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Taihoro Nukurangi

Climate, Freshwater & Ocean Science

28 August 2018 Mapping Marine Biodiversity: Using Open Source GIS Tools to Visualise and Extract Collection Data

Mapping Marine Biodiversity: Using Open Source GIS Tools to Visualise and Extract Collection Data

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Climate, Freshwater & Ocean Science

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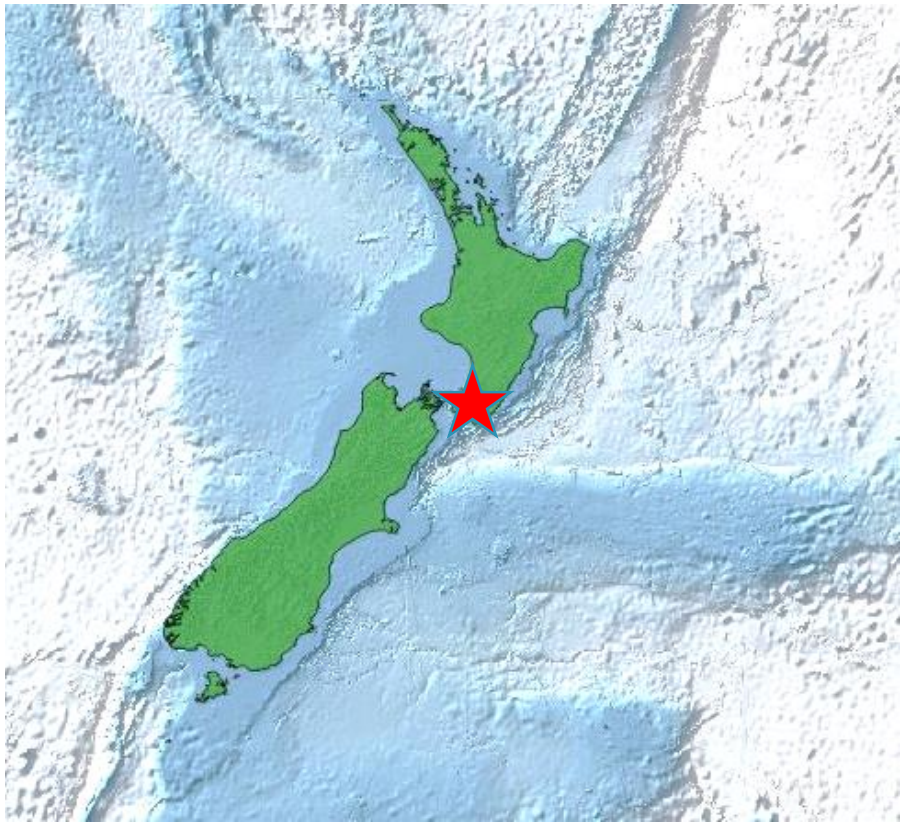
NIWA: National Institute of Water & Atmospheric Research

Crown Research Institute

- Maintains nationally important databases, biological collections, science assets and capabilities to undertake its science

Enhance the stewardship of New Zealand's freshwater and marine ecosystems and biodiversity

- Marine Biological Resources: delivery of fundamental knowledge about the diversity and distribution of the marine biota in New Zealand's territorial waters, EEZ and Southern Ocean, over a variety of space and time scales.



Mapping Marine Biodiversity: Using Open Source GIS Tools to Visualise and Extract Collection Data

- NIWA collections
- Specify database
- The GIS solution we wanted
- The solution found: GDAL Virtual Data Source & QGIS
- How it works
- Example outputs

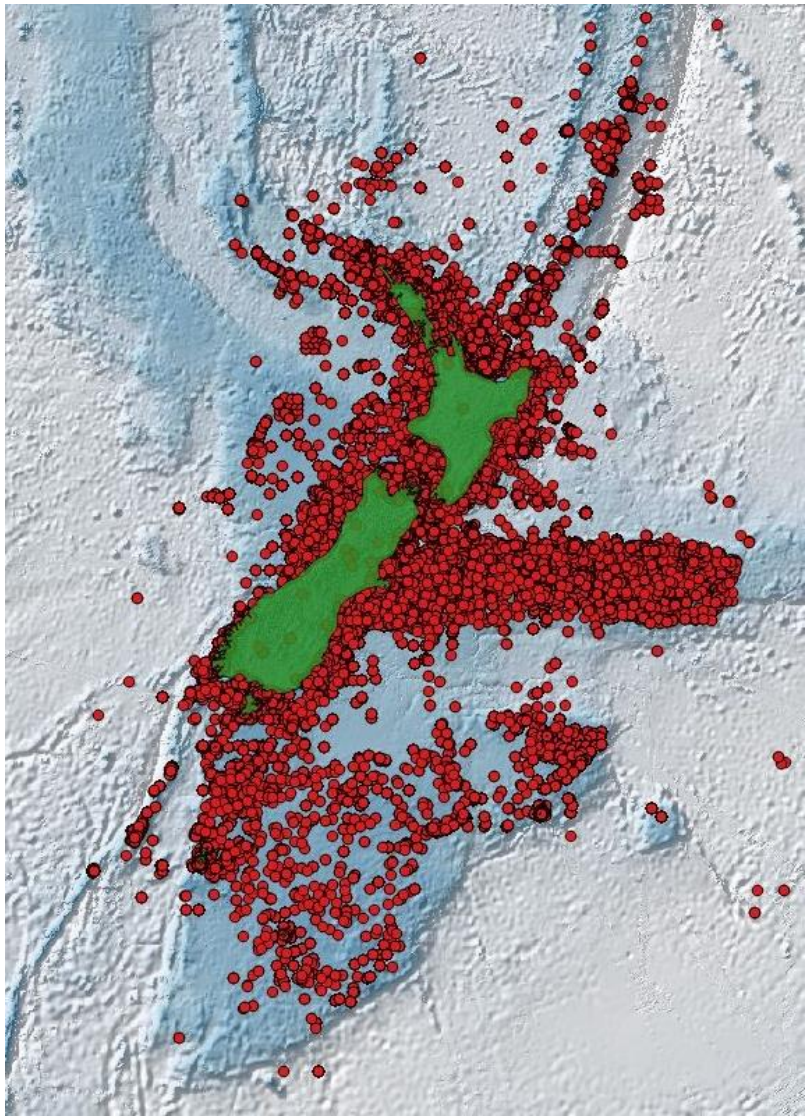
NIWA Invertebrate Collection

MBIE SSIF* nationally significant collection

* Ministry of Business Innovation & Employment Strategic Science Investment Fund

~300,000 jars of preserved marine invertebrates

- from NZ, Ross Sea and SW Pacific
- 8,500 species from 21 phyla
- 140,000 registered jars
- 4,083 type specimens (name bearers of species)



NIWA Invertebrate Collection

New Zealand Oceanographic Institution began the collection in the 1950s

Growing collection:

- biodiversity research (NIWA & international vessels)
- fisheries trawl surveys
- scientific observers on commercial fishing vessels

Other NIWA Collections

Marine Invasive Taxonomic Service collection (MITS)

74,000 specimens of marine invertebrate, algae and fish from ports, harbours, vessel hulls

- MPI funded service providing the taxonomic identification of indigenous and non-indigenous marine species

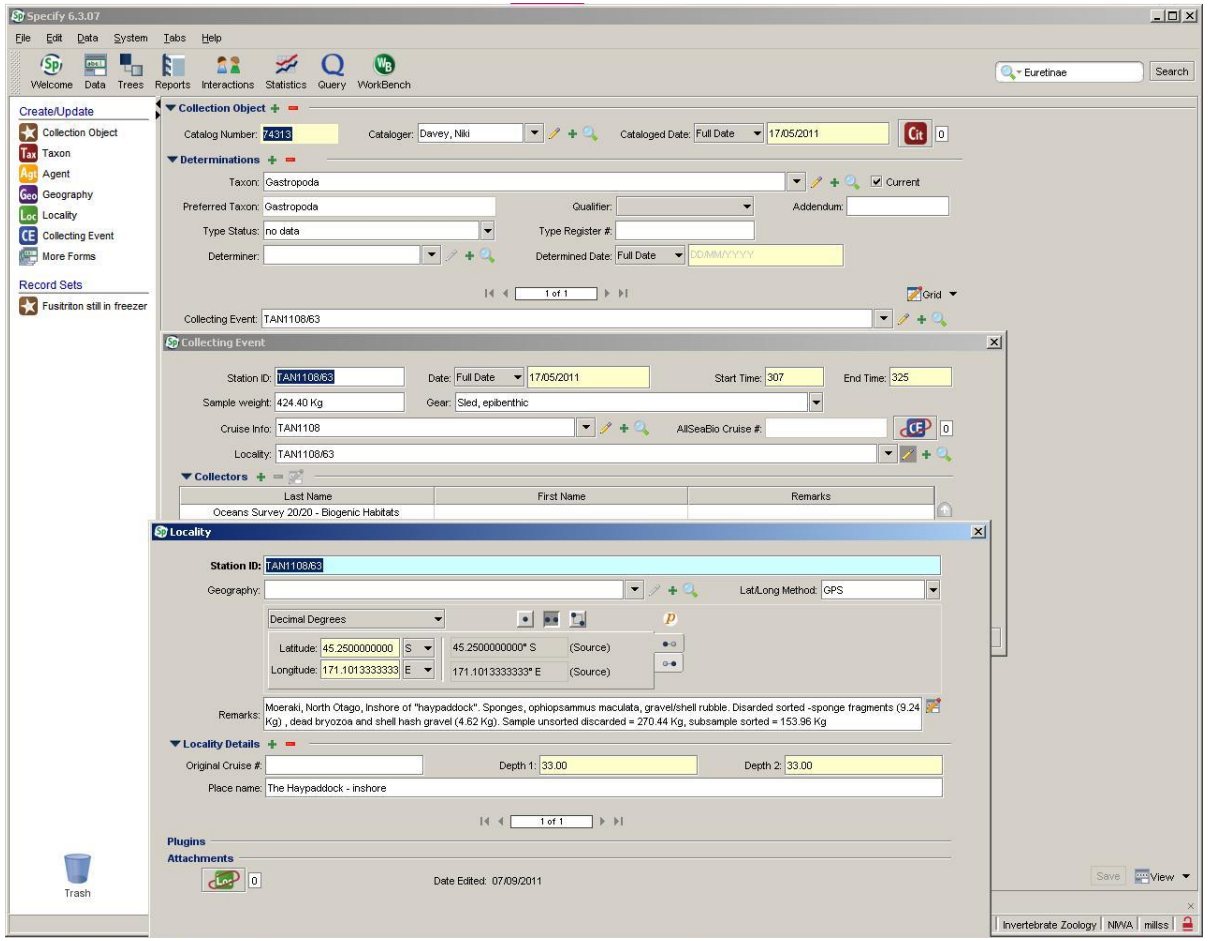
NIWA Algae collection

12,000 macroalgae specimens from NZ and Ross Sea housed in Te Papa herbarium and at NIWA

Specify database

NIWA collections managed using the free, Open Source Specify software package

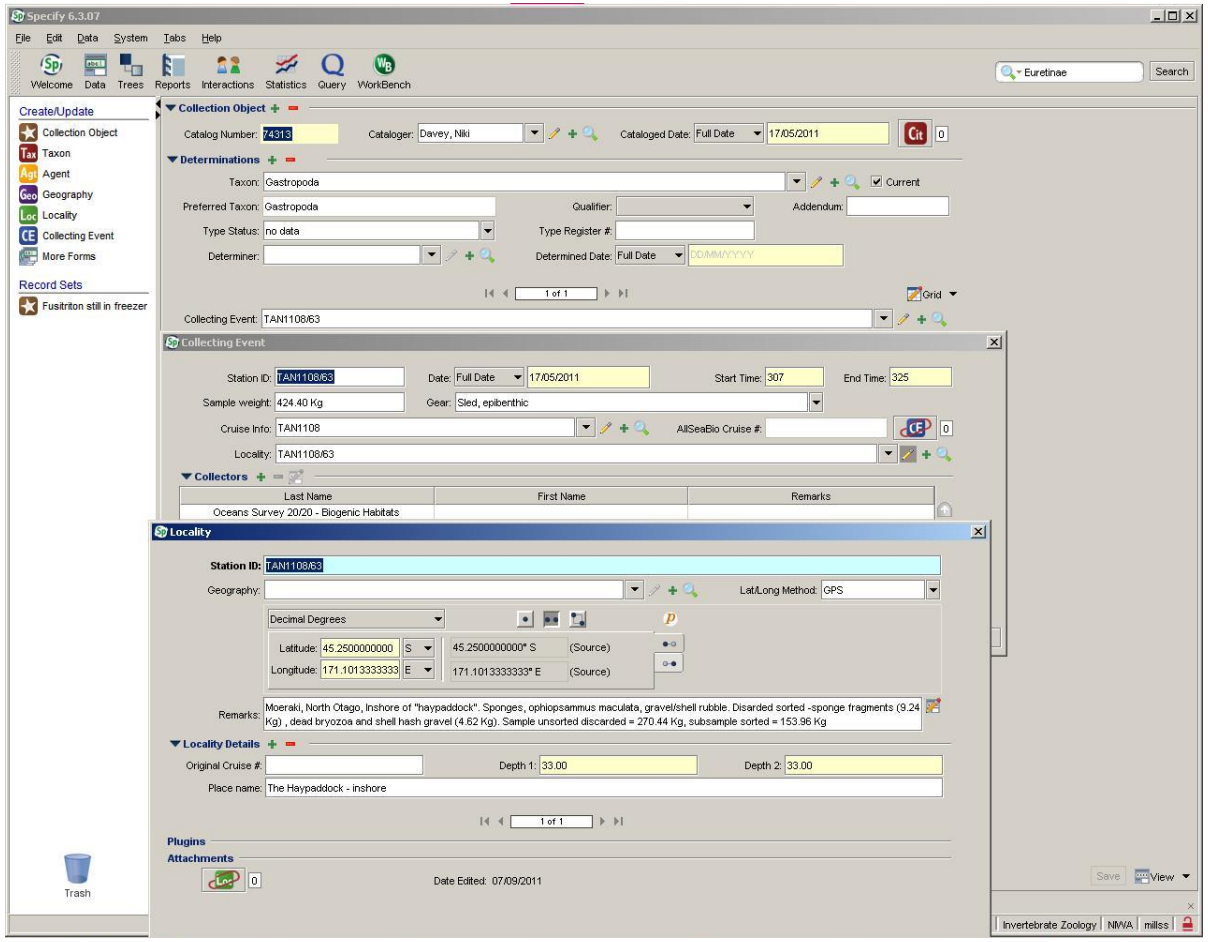
- originally from the University of Kansas
- Specify Software Consortium (NIWA is an Associate Member)
- Currently used in 38 countries, supporting over 450 collections



Specify database

A suite of applications, accessing data managed in an underlying MySQL database

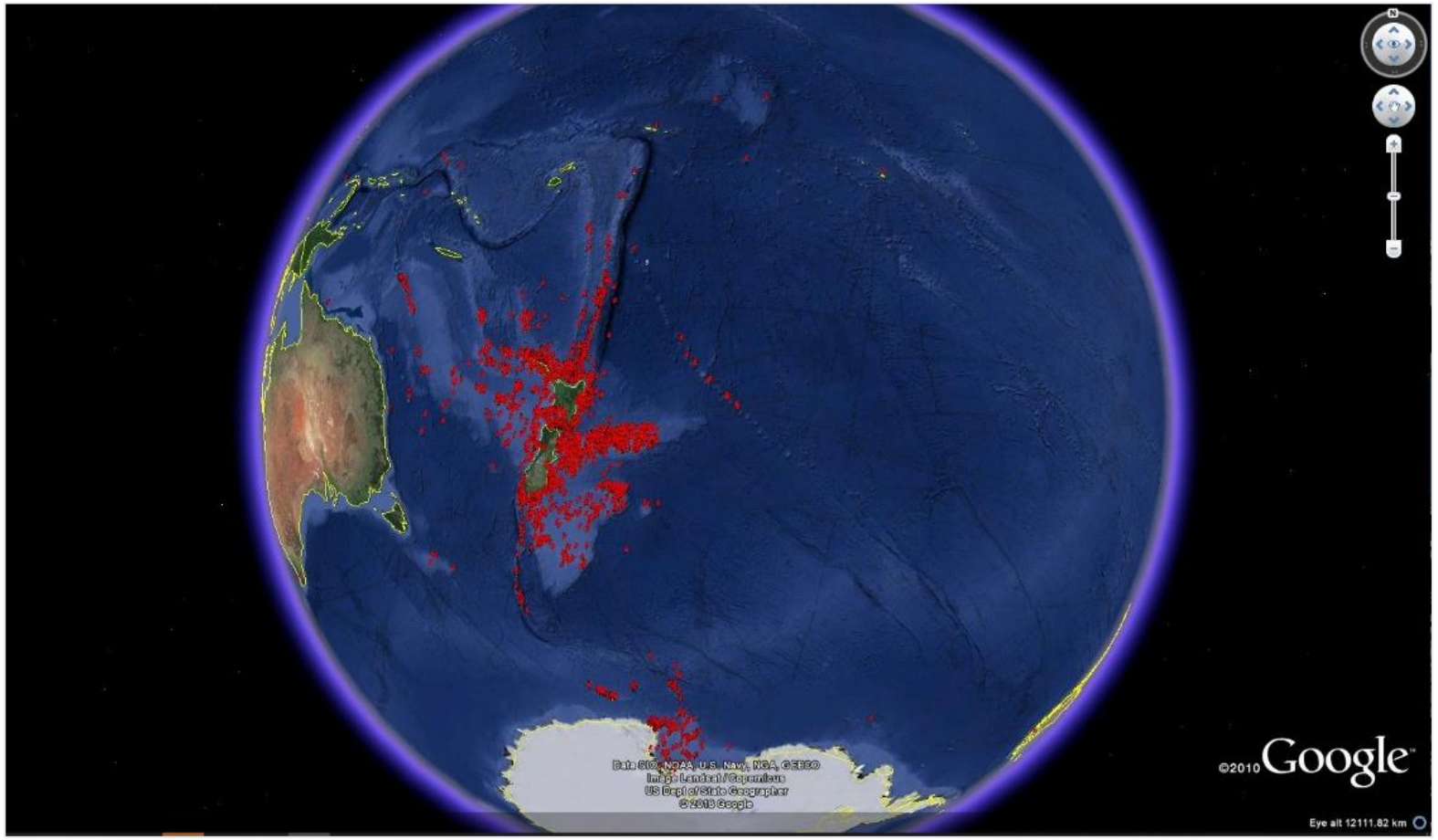
- MySQL supports spatial datatypes (points, lines, polygons)
- Specify does not use these, coordinates are stored as x, y, numbers – essentially aspatial data



Specify database

Viewing records on a map is useful for data QC, general visualisation, etc.

- Specify has native Google Earth plug-in mapping function
- Drag and drop record sets of data



Specify

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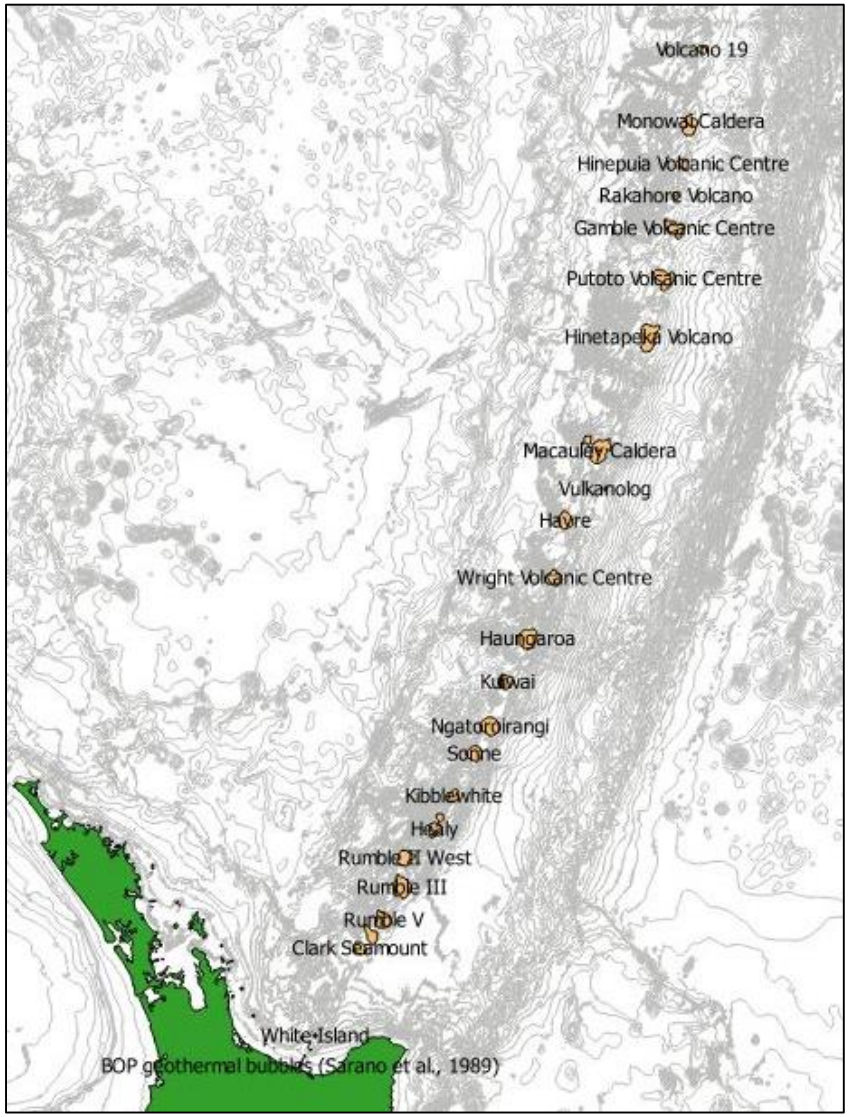
Exporting data

Requests for data can be from odd-shaped areas or multiple polygons

Previously we exported records to use with a separate GIS/mapping application – this has issues:

- different exports created at different times with different values
- exports get out of date – need replacing/updating
- Can only export 20,000 records at a time
- Not everything lives inside a single square box



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The ideal solution

A mapping tool that accesses the Specify database directly

Direct access to database records, providing:

- network access to the live database
- real time validation at time of entry
- publication quality distribution maps
- quickly view/compare taxon distributions
- integrated with other map layers for map compositions

Specify

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The solution!

QGIS with GDAL virtual data source:

- QGIS – powerful open source GIS/mapping software
- GDAL – Geospatial Data Abstraction Library spatial data access software

The GDAL virtual data source:

- main use is to present non-spatial data sources as spatial data
- uses a short XML file to describe the data source, presenting it as a spatial dataset to another program (QGIS in this case)

GDAL virtual data source

It describes (in our case):

- What sort of data source (MySQL database)
- Where to get the data (database server parameters)
- The SQL to run to retrieve the data
- The type of geometry data to provide (POINT)
- The columns in the data that contain the X & Y coordinates (Latitude & Longitude)
- How to create the geometry from the data
- The Coordinate Reference System for the coordinates

- When QGIS opens this “file”, it is used as a pointer or link to the external data, rather than as a local file containing the data. This makes it “live”

- When opened as a layer, users can interact with the data like any conventional data set

Vrt file

The layer name

The database details (many other data formats will work here, e.g. Excel file, Postgres DB etc.)

SpecifyQuery2_180.vrt - Notepad

File Edit Format View Help

```
<OGRVRTDataSource>
  <OGRVRTLayer name="collectionObjects_180">
  <SrcDataSource>MYSQL:Database name,user=username,password=password,host=specify6.niwa.co.nz,port=3306</SrcDataSource>
  <SrcSQL>select catalognumber, latitude1 AS y, case when longitude1 > 360 then -360+longitude1 else longitude1 end AS x,
localityName as StationID, startDate, latitude1, longitude1, latitude2, longitude2,
maxElevation, minElevation, taxon.fullname as TaxonName, prefT.fullname as PreferredName
from collectionobject
INNER JOIN collectingevent ON collectionobject.collectingeventid = collectingevent.collectingeventid
INNER JOIN locality on collectingevent.localityid = locality.localityid
LEFT JOIN determination on collectionobject.collectionobjectid = determination.collectionobjectid
LEFT JOIN taxon on determination.taxonid = taxon.taxonid
LEFT JOIN taxon prefT on determination.preferredtaxonid = prefT.taxonid
WHERE Latitude1 is not null and longitude1 is not null and determination.iscurrent = 1 and catalognumber is not null
ORDER BY Catalognumber</SrcSQL>
  <GeometryType>wkbPoint</GeometryType>
  <GeometryField encoding="PointFromColumns" x="x" y="y"/>
  <LayerSRS>EPSG:4326</LayerSRS>
</OGRVRTLayer>
</OGRVRTDataSource>
```

The columns to retrieve from the database

Turning the x, y data into a spatial point

Spatial reference system to be used for the layer

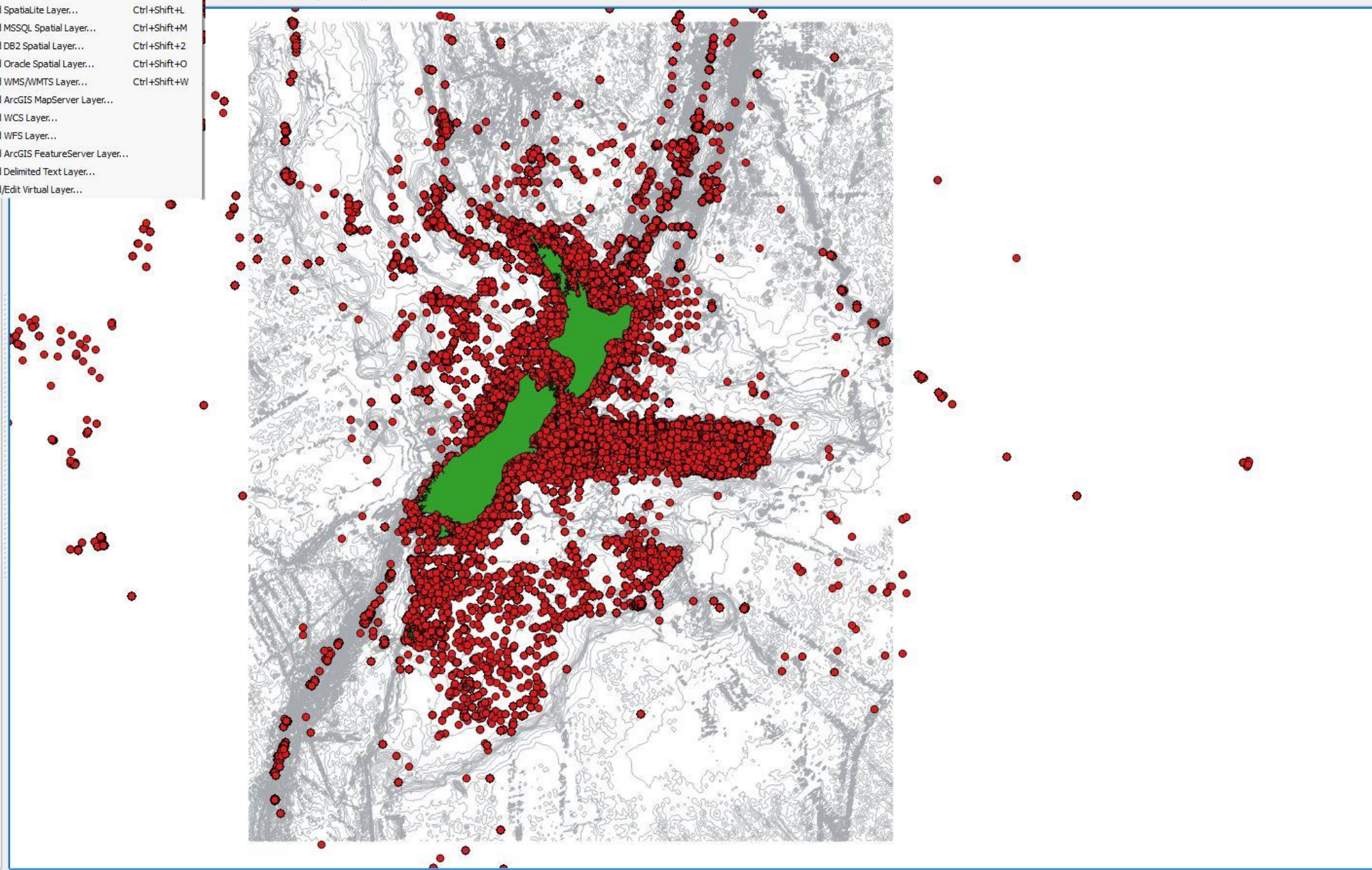
QGIS 2.18.9 - All_Specify_on_NZbathy_simple

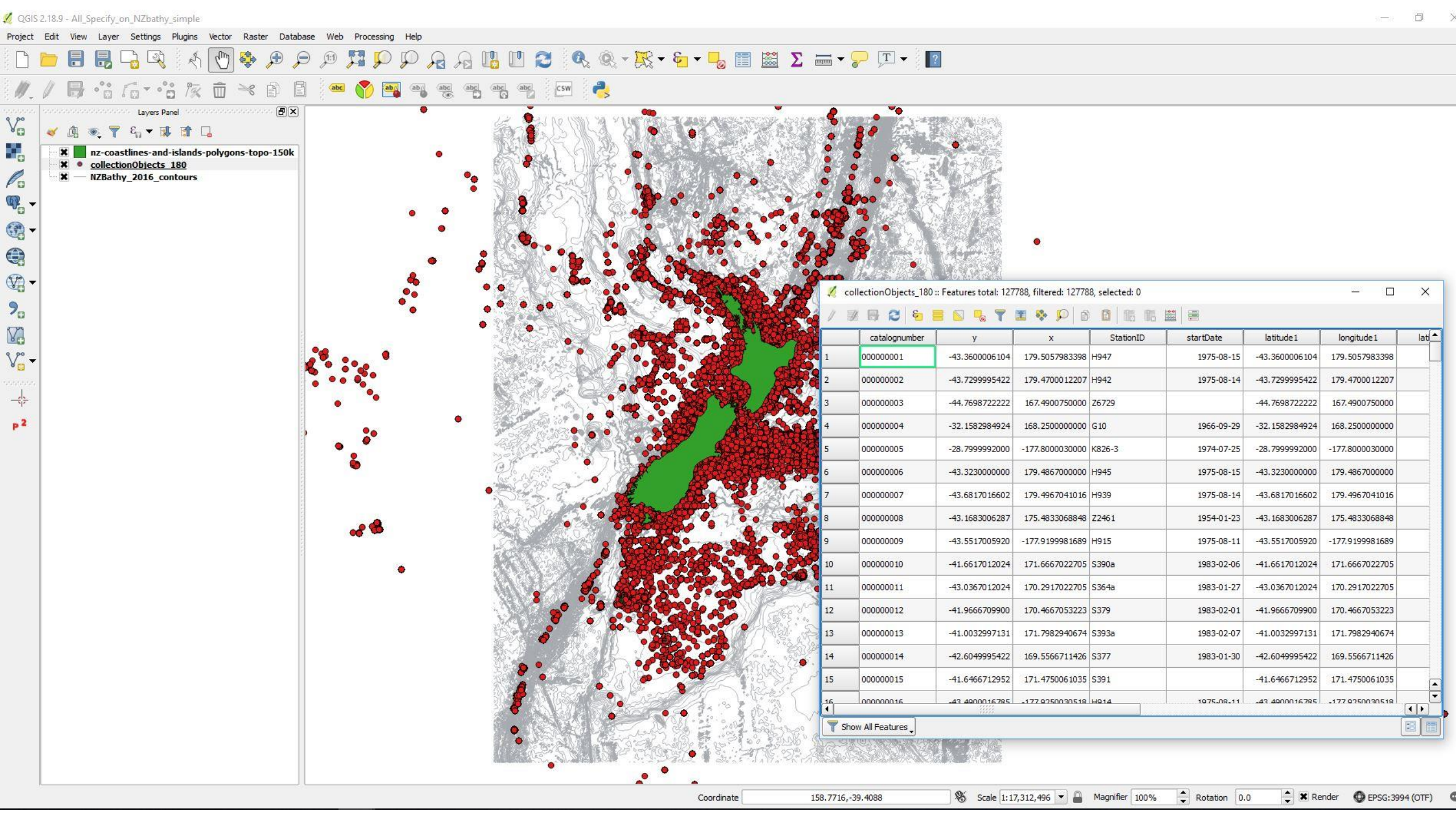
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help

- Create Layer
- Add Layer
- Embed Layers and Groups...
- Add from Layer Definition File...
- Copy style
- Paste style
- Open Attribute Table F6
- Toggle Editing
- Save Layer Edits
- Current Edits
- Save As...
- Save As Layer Definition File...
- Remove Layer/Group Ctrl+D
- Duplicate Layer(s)
- Set Scale Visibility of Layer(s)
- Set CRS of Layer(s) Ctrl+Shift+C
- Set Project CRS from Layer
- Properties...
- Filter... Ctrl+F
- Labeling
- Add to Overview
- Add All to Overview
- Remove All from Overview
- Show All Layers Ctrl+Shift+U
- Hide All Layers Ctrl+Shift+H
- Show Selected Layers
- Hide Selected Layers

Add Layer submenu:

- Add Vector Layer... Ctrl+Shift+V
- Add Raster Layer... Ctrl+Shift+R
- Add PostGIS Layers... Ctrl+Shift+D
- Add SpatiaLite Layer... Ctrl+Shift+L
- Add MSSQL Spatial Layer... Ctrl+Shift+M
- Add DB2 Spatial Layer... Ctrl+Shift+2
- Add Oracle Spatial Layer... Ctrl+Shift+O
- Add WMS/WMTS Layer... Ctrl+Shift+W
- Add ArcGIS MapServer Layer...
- Add WCS Layer...
- Add WFS Layer...
- Add ArcGIS FeatureServer Layer...
- Add Delimited Text Layer...
- Add/Edit Virtual Layer...





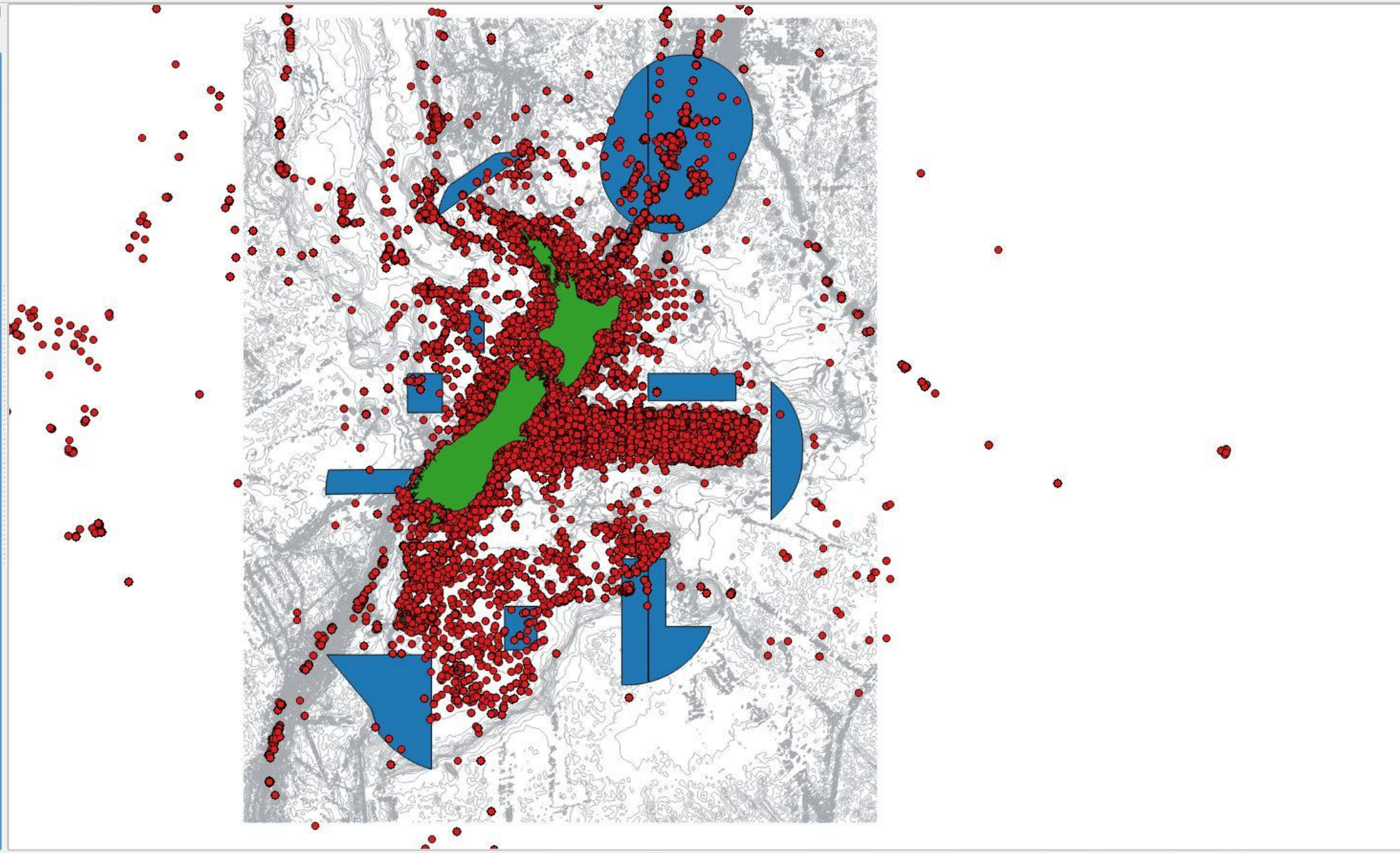
	catalognumber	y	x	StationID	startDate	latitude1	longitude1	lati
1	000000001	-43.3600006104	179.5057983398	H947	1975-08-15	-43.3600006104	179.5057983398	
2	000000002	-43.7299995422	179.4700012207	H942	1975-08-14	-43.7299995422	179.4700012207	
3	000000003	-44.7698722222	167.4900750000	Z6729		-44.7698722222	167.4900750000	
4	000000004	-32.1582984924	168.2500000000	G10	1966-09-29	-32.1582984924	168.2500000000	
5	000000005	-28.7999992000	-177.8000030000	K826-3	1974-07-25	-28.7999992000	-177.8000030000	
6	000000006	-43.3230000000	179.4867000000	H945	1975-08-15	-43.3230000000	179.4867000000	
7	000000007	-43.6817016602	179.4967041016	H939	1975-08-14	-43.6817016602	179.4967041016	
8	000000008	-43.1683006287	175.4833068848	Z2461	1954-01-23	-43.1683006287	175.4833068848	
9	000000009	-43.5517005920	-177.9199981689	H915	1975-08-11	-43.5517005920	-177.9199981689	
10	000000010	-41.6617012024	171.6667022705	S390a	1983-02-06	-41.6617012024	171.6667022705	
11	000000011	-43.0367012024	170.2917022705	S364a	1983-01-27	-43.0367012024	170.2917022705	
12	000000012	-41.9666709900	170.4667053223	S379	1983-02-01	-41.9666709900	170.4667053223	
13	000000013	-41.0032997131	171.7982940674	S393a	1983-02-07	-41.0032997131	171.7982940674	
14	000000014	-42.6049995422	169.5566711426	S377	1983-01-30	-42.6049995422	169.5566711426	
15	000000015	-41.6466712952	171.4750061035	S391		-41.6466712952	171.4750061035	

QGIS 2.18.9 - All_Specify_on_NZbathy_simple

Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help

Layers Panel

- nz-coastlines-and-islands-polygons-topo-150k
- collectionObjects_180
- BPA
- NZBathy_2016_contours



Toggles the editing state of the current layer

Coordinate 153.3273,-33.4303 Scale 1:17,312,496 Magnifier 100% Rotation 0.0 Render EPSG:3994 (O

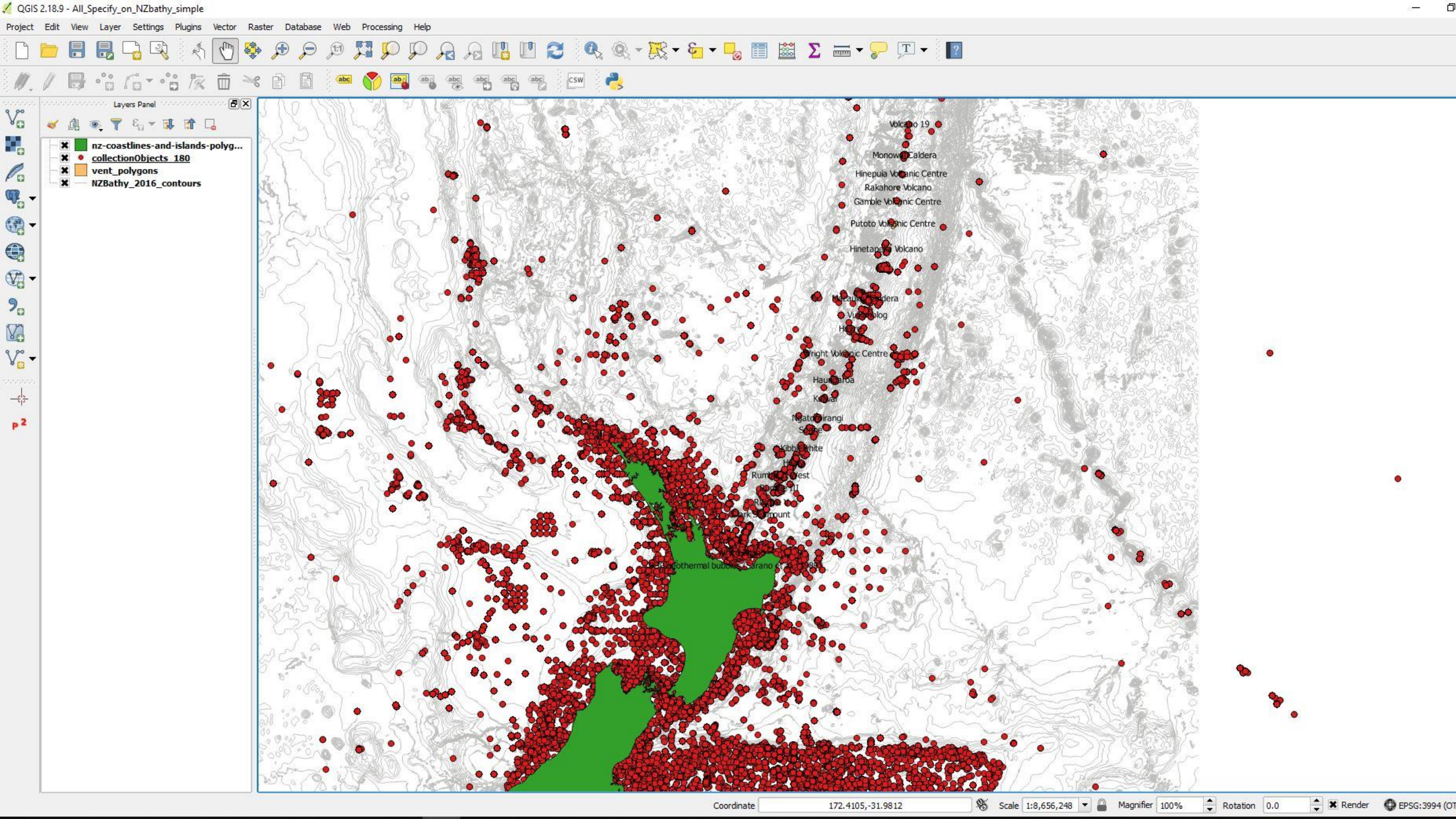
QGIS 2.18.9 - All_Specify_on_NZbathy_simple

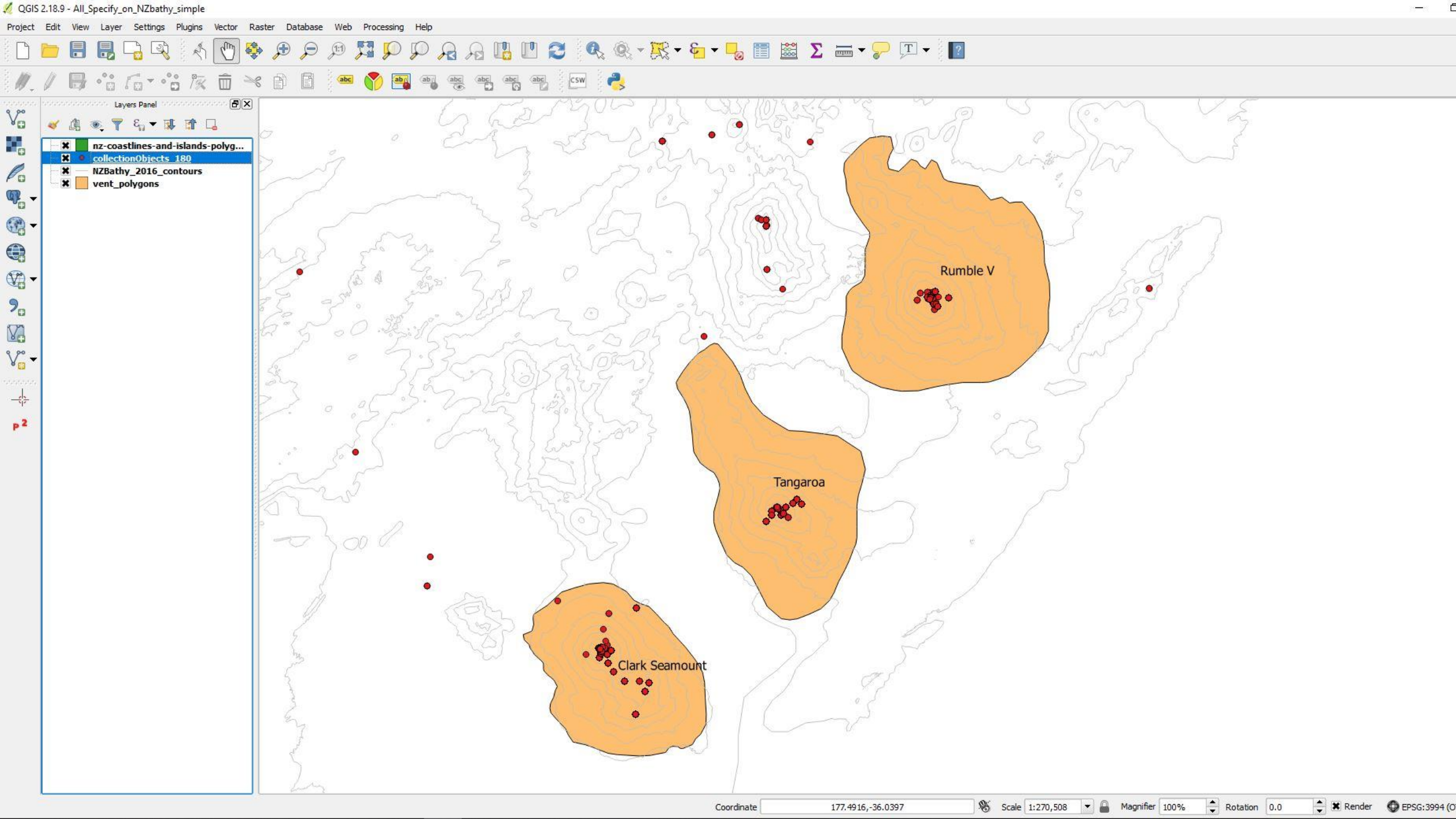
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help

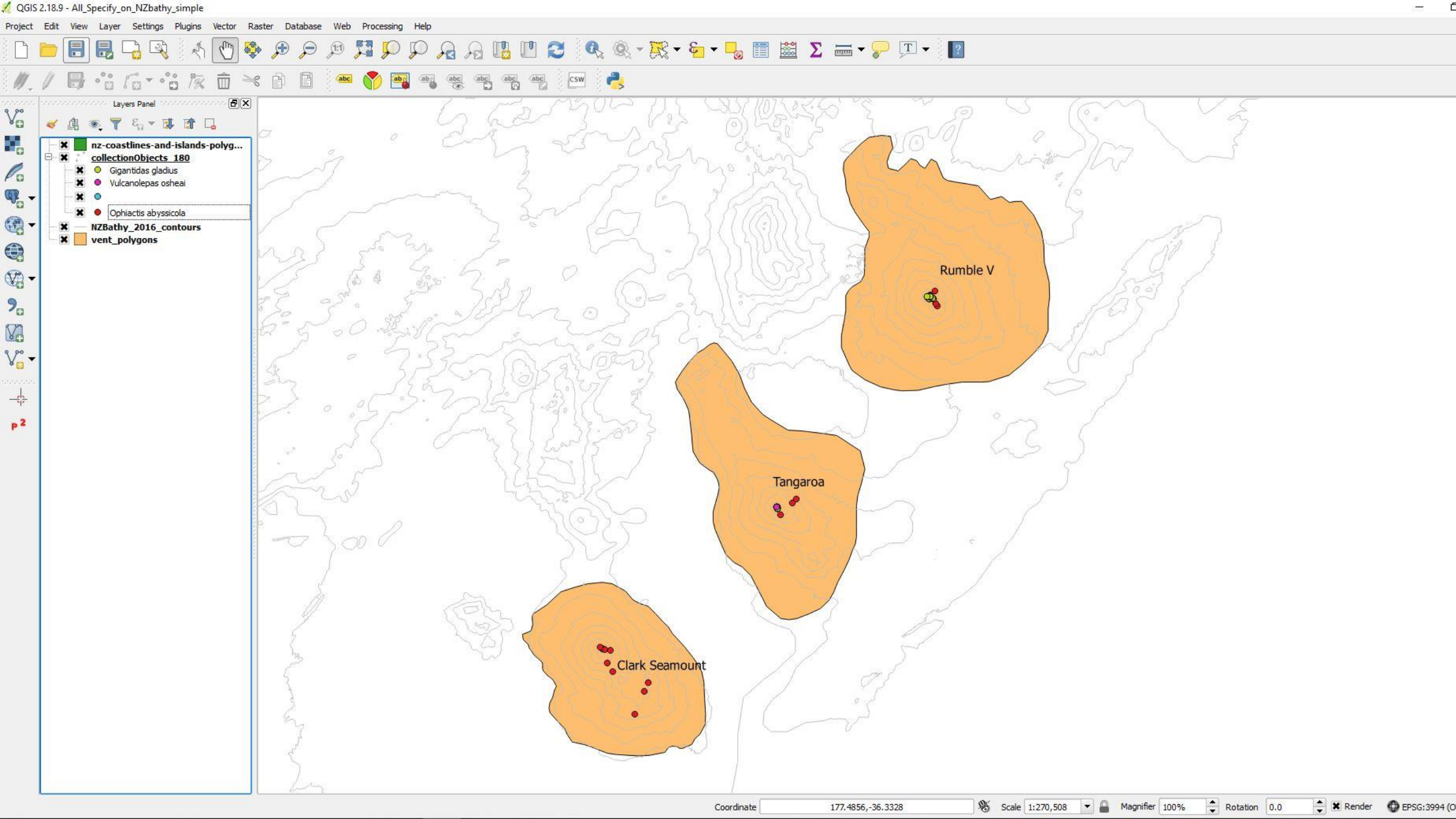
Layers Panel

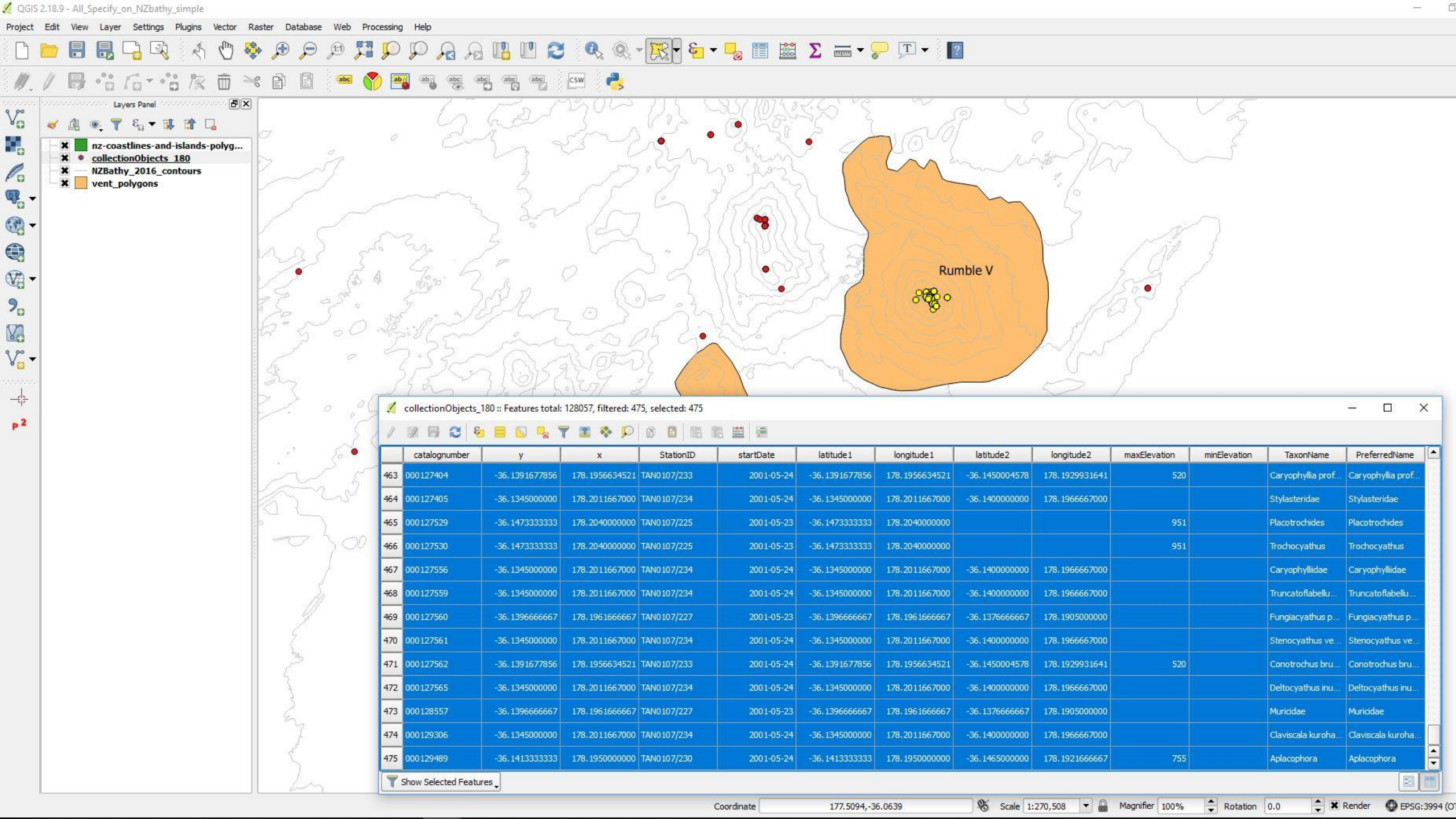
- nz-coastlines-and-islands-polyg...
- collectionObjects_180
- vent_polygons
- NZBathy_2016_contours

Coordinate 162.2296,-43.2846 Scale 1:8,656,248 Magnifier 100% Rotation 0.0 Render EPSG:3994 (O

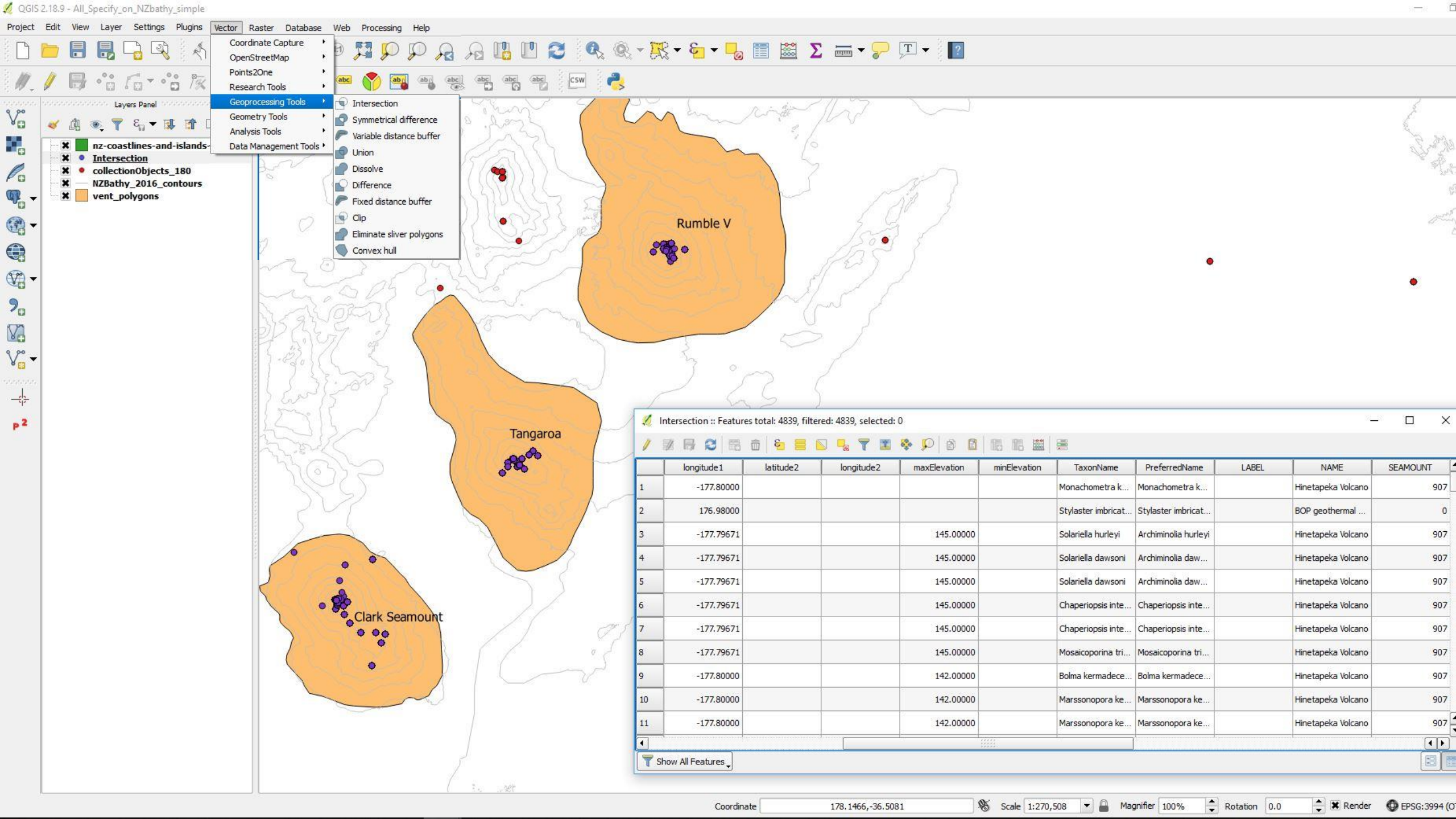

QGIS 2.18.9 - All_Specify_on_NZbathy_simple
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help
Layers Panel
nz-coastlines-and-islands-polyg...
collectionObjects_180
vent_polygons
NZBathy_2016_contours
Volcano 19
Monowai Caldera
Hinepuia Volcanic Centre
Rakahore Volcano
Gamble Volcanic Centre
Putoto Volcanic Centre
Hinetapora Volcano
Wright Volcanic Centre
Haumaroa
Kawhai
Ngatoro-i-rangi
Kibbler White
Coordinate 172.4105,-31.9812
Scale 1:8,656,248
Magnifier 100%
Rotation 0.0
Render
EPSG:3994 (OT


QGIS 2.18.9 - All_Specify_on_NZbathy_simple
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help
Layers Panel
nz-coastlines-and-islands-polyg...
collectionObjects_180
NZBathy_2016_contours
vent_polygons
Rumble V
Tangaroa
Clark Seamount
Coordinate 177.4916,-36.0397
Scale 1:270,508
Magnifier 100%
Rotation 0.0
Render
EPSG:3994

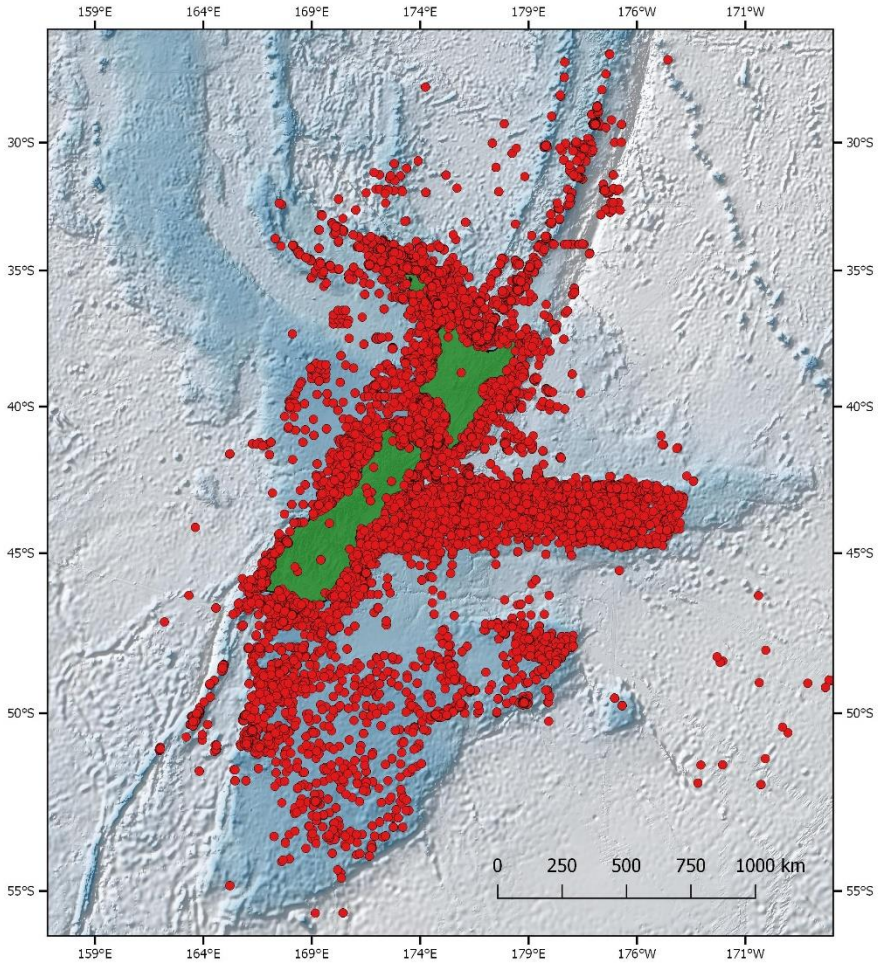

QGIS 2.18.9 - All_Specify_on_NZbathy_simple
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help
Layers Panel
nz-coastlines-and-islands-polyg...
collectionObjects_180
Gigantidas gladius
Vulcanolepas osheai
Ophiactis abyssicola
NZBathy_2016_contours
vent_polygons
Rumble V
Tangaroa
Clark Seamount
Coordinate 177.4856,-36.3328
Scale 1:270,508
Magnifier 100%
Rotation 0.0
Render
EPSG:3994

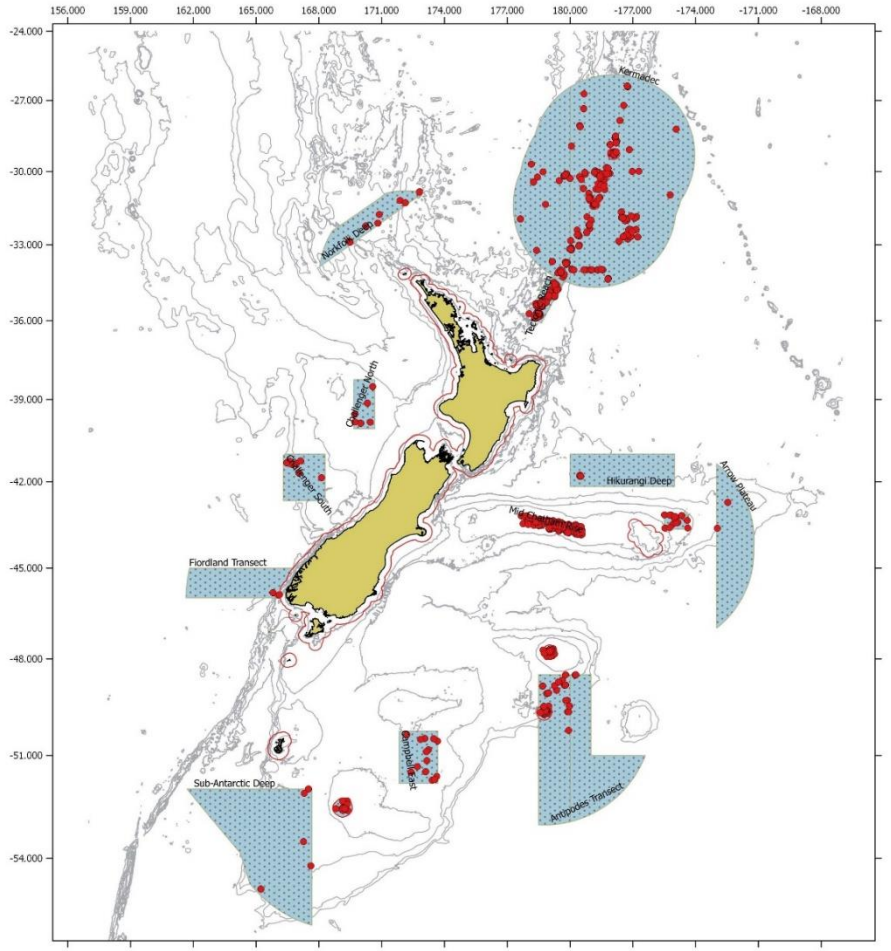


	catalognumber	y	x	StationID	startDate	latitude1	longitude1	latitude2	longitude2	maxElevation	minElevation	TaxonName	PreferredName
463	000127404	-36.1391677856	178.1956634521	TAN0107/233	2001-05-24	-36.1391677856	178.1956634521	-36.1450004578	178.1929931641	520		Caryophyllia prof...	Caryophyllia prof...
464	000127405	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Stylasteridae	Stylasteridae
465	000127529	-36.1473333333	178.2040000000	TAN0107/225	2001-05-23	-36.1473333333	178.2040000000			951		Placotrochides	Placotrochides
466	000127530	-36.1473333333	178.2040000000	TAN0107/225	2001-05-23	-36.1473333333	178.2040000000			951		Trochocyathus	Trochocyathus
467	000127556	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Caryophylliidae	Caryophylliidae
468	000127559	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Truncatoflabellu...	Truncatoflabellu...
469	000127560	-36.1396666667	178.1961666667	TAN0107/227	2001-05-23	-36.1396666667	178.1961666667	-36.1376666667	178.1905000000			Fungiacyathus p...	Fungiacyathus p...
470	000127561	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Stenocyathus ve...	Stenocyathus ve...
471	000127562	-36.1391677856	178.1956634521	TAN0107/233	2001-05-24	-36.1391677856	178.1956634521	-36.1450004578	178.1929931641	520		Conotrochus bru...	Conotrochus bru...
472	000127565	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Deltocyathus inu...	Deltocyathus inu...
473	000128557	-36.1396666667	178.1961666667	TAN0107/227	2001-05-23	-36.1396666667	178.1961666667	-36.1376666667	178.1905000000			Muricidae	Muricidae
474	000129306	-36.1345000000	178.2011667000	TAN0107/234	2001-05-24	-36.1345000000	178.2011667000	-36.1400000000	178.1966667000			Claviscala kuroha...	Claviscala kuroha...
475	000129489	-36.1413333333	178.1950000000	TAN0107/230	2001-05-24	-36.1413333333	178.1950000000	-36.1465000000	178.1921666667	755		Aplacophora	Aplacophora


QGIS 2.18.9 - All_Specify_on_NZbathy_simple
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help
Coordinate Capture
OpenStreetMap
Points2One
Research Tools
Geoprocessing Tools
Geometry Tools
Analysis Tools
Data Management Tools
Intersection
Symmetrical difference
Variable distance buffer
Union
Dissolve
Difference
Fixed distance buffer
Clip
Eliminate sliver polygons
Convex hull
Layers Panel
nz-coastlines-and-islands-
Intersection
collectionObjects_180
NZBathy_2016_contours
vent_polygons
Rumble V
Tangaroa
Clark Seamount
Intersection :: Features total: 4839, filtered: 4839, selected: 0
longitude1 latitude2 longitude2 maxElevation minElevation TaxonName PreferredName LABEL NAME SEAMOUNT
1 -177.80000 Monachometra k... Monachometra k... Hinetapeka Volcano 907
2 176.98000 Stylaster imbricat... Stylaster imbricat... BOP geothermal ... 0
3 -177.79671 145.00000 Solariella hurleyi Archiminolia hurleyi Hinetapeka Volcano 907
4 -177.79671 145.00000 Solariella dawsoni Archiminolia daw... Hinetapeka Volcano 907
5 -177.79671 145.00000 Solariella dawsoni Archiminolia daw... Hinetapeka Volcano 907
6 -177.79671 145.00000 Chaperiopsis inte... Chaperiopsis inte... Hinetapeka Volcano 907
7 -177.79671 145.00000 Chaperiopsis inte... Chaperiopsis inte... Hinetapeka Volcano 907
8 -177.79671 145.00000 Mosaicoporina tri... Mosaicoporina tri... Hinetapeka Volcano 907
9 -177.80000 142.00000 Bolma kermadece... Bolma kermadece... Hinetapeka Volcano 907
10 -177.80000 142.00000 Marssonopora ke... Marssonopora ke... Hinetapeka Volcano 907
11 -177.80000 142.00000 Marssonopora ke... Marssonopora ke... Hinetapeka Volcano 907
Show All Features
Coordinate 178.1466,-36.5081
Scale 1:270,508
Magnifier 100%
Rotation 0.0
Render
EPSG:3994

Examples of outputs





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QGIS 2.18.9 - Antarctic_view_AllSpecify

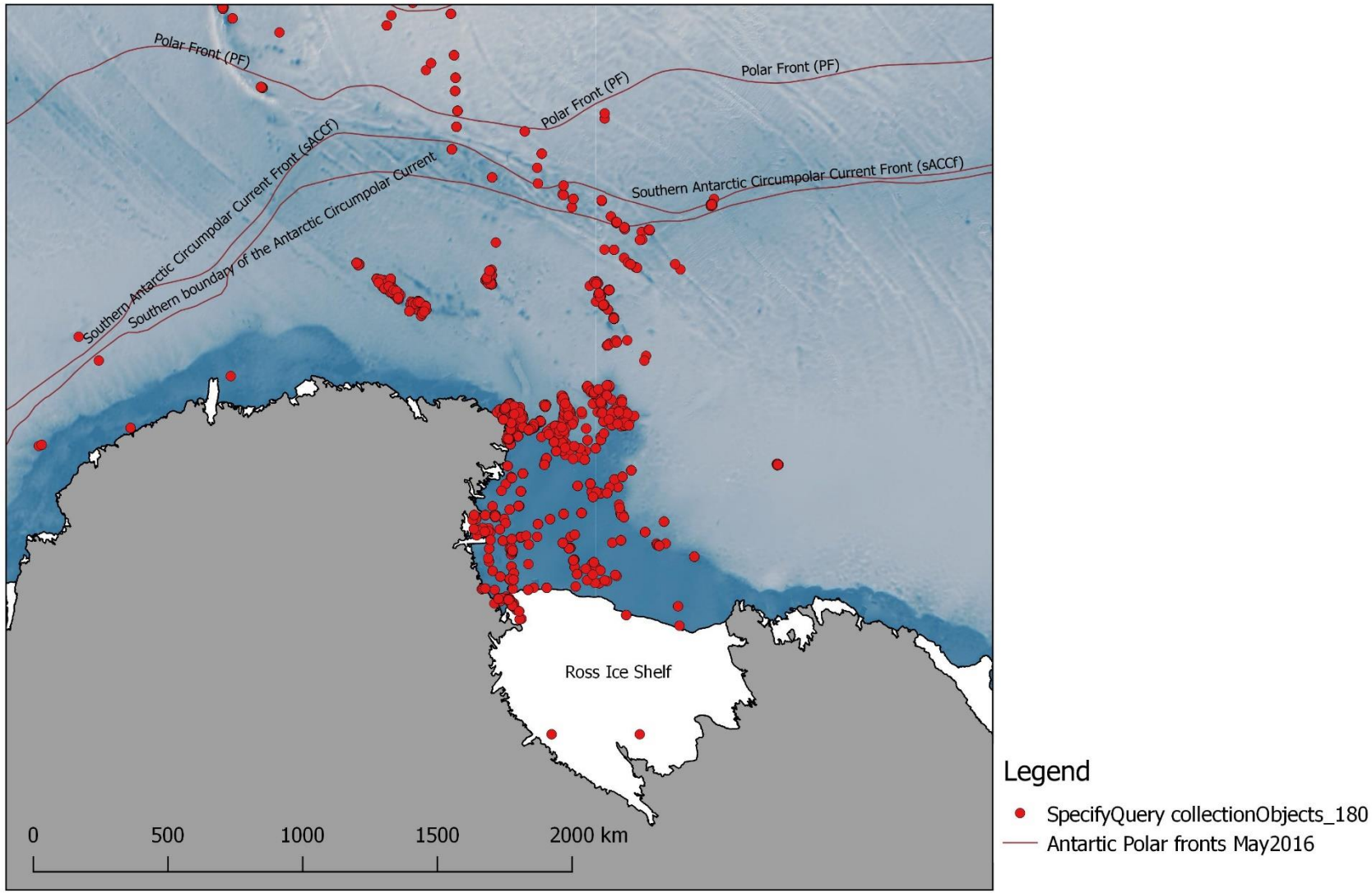
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help

Layers Panel

- Coastlines_excluding_Antarctica...
- SpecifyQuery2_180 collectionObj...
- AntarcticIslands_May2016
- AntarcticContinent_May2016
- Antarctic_iceshelves_fill_May2016
- antartic_Polar_front_May2016
- NZ_Antarctic_Map_Layers
- CCAMLR_Bathy_geb08south_clip...
  - -5885
  - -4714
  - -3543
  - -2372
  - -1201
  - -30.45
  - 1140
  - 2221
  - 3122
- hill08south_clip40_102020
  - 174
  - 255

Toggles the editing state of the current layer

Coordinate -13126557,-17178961 Scale :139,506,274 Magnifier 100% Rotation 0.0 Render USER:100002 (O


Polar Front (PF)
Polar Front (PF)
Polar Front (PF)
Southern Antarctic Circumpolar Current Front (sACCf)
Southern boundary of the Antarctic Circumpolar Current
Southern Antarctic Circumpolar Current Front (sACCf)
Ross Ice Shelf
0
500
1000
1500
2000 km
Legend
SpecifyQuery collectionObjects_180
Antartic Polar fronts May2016

The ideal solution – found and implemented

Direct access to database records, providing:

- network access to the live database
- real time validation at time of entry
- quickly view/compare taxon distributions

More control over styles and symbols than Google Earth

Easily include a wide range of other datasets as map layers (points, lines and polygons)

Ability to change and control projections to suit (i.e., polar views)

Publication quality maps

Ideally using free, Open Source tools

This could work for your data too!

QGIS Specify NIWA Taihoro Nukurangi

Thank you

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Thank you to the QGIS community and Specify Software Team.

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