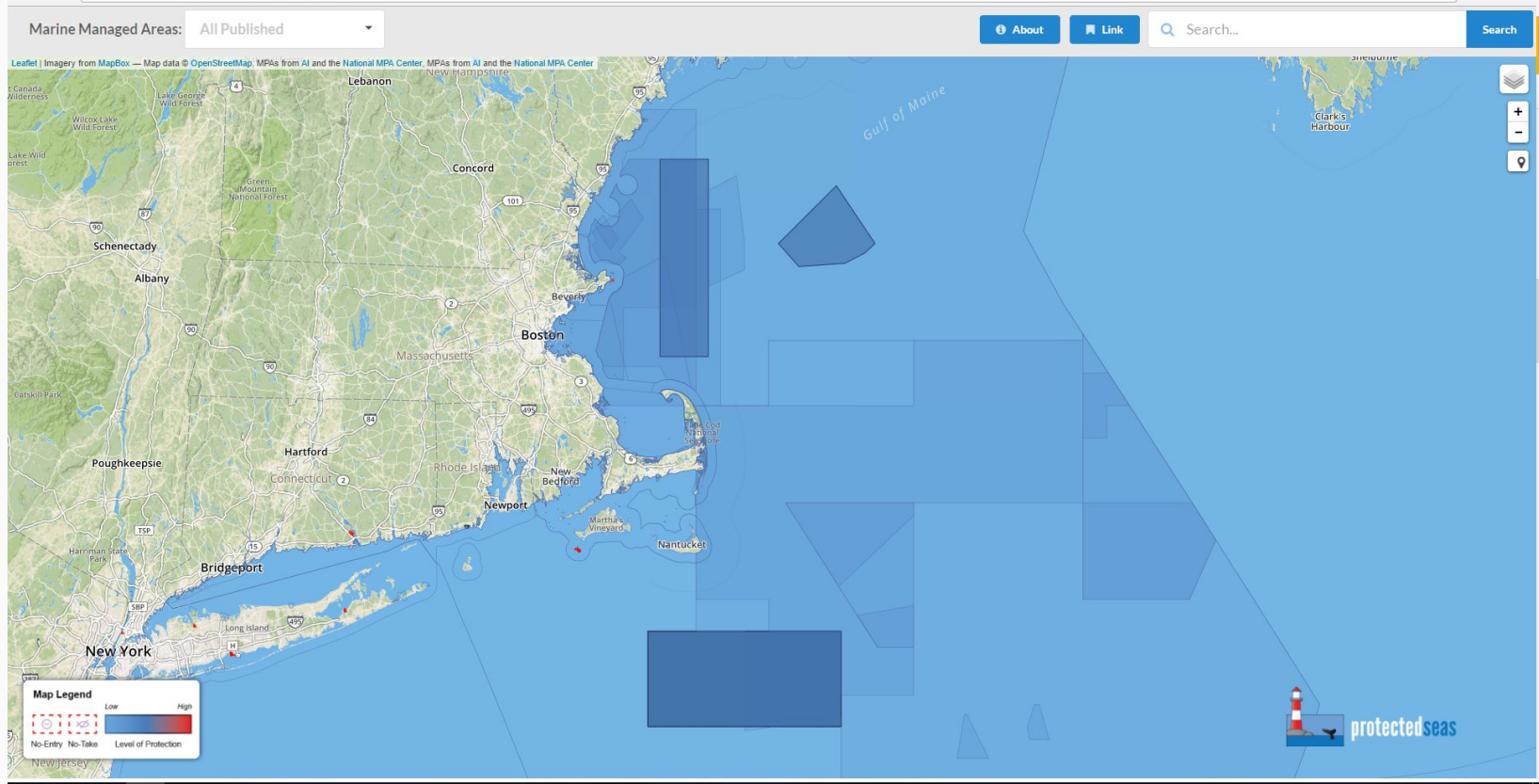


Where to Start?

- Aggregate the data
 - What is your coverage responsibility?
 - Who has the regulations? The boundaries?
 - Organize all the required information
 - Guaranteed none of this will be in S-122 'format' nor in one spot

- For this experiment, we leveraged Anthropocene Institute's Marine Managed Area Mapping project and database
 - <https://mpa.protectedseas.net>
 - ~3500 US protected or otherwise conservation managed areas in coastal waters
 - Built under private/public partnership with NOAA MPA Center

Protected Seas MPA Map for New England



What does ProtectedSeas MPA data look like?

● PostGIS Database

- MPA Attribute Table
 - Descriptive text info
 - Binary restrictions coding
 - URLs to regulations
- MPA Boundary Table (MultiPolygon)
 - Spatial Full Resolution
 - Reduced Resolution
 - Boundary Source Citations
- Related References
 - PDF files with extended MPA info
- MPA to Region Assignment
 - MPAs can belong to one or more geographic regions
- Pre-generated “Helper” text
 - Convert Binary codings to english text lists

Edit Data - Anthro (turnip.findpage.com/5432) - gisdb - public.mpa_attributes

ogc_fid [PK] integer	site_id character varying	site_name character varying	url character varying	country character varying	state character varying	managing_authority character varying	designation character varying	purpose character varying	restriction character
1	CA302	Pyramid Point State MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To support Aleutian	It is un
2	CA303	Point St. George F MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
3	CA304	Southern Seal Roc	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Southern Seal Roc	It is un
4	CA305	Cassia Rock Specia	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Cassia Rock was cl	It is un
5	CA306	False Klamath Rock	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	False Klamath was	From Mar
6	CA307	Reading Rock State MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
7	CA308	Reading Rock State	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
8	CA309	Samoa State Marine MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
9	CA310	South Humboldt Bay	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
10	CA311	Sugarloaf Island S	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Sugarloaf Island v	Who vesse
11	CA312	South Cape Mendoc	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
12	CA313	Steamboat Rock Spe	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Steamboat Rock was	From Mar
13	CA314	Mattole Canyon Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
14	CA315	Sea Lion Gulch Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
15	CA316	Big Flat State Mar MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To enhance and pr	It is un
16	CA317	Double Cone Rock S	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
17	CA318	Rockport Rocks Spe	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Rockport Rocks was	From Mar
18	CA319	Viscaino Rock Spec	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Special Closure	Viscaino Rock was	From Mar
19	CA320	Ten Mile State Mar	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To maintain biodi	It is un
20	CA321	Ten Mile Beach Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
21	CA322	Ten Mile Estuary S	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve fish	It is un
22	CA323	MacKerricher State MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve harbor	It is un
23	CA324	Point Cabrillo Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
24	CA325	Russian Gulch State MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
25	CA326	Big River Estuary MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve this	It is un
26	CA327	Van Damme State Ma MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve and p	It is un
27	CA328	Navarro River Estu MPA	Website:https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve the m	It is un
28	CA329	Point Arena State	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect one of	It is un
29	CA330	Point Arena State	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect one of	It is un
30	CA331	Sea Lion Cove Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect marine	It is un
31	CA332	Saunders Reef Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To preserve rocky	It is un
32	CA333	Del Mar Landing St	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect the tid	It is un
33	CA334	Stewarts Point Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect a comp	It is un
34	CA335	Stewarts Point Sta	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect a comp	It is un
35	CA336	Salt Point State M	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	To protect bull k	It is un
36	CA337	Geracle Cove State	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	The sheltered sea	It is un
37	CA338	Russian River State	https://www.wildlife.ca.gov/ConservatUSA	USA	CA	California Department of State Marine Reser	Conservation	The Russian River	It is un

MPA Example - Northwestern Hawaiian Islands Marine Refuge

Northwestern Hawaiian Islands Marine Refuge

Managed By: Hawaii Department of Land and Natural Resources

Purpose: To establish a marine refuge in the Northwestern Hawaiian Islands for the longterm conservation and protection of the unique coral reef ecosystems and the related marine resources and species, to ensure their conservation and natural character.

 Feedback

Restricted: 1. Entry into the refuge is prohibited without a permit.
2. Fishing or taking of marine life within the refuge is prohibited.

Allowed: Persons may enter the refuge to engage in activities that do no harm to the coral reef ecosystem for the following purposes:
1. Scientific or education purposes;
2. Non-extractive purposes undertaken to further the knowledge of resources or which provide for enhanced resources protection or benefit resource management; and
3. Subsistence, traditional and customary practices by Native Hawaiians.

Governing Regulation: HAR § 13-60.5
Effective: Year-round

Report Violations to: (808) 643-DLNR (3567)

Latest Updates:
For the latest fishing regulation information:
Check the [the Western Pacific Regional Fishery Management Council](#)
In season changes to commercial and recreational fishing regulations, call the Hawaii Department of Natural Resources, Division of Aquatic Resources, at (808) 587-0100 or visit the DLNR [website](#).
Announcements by the Division of Aquatic Resources are made available [here](#).

- Site name
- Managing authority
- Purpose
- Restrictions summary
- Exceptions summary
- Governing regulation citation (s)
- Seasonality (if any)
- Violations reporting
- Sources for news & updates (phone, web, email, ...)
- URL links to official 'homepages', regulation full text, ...
- Binary coding for Specific Restrictions
 - Trawling
 - Longlining
 - Commercial Fishing
 - Recreational Fishing
 -

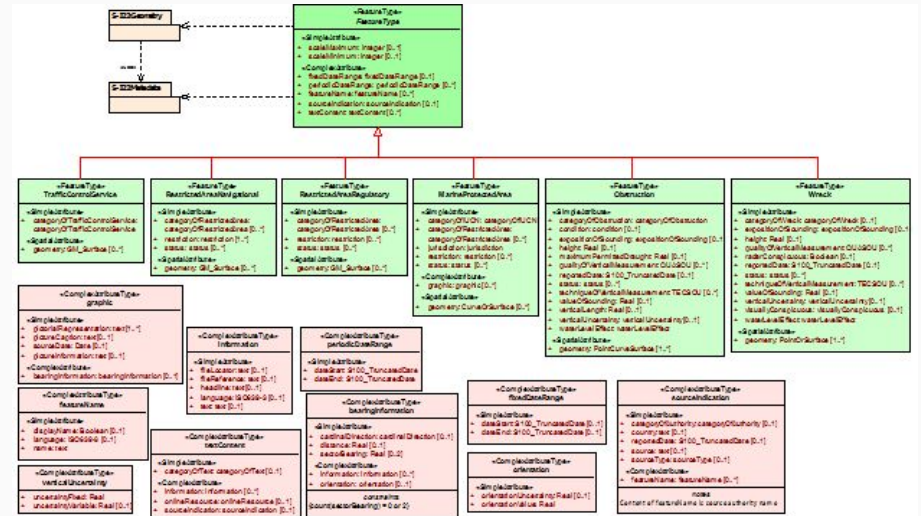
What's a XML Schema (.xsd)?

- Schema describes the attributes and relationships that define 'MPAs' in IHO S-122 format

- What attributes / elements are required?
- One, None, or Many?
- What are the data types for each element?

- Schema adherence hardware and software implementations should work with your data

- OEM's will not implement S-122 if they can't count on data formats being standardized



S-122 xsd in Oxygen Editor

Project

- sample.xpr
 - css
 - debugger
 - epub
 - fo
 - import
 - json
 - jsp
 - rvld
 - relaxng
 - schematron
 - svg
 - wsdl
 - xquery

The Master Files support is disabled
[Enable](#) [Read more](#)

Project [Open/Find Resource](#)

Outline

Type filter text

- onlineResourceType
- orientationType
- periodicDateRangeType
- PermissionType
- PointCurveSurface
- PointOrCurve
- PointOrSurface
- RecommendationsType
- RegulationsType
- RestrictedAreaType
- RestrictionsType
- S100_TruncatedDate
- sectorLimitType
- ServiceHourType
- ShipReportType
- sourceIndicationType
- SupplementaryInformationType
- telecommunicationsType
- textContentType

S-122.xsd

- 0..∞ periodicDateRange (Type: periodicDateRangeType)
- 0..∞ featureName (Type: featureNameType)
- sourceIndication (Type: sourceIndicationType)
- 0..∞ textContent (Type: textContentType)
 - categoryOfText (Type: categoryOfTextType)
 - 0..∞ information (Type: informationType)
 - onlineResource (Type: onlineResourceType)
 - sourceIndication (Type: sourceIndicationType)

MarineProtectedAreaType
Base Type: FeatureType
Marine Protected Area: Any area of the intertidal or sub-tidal terrain, together with its overlying water and...

Generalized feature type which carry all the common attributes

categoryOfText
categoryOfRUCN (Type: categoryOfRUCNType)
(International Union for Conservation of Nature and Natural Resources)

0..∞ categoryOfRestrictedArea (Type: categoryOfRestrictedAreaType)

jurisdiction (Type: jurisdictionType)

0..∞ restriction (Type: restrictionType)

0..∞ status (Type: statusType)

[Xoxygen] Hint: Some components referred by your schema were not found. If this schema file is included in a schema from where those components are visible then you should validate from relativeType.

Text Grid Author Design

F:\temp\S122.xsd

- If you're very lucky, most of what you need can be directly mapped
- No one is that lucky!
 - At a minimum, mapping attributes like MPA name, country, and managing authority are hopefully readily apparent
 - You'll probably need to transform data
 - Some attributes might need split up from your source into more than one S-122 element type
 - You may have to derive some values from existing data so that it matches the S-122 format
 - Or maybe you have important attributes that aren't in your existing data and will need to be added (and someone(s) will need to do that work)

UNH / Anthinst Mapping Example

- Start with a single, representative MPA and fill in the blanks
- Use this as a template

```
AI-data-MPA-s122v1-mapped.xml      hawaii_1.xml
44   </gml:envelope>
43   </gml:boundedBy>
44   <member>
45     <MPA:MarineProtectedArea gml:id="AIHI001"><!-- AI-site_ID -->
46     <!--information associations go first-->
47     <S100:informationAssociation gml:id="US1a001" xlink:href="#USAUTORIHDLNLR" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/responsibleAuthority"/>
48     <S100:informationAssociation gml:id="US1a002" xlink:href="#USSUPINFHDLNLR" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/providesInformation"/>
49     <S100:informationAssociation gml:id="US1a003" xlink:href="#USRESDESHDLNLR" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/theRXN"/>
50     <S100:informationAssociation gml:id="US1a004" xlink:href="#USREGLTSHIDLNR" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/theRegulation"/>
51     <!--<S100:informationAssociation gml:id="US1a003" xlink:href="#USNATINF12" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/theNauticalInformation"/>
52     <S100:informationAssociation gml:id="US1a0025" xlink:href="#USREGLTS1" xlink:role="http://www.ihp.int/S-122/gml/1.0/roles/theRegulations"/>-->
53     <featureName>
54     <language>eng</language>
55     <name>'Ewa Limu Management Area</name><!--AI-site_name-->
56     </featureName>
57     <categoryOfIUCN>Category IV</categoryOfIUCN><!-- Category IV : Habitat/Species Management Area; protected area managed mainly for conservation through management intervention.
58     *
59     Categories", IUCN, 1994)-->
60     <categoryOfRestrictedArea>environmentally sensitive sea area</categoryOfRestrictedArea>
61     <jurisdiction>national sub-division</jurisdiction>
62     <restriction>dragging prohibited</restriction>
63     <restriction>dredging prohibited</restriction>
64     <restriction>industrial or mineral exploration/development prohibited</restriction>
65     <restriction>construction prohibited</restriction>
66     <restriction>drilling prohibited</restriction>
67     <status>permanent</status>
68   </MPA:MarineProtectedArea>
69 </member>
70 </member>
71 <MPA:Authority gml:id="USAUTORIHDLNLR">
72 <S100:informationAssociation gml:id="US
73 <S100:invInformationAssociation gml:id=
74 <featureName>
75 <name>Hawaii Department of Land and
76 </featureName>
77 <sourceIndication>
78 <categoryOfAuthority>fishery</categ
79 <country>USA</country><!-- AI-count
80 <reportedDate>
81 <date>2016-11-14</date>
82 </reportedDate>
83 </sourceIndication>
84 <categoryOfAuthority>environmental</cat
85 <textContent>
86 <onlineResource>
87 </onlineResource>
88 </MPA:Authority>
89 </member>
```

```
<language>eng</language>
<name>'Ewa Limu Management Area</name><!--AI-site_name-->
</featureName>
<categoryOfIUCN>Category IV</categoryOfIUCN><!-- Category IV : Habitat/Species Management
Categories", IUCN, 1994)-->
<categoryOfRestrictedArea>environmentally sensitive sea area</categoryOfRestrictedArea>
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<restriction>dredging prohibited</restriction>
<restriction>industrial or mineral exploration/development prohibited</restriction>
<restriction>construction prohibited</restriction>
<restriction>drilling prohibited</restriction>
<status>permanent</status>
</MPA:MarineProtectedArea>
</member>
```

XML Mapping Demonstration

- It's impossible to generate S-122 for any reasonable number of MPAs by hand
 - The schema is too detailed and it's easy to make mistakes
 - Even with good tools, editing XML can be tricky
 - Information Associations further complicate editing by hand
- **Automation is Key!**
 - Keep your source data in whatever tool is familiar and usable by the people who will manage your data
 - Proper S-122 is worthless if the underlying data isn't correct and complete
 - You may have no control over the source formats if you're getting it from other organizations outside your own
 - Create the workflow / scripts to transform your source data to S-122 as needed

Protected Seas Data Transformation Experiment

- We created a simple PHP script to do our conversion
 - <500 lines of code so far
 - 15 functions
- Directly access our database so we can create different sets of S-122 by query without changing the core code and easily regenerate after updates
 - Specific region
 - Specific restrictions
 - Specific managing authority
 -
- Concentrated 1st on transforming attribute data, next step is to add the postgis -> GML format boundary insertion
- Then explore potential issues based on geometry complexity and total file size (current database is nearly 1GB in shapefile format)

A Few Words About Normalization

- The S-122 schema supports significant normalization via InformationAssociations
 - Pros:
 - This reduces filesize by removing redundant data
 - If there is a change in shared information, it only needs updated in one place
 - Example: List a regulation only once, then refer to it from each MPA that it governs
 - Cons:
 - It is very unlikely that your source data is normalized to any significant degree
 - Transformation code that can identify and create normalization is much more complex to write and properly test
 - Example: If your source data comes via spreadsheet, it's not normalized

Next Steps for UNH / AnthInst

- Update the PHP S-122 transformation code to include GML boundaries
- Run the export on different sized geo regions to characterize file sizes
- Provide sample data to anyone who would like to experiment with it
- Help add your MPA data to our global database and return it to you in S-122

Thank you!

