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ECOTOX Knowledgebase History and Demonstration of New Tools and Data Visualization

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CSRA contract staff
SEE staff

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What is the ECOTOX Knowledgebase?

- Publicly available, curated database providing chemical environmental toxicity data on aquatic life, terrestrial plants and wildlife
  - Curated data > 47,000 publications
  - From comprehensive search and review of open literature
  - Updated quarterly, with an average of 16,000 new records added each quarter
- 30+ year history:
  Originated in the early 1980s, maintained by ORD/NHERRL/MED

Number of Species, Chemicals and Results added each year

Year	Unique Species	Unique Chemicals	Result Records
2007	1974	900	43441
2008	2522	1013	61028
2009	2762	1170	58412
2010	2023	1811	67787
2011	1359	1764	46923
2012	1674	1353	42038
2013	2215	1347	48913
2014	2037	1456	53083
2015	1915	1307	60463
2016	2216	1007	44401
2017	1883	1449	37919

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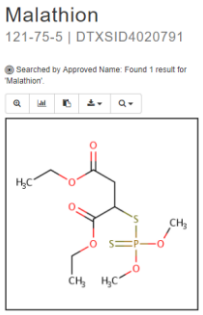
What is the ECOTOX Knowledgebase?

- As of March 2018:
  - 11,506 chemicals
  - 12,583 species
  - 47,661 references
  - 905,267 test results



The impact of the Cyanamid Canada Co. discharges to benthic invertebrates in the Welland River in Niagara Falls, Canada

MIKE DICKMAN and GRAZYNA RYGIEL

- Available on the Internet (http://www.epa.gov/ecotox)
  - 150,000-200,000 data downloads each month (6,000-10,000 unique servers)
- Interactive queries by chemical, species, endpoint
  - Default and customizable output via html, delimited file output, MS Excel, or ASCII download files
- Web application maintained on EPA servers; Java Script front end; Oracle back end

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Why was ECOTOX developed?

- An identified need for authoritative source of toxicological data for regulators and researchers to document literature searches and acquisition of data used in risk assessment, risk management and research.
- Risk assessors needed a cost-effective means of locating high quality ecological effects data to use in prioritizing chemical cleanup at hazardous waste sites and assisting in the assessment of potential hazards of pollutants through the CAA, FIFRA, CWA and TSCA.
- Need for documented systematic and transparent literature searching, acquisition and curation.
- Duplicative efforts for data gathering wastes resources across state and federal agencies.

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ECOTOX Pipeline: Systematic Review and Data Curation

Chemical verification and ID relevant search terms

Literature searches

Identify potentially applicable studies

Acquire potentially applicable studies

Review literature and apply ECOTOX applicability criteria

Extract data and code into ECOTOX

Targeted Chemical Searches and Monthly Literature Searches

- Targeted Chemical Searches (Manual)
  - 35-50 chemicals requested
  - Dictated by EPA ORD and Program Office needs
  - From relevant papers, all chemicals coded into ECOTOX
  - In 2017, over 90,000 references skimmed
- Electronic Literature Searches (Monthly)
  - 26 journals queried
  - Determined based on historical applicability rates
  - In 2017, approximately 18,540 references skimmed; 2,160 applicable (1-76% per journal)
- Initial Systematic Review: Inclusion/Exclusion Criteria
  - ~15-30 % of literature identified ends up being curated

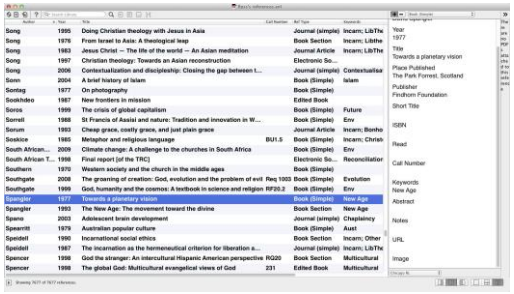
Literature Searches

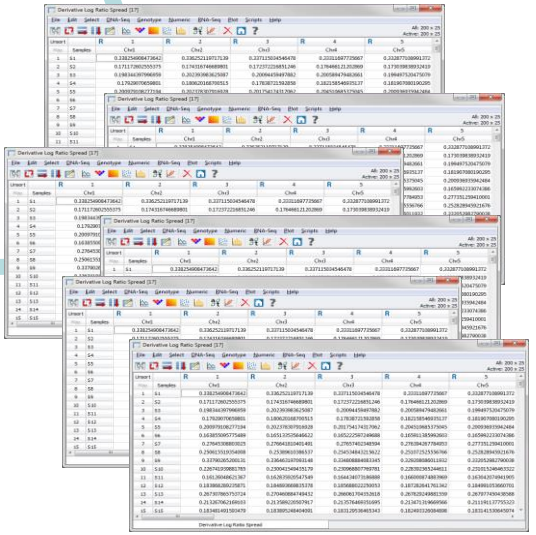
Literature searches → Identify potentially applicable studies → Acquire potentially applicable studies

Chemical specific searches (using terms from chemical verification step)
OR
Monthly electronic searches of 26 relevant journals

Search Engines

1. Science Direct
2. AGRICOLA
3. TOXNET
4. ProQuest ESPM
5. ProQuest Dissertation Abstracts
6. Web of Science/ Current Contents





In 2017:
References/ Abstracts
~44,000

Collate data and remove duplicates

Applicability Criteria

Review literature and apply ECOTOX applicability criteria

- Paper must meet these criteria
  - Single chemical exposure
  - Ecologically-relevant species
  - Must be able to verify CAS registry numbers
  - Must be able to verify taxonomic information for test species
  - Exposure to live organism, viable tissue or cells
  - Report concurrent exposure concentration, dose or application rate
  - Report duration of exposure
  - Must have a control treatment
  - Primary source of the data
  - Study must be a full article in English

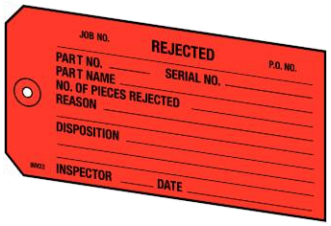
Applicability Criteria

Review literature and apply ECOTOX applicability criteria

- The following studies are excluded
  - Air pollution studies related to CO2 and ozone
  - Studies on humans, monkeys, bacteria, viruses and yeast
  - Review and summary articles
  - Terrestrial studies with an inhalation route of exposure
  - Non-English publications and abstracts

Applicability Criteria

- All Excluded and Non-Applicable studies are Tagged with the reason for rejection
  - Abstract – Published as an abstract
  - Bacteria – only test organism is a Bacteria
  - CAS # Unavailable – could not verify/locate chemical CAS Registry number
  - Chemical method – description of chemical analysis procedures
  - Effluent – tests conducted with sewage or polluted runoff - mixtures
  - Fate – only report chemical distribution in media
  - Human Health – data on human subjects of surrogate animal subjects for human health risk assessment
  - In vitro – only in vitro study designs
  - Incident – reports death of animal by poison, but does not provide concentration/duration of exposure
  - Inhale – study is a terrestrial mammal paper with an inhalation route of exposure
  - Method – paper only reports methods for conducting a toxicity test or other aspect of an experiment
  - Mixture – paper reports results from mixture of chemicals; no single chemical exposure results
  - Modeling – results of the development of a model; no primary data available
  - Monkey – only test organism is a monkey
  - No Conc – the authors report a response in an organism but do not provide conc/dose/app rate
  - No Duration – duration of exposure is not presented
  - No Effect – paper does not report observed responses adverse of otherwise
  - No Species – used for dead organisms
  - No Toxicant (ozone, CO2)
  - Non-English
  - Nutrient – in situ chemical tested as nutrient
  - PUBL AS – duplicate data published elsewhere
  - QSAR – modeled data
  - Retracted – paper retracted by Journal
  - Review – primary data published elsewhere
  - Sediment – only sediment concentration presented
  - Survey – chemical measured in organism, but lack quantification of exposure (dose/duration)
  - Virus – only test organism a virus
  - Yeast – only test organism is a yeast



Literature Review and Data Extraction

Fields Coded into the ECOTOX Knowledgebase

Chemical

- CAS Registry No.
- Collective Indices Name
- Synonyms
- Chemical Grade
- Chemical Formulation
- Chemical Purity
- Solvent / Vehicle Used
- Chemical Radiolabel
- Other Comments on Chemical Noted by Author

Species

- Common Name
- Scientific Name
- Taxonomic Hierarchy
- Organism Age
- Organism Sex
- Organism Source
- Initial Weight and Length
- Initial Life Stage
- Other Comments on Organism Noted by Author

Methods

- Route of Exposure
- Exposure Media
- Study / Exposure Duration
- Application Frequency
- Study Location
- Water / Soil Chemistry
- Control Type
- Chemical Concentration Information
- Comments on Experimental Design
- Chemical Analysis Info
- Application Frequency / Season / Date / Rate
- Habitat Description for Field Studies
- Longitude / Latitude for Field Studies

Results

- Major Effect Category (e.g., Enzyme
- Observed Effect Measurements (e.g., P450 Enzyme Response
- Calculated Endpoints (e.g., EC50)
- Dose Response (Terrestrial Studies only)
- % Effect Response
- Statistical Info

Source of Data

- Author
- Publication Year
- Reference Number
- Full Citation Presented for Each Test Result
- Independently Compiled Data Set
- Database Update

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Why update the ECOTOX Knowledgebase?

- Immense amount of single chemical toxicity data
  - Queries can be cumbersome
  - Output is overwhelming and time consuming to translate/interpret
  - Not easy to explore the data
- Demand for easy, efficient access to essential toxicology literature so that end users can rapidly identify critical data
- Need for interoperability across tools and databases
  - Provide end users easy access to wealth of information
  - Increases efficiency
- New applications for data in ECOTOX Knowledgebase
  - Development of Adverse Outcome Pathways

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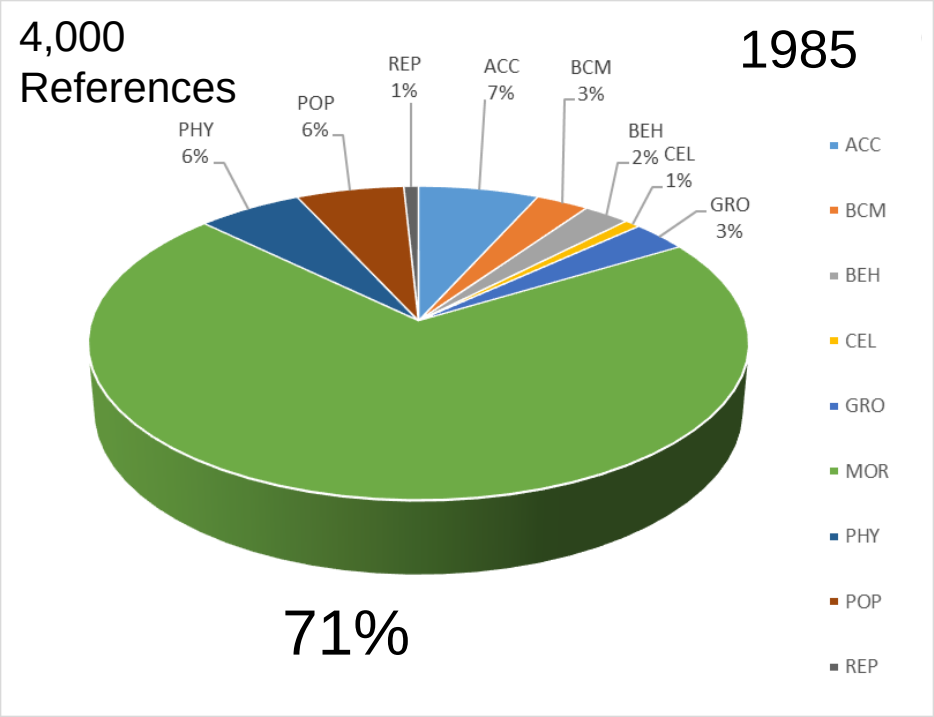
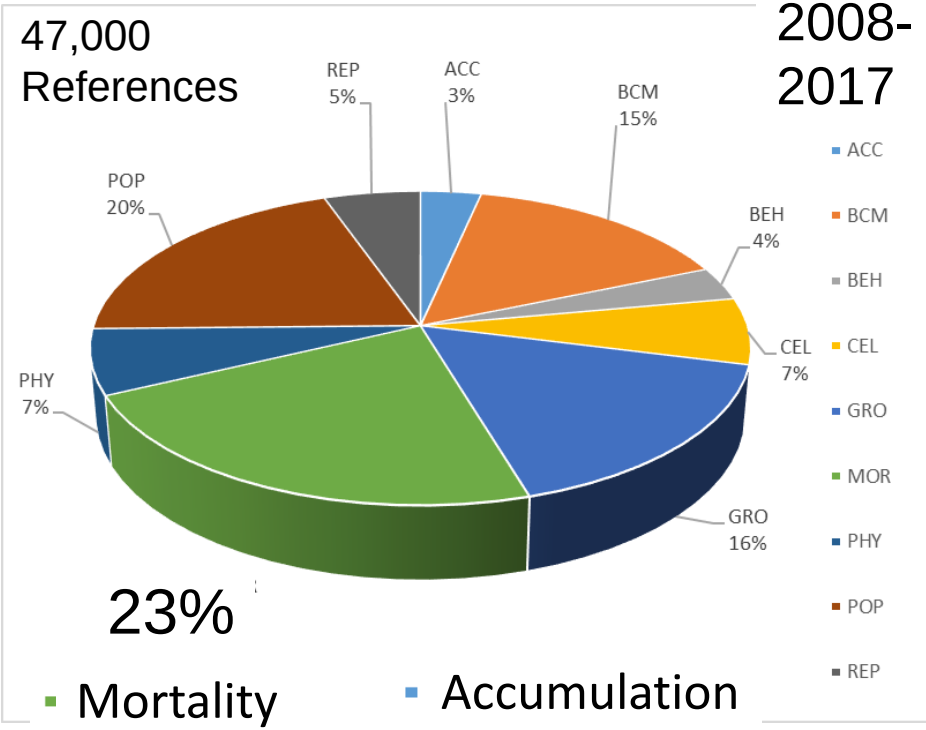
Next Generation ECOTOX Knowledgebase

Beta release February 2018

- Improved data accessibility and end user experience
- Risk assessor default output focused on critical data
- Graphical Data Visualization tools
- Direct linkages to other chemical knowledgebases

Ecological Effects in ECOTOX





- Mortality
- Physiology
- Population
- Reproduction
- Accumulation
- Biochemical
- Behavior
- Cellular
- Growth

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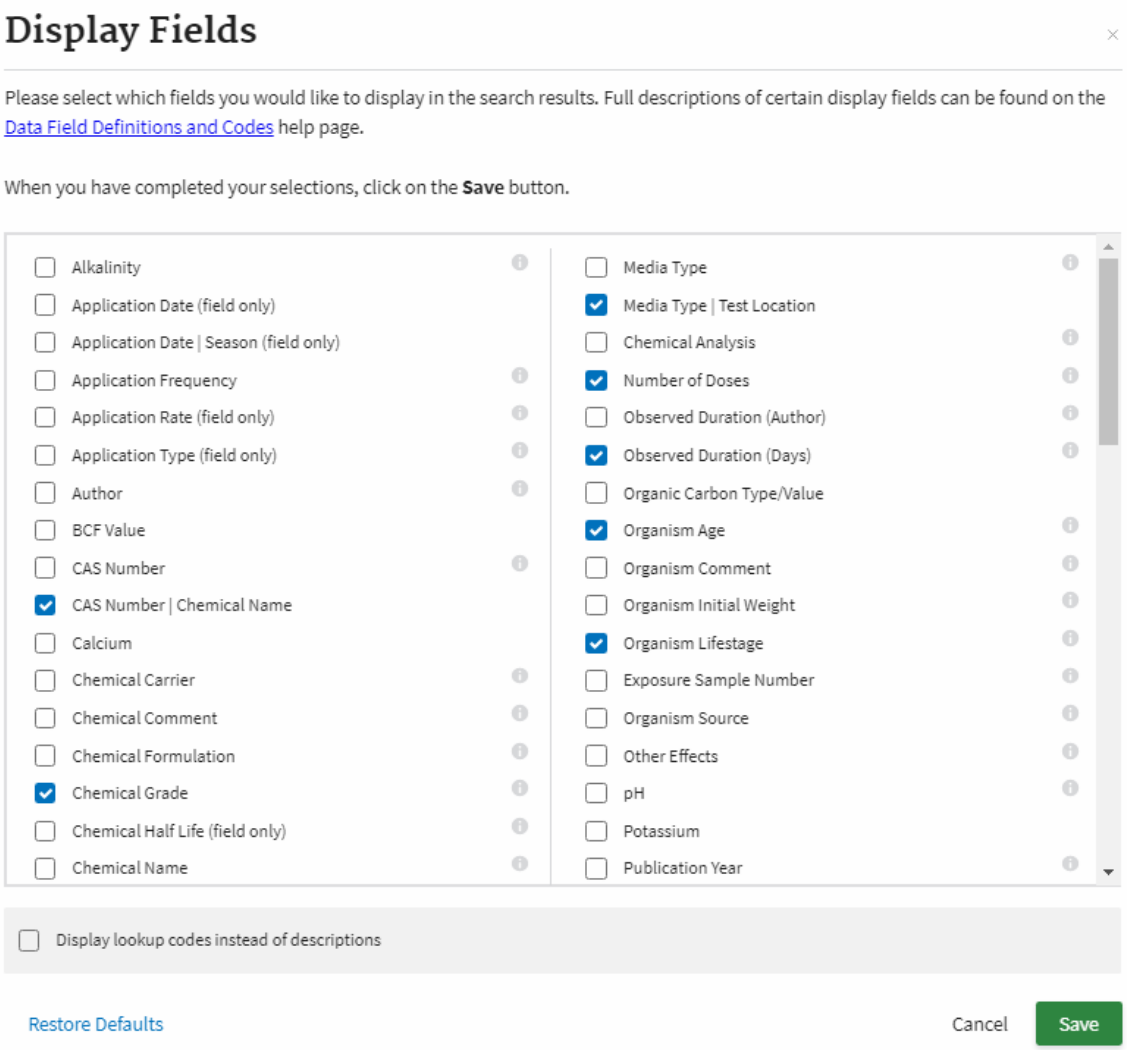
Customizable Output



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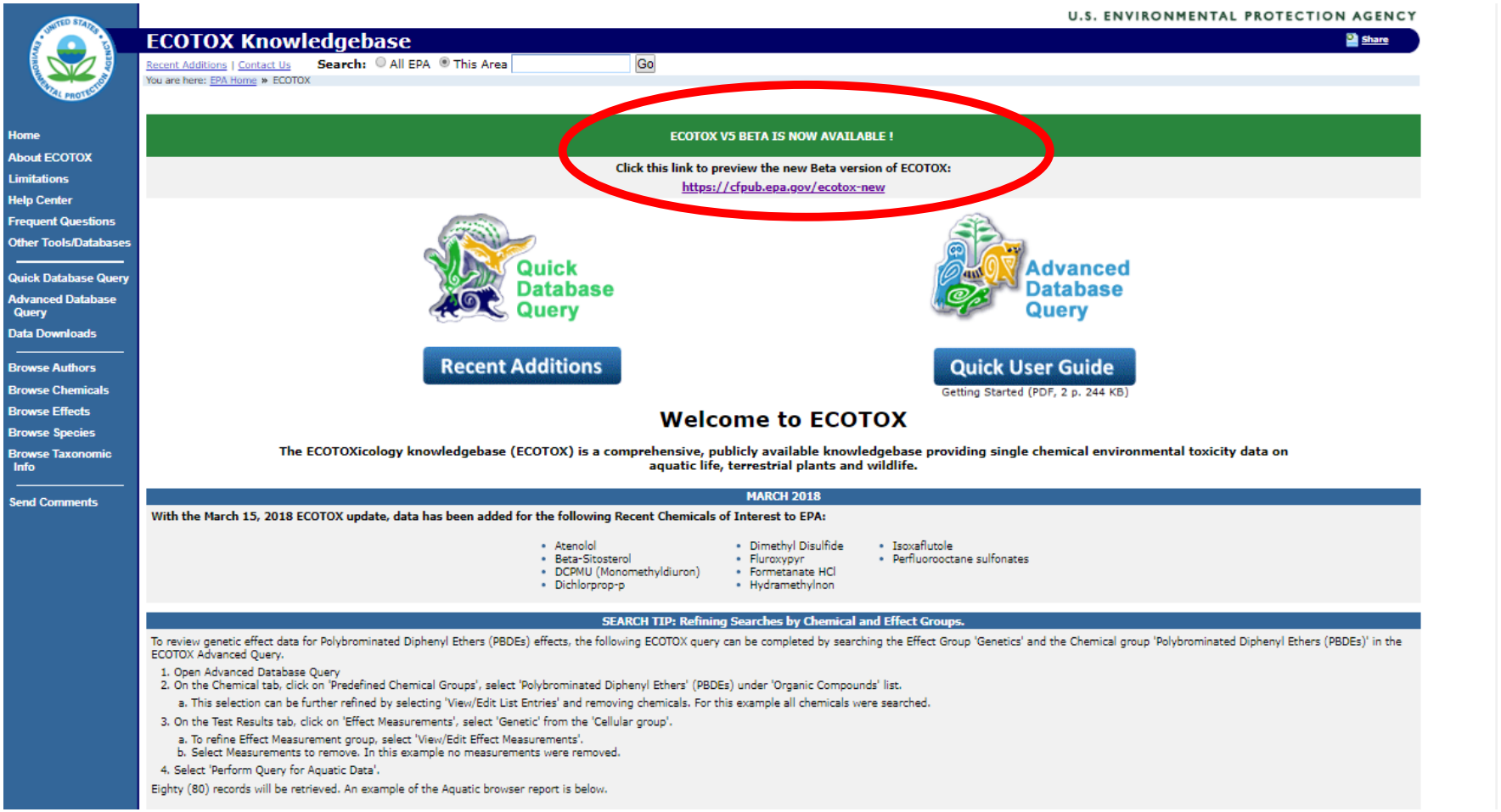
From: The Current ECOTOX User Interface



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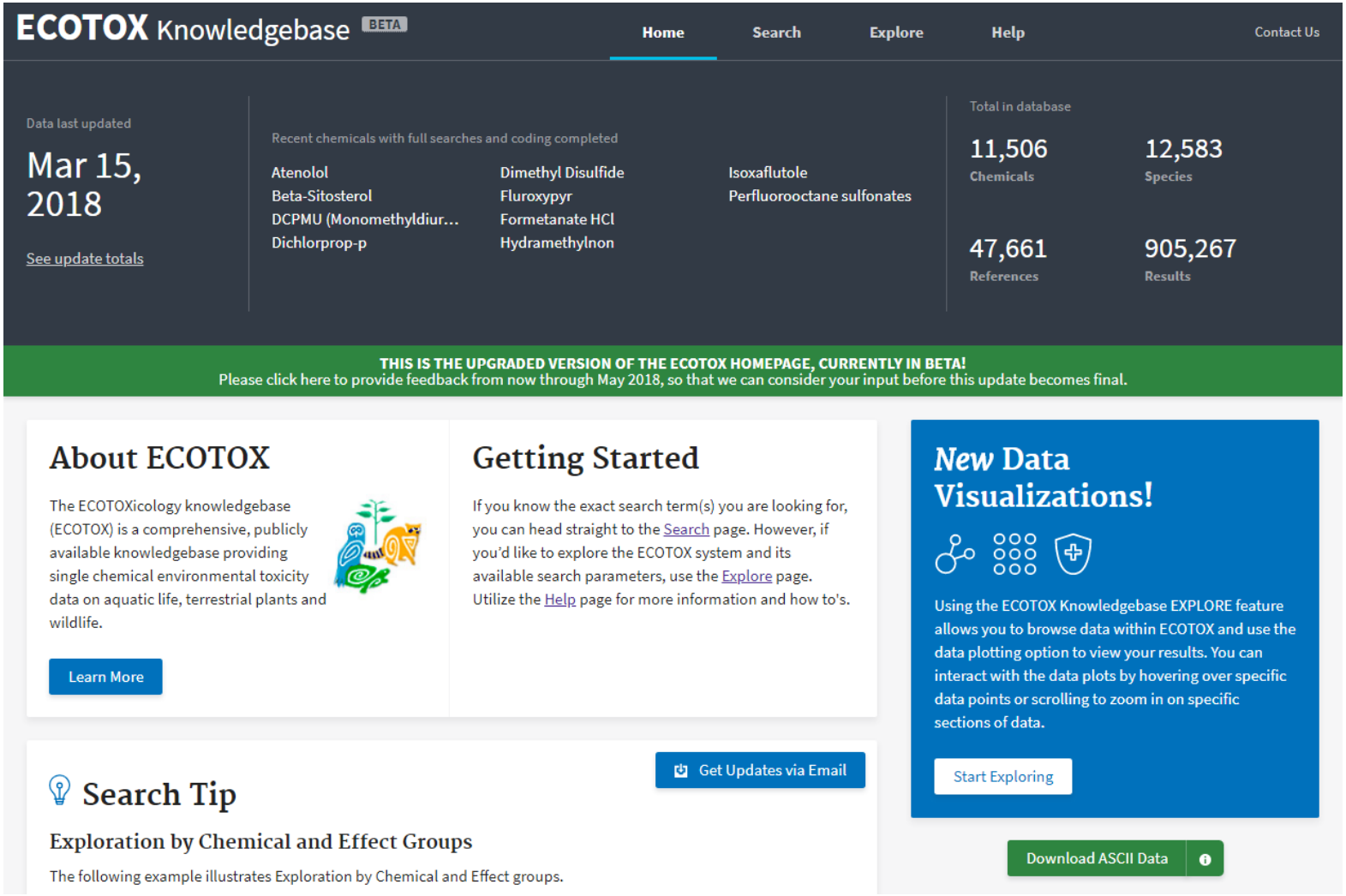
To: The New ECOTOX User Interface



https://cfpub.epa.gov/ecotox-new/

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Search ECOTOX

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Chemistry Dashboard

Aa Aa Aa

761 Thousand Chemicals

Search a chemical by systematic name, synonym, CAS number, or InChIKey

Identifier substring search

See what people are saying, read the dashboard comments!

Latest News

Read more news

ALL PUBLICATION OPTIONS +

Animals

- Amphibians
- Birds
- Crustaceans
- Fish
- Insects/Spiders
- Other Invertebrates
- Mammals
- Molluscs
- Reptiles
- Worms

Plants

- Algae, Moss, Fungi
- Flowers, Trees, Shrubs, Ferns

Special Interests

- Standard Test Species
- U.S. Threatened/Endangered Species
- U.S. Exotic/Nuisance Species

Note: The Endangered Species List is current as of September 2016.

options, you are able to view the report in the an excel or delimited format.

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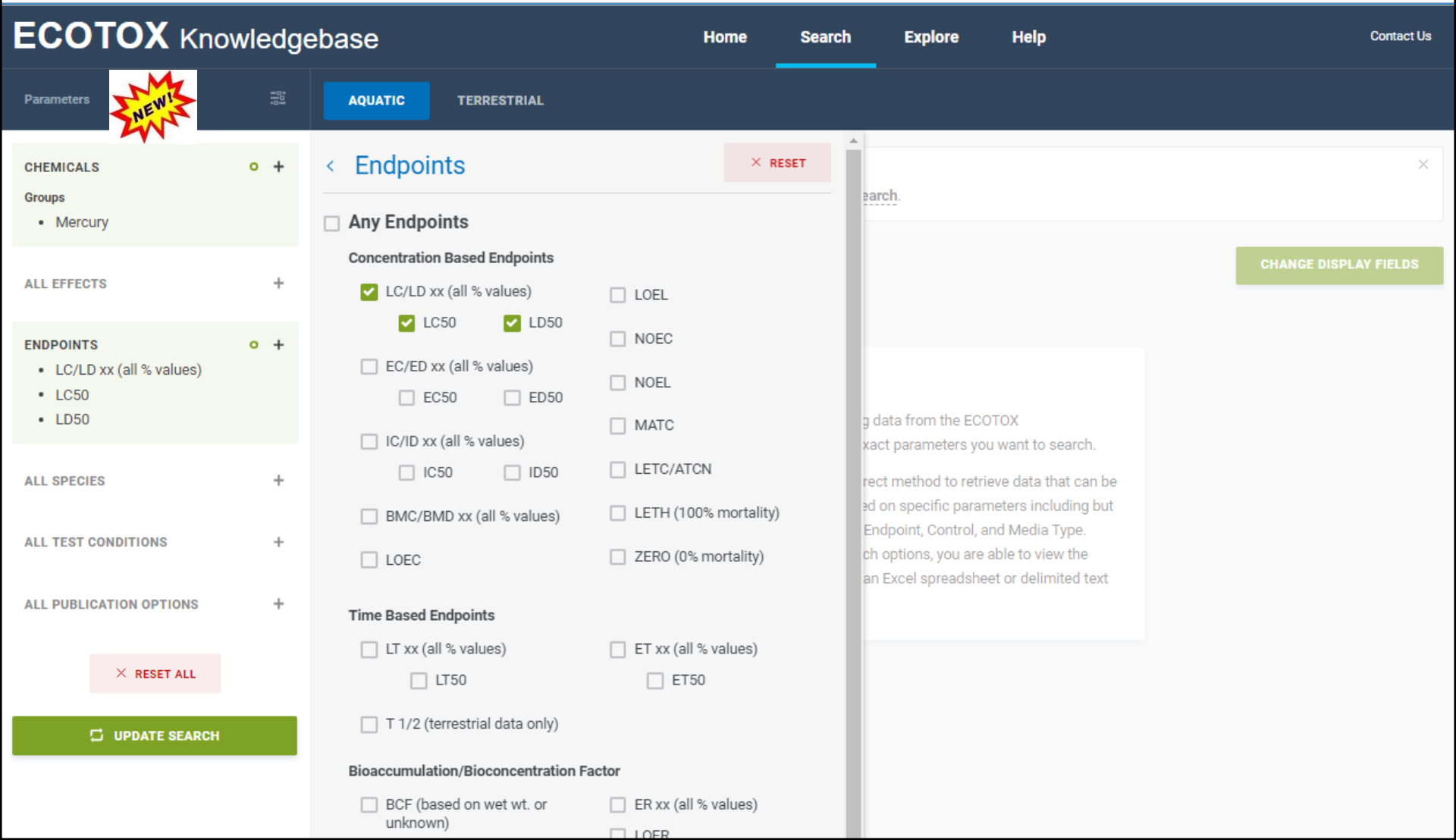
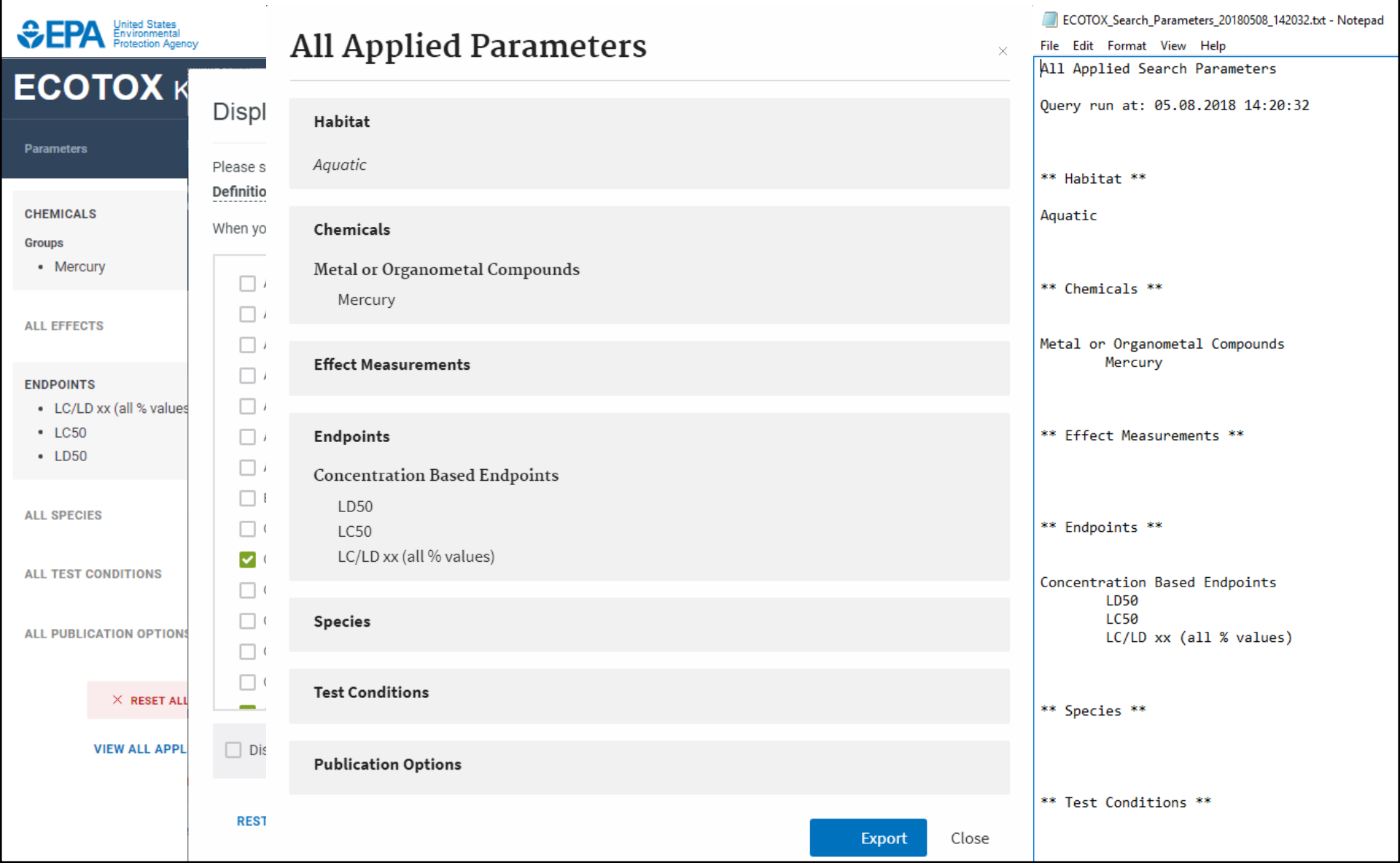
Search ECOTOX



Search ECOTOX



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ECOTOX Knowledgebase BETA

Home | Search | Explore | Help | Contact Us

Data last updated

Mar 15, 2018

See update totals

Recent chemicals with full searches and coding completed

Atenolol
Beta-Sitosterol
DCPMU (Monomethyldiur...
Dichlorprop-p
Dimethyl Disulfide
Fluroxypyr
Formetanate HCl
Hydramethylnon
Isoxaflutole
Perfluorooctane sulfonates

Total in database

11,506 Chemicals
12,583 Species
47,661 References
905,267 Results

THIS IS THE UPGRADED VERSION OF THE ECOTOX HOMEPAGE, CURRENTLY IN BETA!
Please click here to provide feedback from now through May 2018, so that we can consider your input before this update becomes final.

About ECOTOX

The ECOTOXicology knowledgebase (ECOTOX) is a comprehensive, publicly available knowledgebase providing single chemical environmental toxicity data on aquatic life, terrestrial plants and wildlife.

Learn More

Getting Started

If you know the exact search term(s) you are looking for, you can head straight to the Search page. However, if you'd like to explore the ECOTOX system and its available search parameters, use the Explore page. Utilize the Help page for more information and how to's.

New Data Visualizations!

Using the ECOTOX Knowledgebase EXPLORE feature allows you to browse data within ECOTOX and use the data plotting option to view your results. You can interact with the data plots by hovering over specific data points or scrolling to zoom in on specific sections of data.

Start Exploring

Get Updates via Email

Search Tip

Exploration by Chemical and Effect Groups

The following example illustrates Exploration by Chemical and Effect groups.

Download ASCII Data

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Explore ECOTOX

NEW!

ECOTOX Knowledgebase

Home | Search | Explore | Help | Contact Us

Explore | Effects

Group Filters

Select one or more categories from the graph to filter groups in the table.

- **1** Accumulation Group
- **3** Behavior Group
- **3** Biochemical Group
- **3** Cellular Group
- **1** Ecosystem Group
- **3** Growth Group
- **1** Mortality Group
- **1** No Effect Group Coded
- **4** Physiology Group
- **1** Population Group
- **2** Reproduction Group
- **1** Not Reported

24 Effect Groups

Select one or more groups then click "Explore Data" to continue.

RESET ALL | EXPORT CSV | EXPLORE DATA

EFFECT GROUP	RECORDS	PUBLICATIONS	YEAR MIN	YEAR MAX
Accumulation	43681	6805	1915	2017
Avian/reptilian egg	888	212	1964	2015
Avoidance	3877	519	1947	2017
Behavior	15036	2270	1946	2017
Biochemistry	61962	8819	1931	2017
Cell(s)	9975	2036	1935	2017
Development	27073	3352	1925	2017
Ecosystem process	648	157	1963	2014
Enzyme(s)	37093	5619	1931	2017
Feeding behavior	8379	2073	1937	2017
Genetics	28176	2619	1938	2017
Growth	76868	10887	1925	2017
Histology	7020	2270	1937	2017
Hormone(s)	8111	1399	1938	2016
Immunological	2755	590	1948	2017

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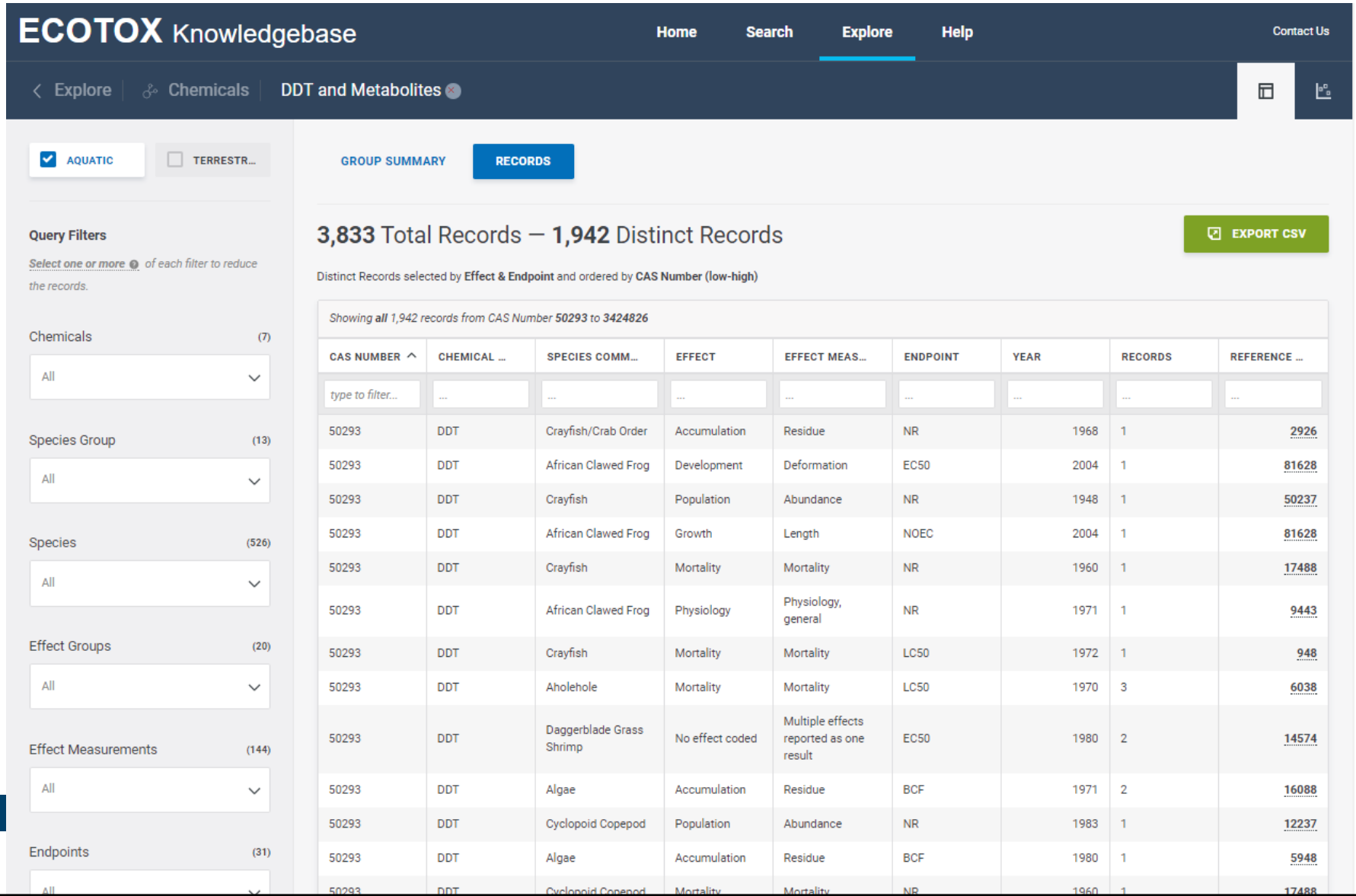
Explore with Data Visualization



CAS NUMBER	CHEMICAL ...	SPECIES COMM...	EFFECT	EFFECT MEAS...	ENDPOINT	YEAR	RECORDS	REFERENCE ...
type to filter...	...	...	...	...	...	...	...	...
50293	DDT	Crayfish/Crab Order	Accumulation	Residue	NR	1968	1	2926
50293	DDT	African Clawed Frog	Development	Deformation	EC50	2004	1	81628
50293	DDT	Crayfish	Population	Abundance	NR	1948	1	50237
50293	DDT	African Clawed Frog	Growth	Length	NOEC	2004	1	81628
50293	DDT	Crayfish	Mortality	Mortality	NR	1960	1	17488
50293	DDT	African Clawed Frog	Physiology	Physiology, general	NR	1971	1	9443
50293	DDT	Crayfish	Mortality	Mortality	LC50	1972	1	948
50293	DDT	Aholehole	Mortality	Mortality	LC50	1970	3	6038
50293	DDT	Daggerblade Grass Shrimp	No effect coded	Multiple effects reported as one result	EC50	1980	2	14574
50293	DDT	Algae	Accumulation	Residue	BCF	1971	2	16088
50293	DDT	Cyclopoid Copepod	Population	Abundance	NR	1983	1	12237
50293	DDT	Algae	Accumulation	Residue	BCF	1980	1	5948
50293	DDT	Cyclopoid Copepod	Mortality	Mortality	NR	1960	1	17488

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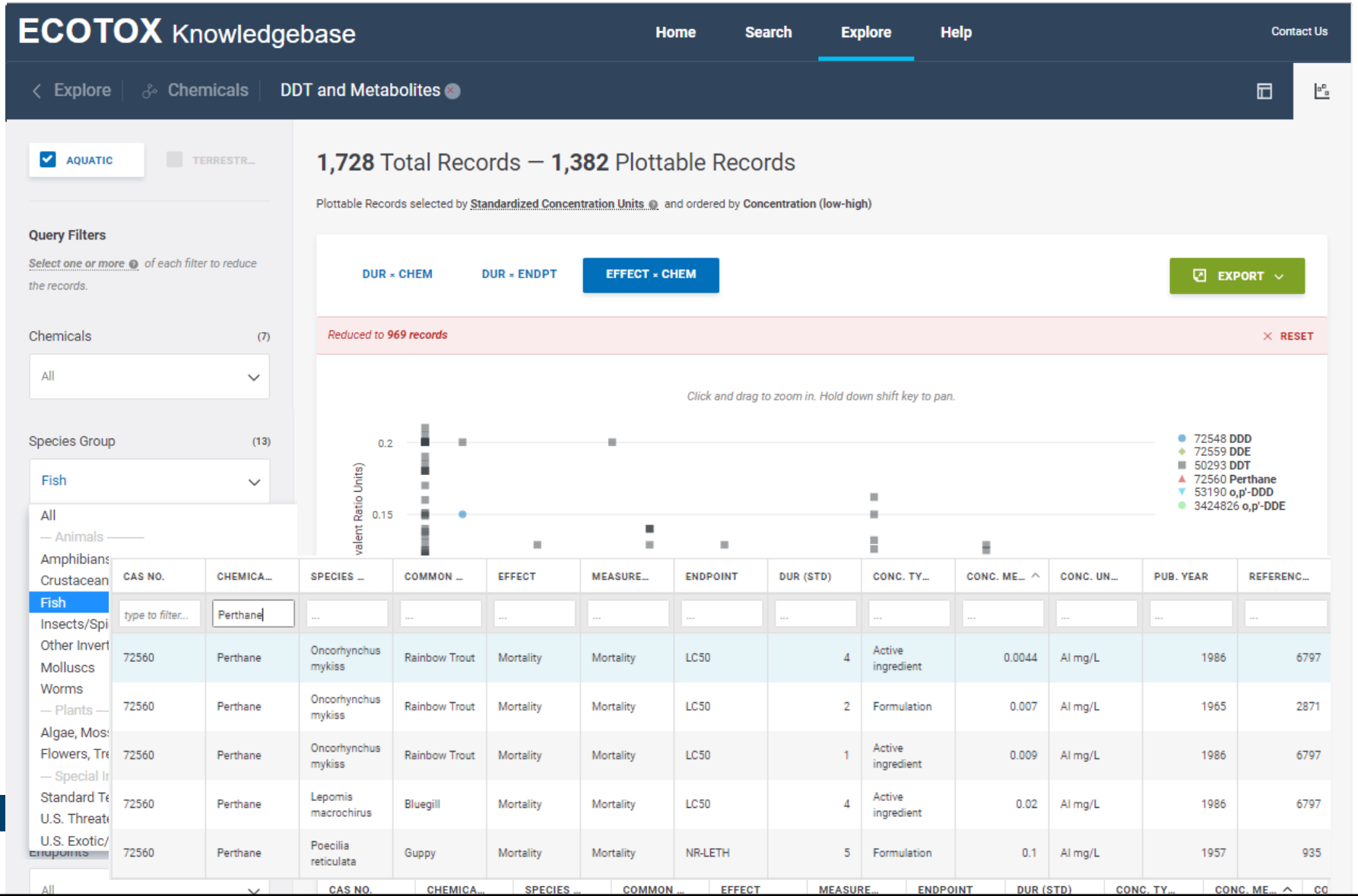
Explore with Data Visualization

NEW!



Case Example in Interoperability

Question:

What are the effects of pharmaceuticals on aquatic organisms?

Detections in environmental samples

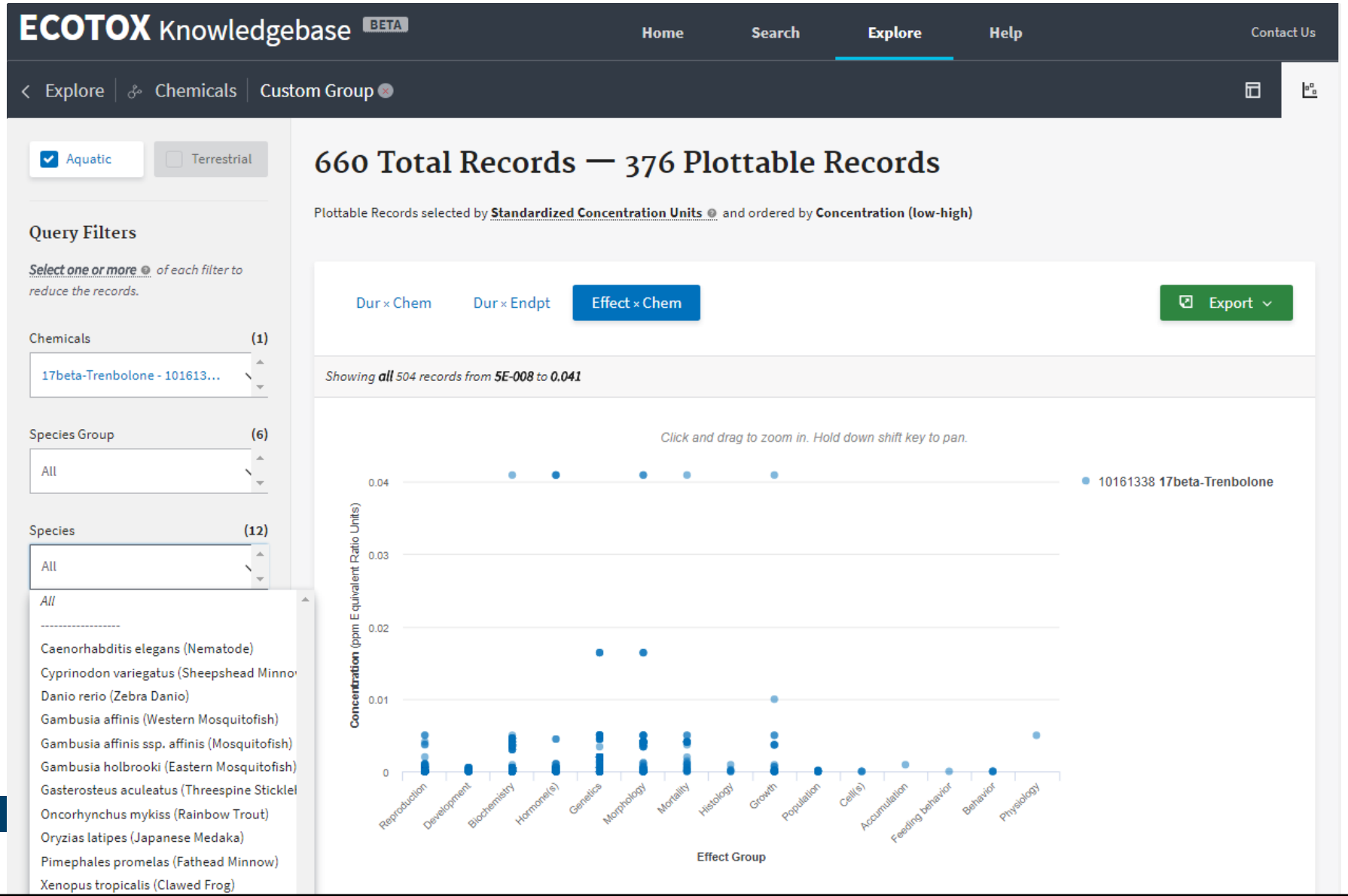
Need:

- Chemical information
- Potential molecular target
- Effects at cellular, tissue, and organismal levels
- Species applicability

Pharmaceuticals of interest

Name	CAS Num
Trenbolone	10161-33-8
Ketoconazole	65277-42-1
Acetaminophen	103-90-2
Ranitidine	66357-35-5
Diphenhydramine	58-73-1
Spironolactone	52-01-7
Sulfamethoxazole	723-46-6
Propranolol	525-66-6
Venlafaxine	93413-69-5
Dexamethasone	50-02-2
Sertraline	79617-96-2

ECOTOX Knowledgebase



CompTox Chemistry Dashboard

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Home | Advanced Search | Batch Search | Lists | Predictions | Downloads | Search All Dat

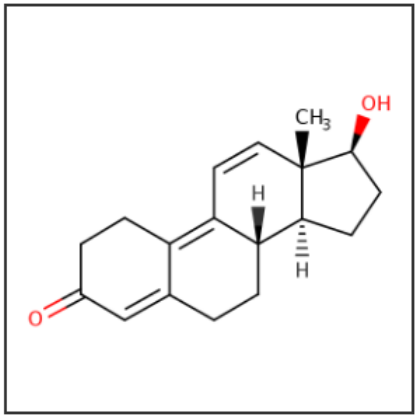
Chemistry Dashboard

Submit Comment | Share | Copy | Aa | Aa | Aa

17beta-Trenbolone

10161-33-8 | DTXSID0034192

Searched by Expert Validated Synonym: Found 1 result for 'Trenbolone'.



Wikipedia

Trenbolone is an androgen and anabolic steroid (AAS) of the nandrolone group which itself was never marketed. Trenbolone ester prodrugs, including trenbolone acetate (brand names Finajet, Finaplix, others) and trenbolone hexahydrobenzylcarbonate (brand names Parabolan, Hexabolan), are or have been marketed for veterinary and clinical use. Trenbolone acetate is used in veterinary medicine in livestock to increase muscle growth and appetite, while trenbolone hexahydrobenzylcarbonate...Read more

- Intrinsic Properties
- Structural Identifiers
- Linked Substances
- Presence in Lists
- Record Information
- Quality Control Notes

Executive Sum...Beta) | Chemical Properties | Env. Fate/Transport | Hazard | ADME (Beta) | Exposure | Bioassays | Similar Compounds | Related Substances | Synonyms

Literature | Links | Comments

General	Toxicology	Publications	Analytical	Prediction
EPA Substance Regis...	ECOTOX	Toxline	RSC Analytical Abstra...	2D NMR HSQC/HMB...

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ToxCast *In Vitro* Assays

ToxCast *In Vitro* Assays

Download as: TSV | Excel Show: Inactive | Background

AC50 lowest to highest conc.

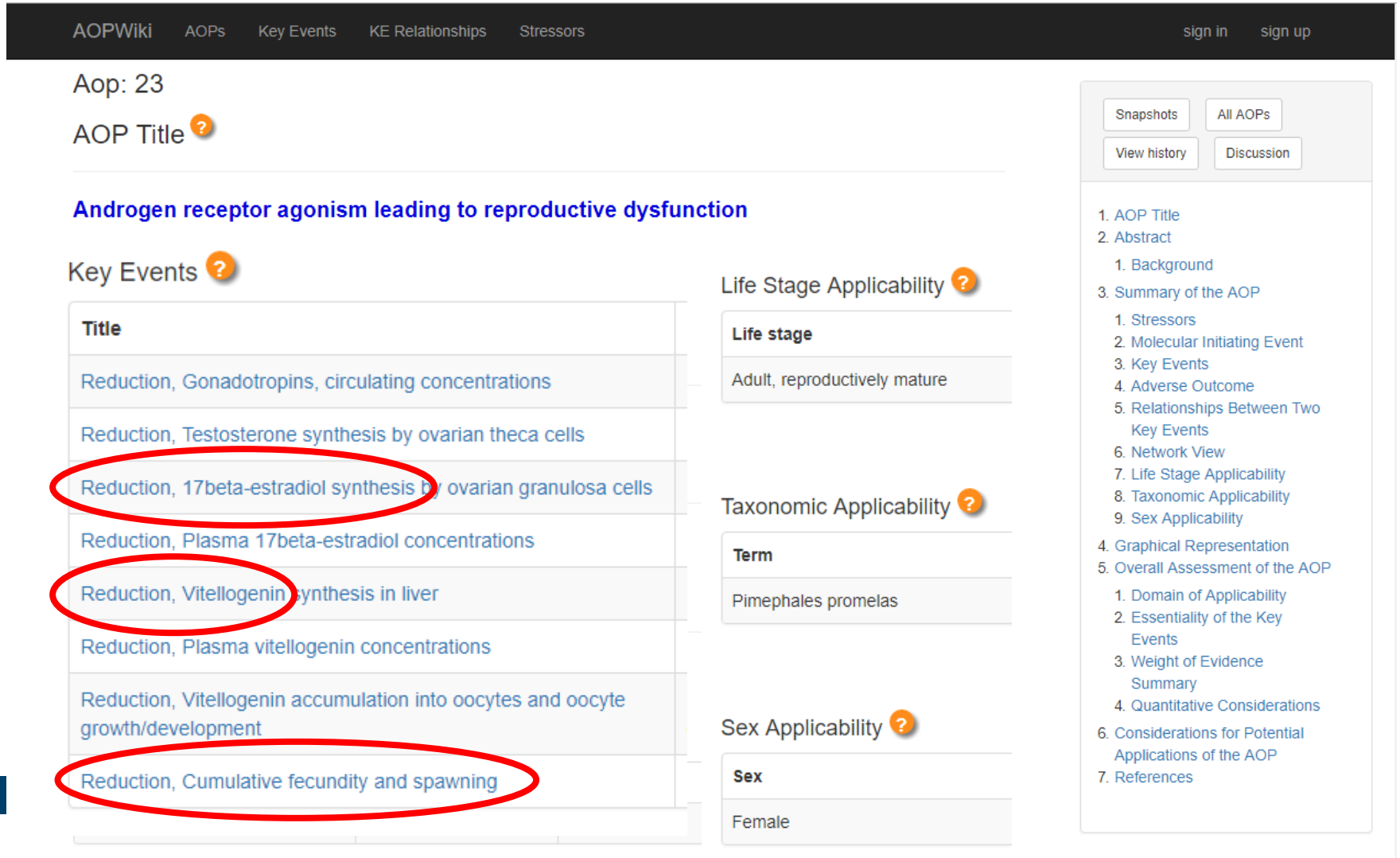
Assay Name	Hit Call	Top	Scaled Top	AC50 ↑	log AC50	Intended Target Family
TOX21_AR_LUC_MDAKB2_Agonist	ACTIVE	143	7.17	0.0000100	-5.00	nuclear receptor
TOX21_p53_BLA_p2_viability	ACTIVE	79.6	1.16	0.0000472	-4.33	cell cycle
NVS_NR_hAR	ACTIVE	101	4.53	0.000304	-3.52	nuclear receptor
OT_AR_ARSRC1_0480	ACTIVE	119	5.93	0.000554	-3.26	nuclear receptor
OT_AR_ARSRC1_0960	ACTIVE	101	5.04	0.00147	-2.83	nuclear receptor
TOX21_AR_BLA_Agonist_ratio	ACTIVE	122	3.73	0.00162	-2.79	nuclear receptor
NVS_NR_hPR	ACTIVE	104	4.44	0.00500	-2.30	nuclear receptor

Androgen Receptor

Linked to AOPs:

- **Androgen receptor antagonism leading to adverse effects in the male foetus (mammals)**
- **Androgen receptor agonism leading to reproductive dysfunction (in repeat-spawning fish)**

Adverse Outcome Pathway Wiki



ECOTOX Knowledgebase

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ECOTOX Knowledgebase BETA | Home | Search | Explore | Help | Contact Us

Explore | Chemicals | Custom Group

Aquatic | Terrestrial

184 Total Records — 120 Plottable Records

Plottable Records selected by **Standardized Concentration Units** and ordered by **Concentration (low-high)**

Query Filters

Select one or more of each filter to reduce the records.

Chemicals (1)
17beta-Trenbolone - 101613...

Species Group (1)
Fish

Species (9)
All

Effect Groups (11)
All

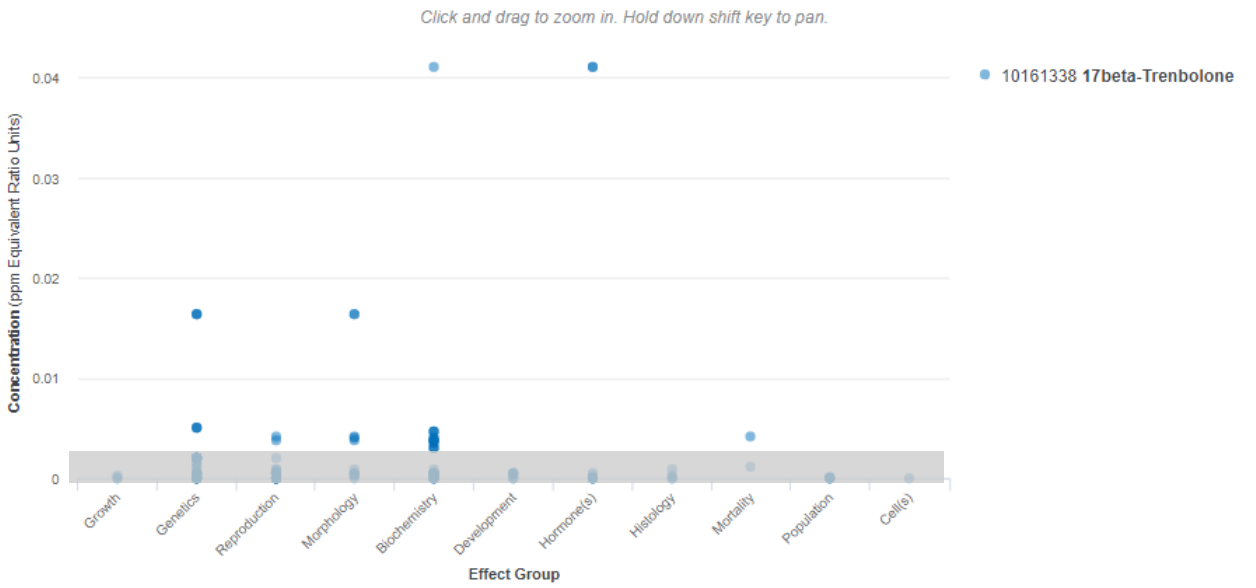
Effect Measurements (49)
All

Endpoints (1)
LOEC

Publication Years

Dur × Chem | Dur × Endpt | Effect × Chem | Export

*Showing **all** 153 records from **7E-006** to **0.041***



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Explore | Chemicals | Custom Group

Aquatic | Terrestrial

184 Total Records — 120 Plottable Records

Plottable Records selected by **Standardized Concentration Units** and ordered by **Concentration (low-high)**

Dur × Chem | Dur × Endpt | Effect × Chem | Export

CAS NO.	CHEMICA...	SPECIES ...	COMMON ...	EFFECT	MEASURE...	ENDPOINT	DUR (STD)	CONC. TY...	CONC. ME...	CONC. UN...	PUB. YEAR	REFERENC...
type to filter...	...	...	...	Biochemistry	...	...	...	...	...	...	...	...
10161338	17beta-Trenbolone	Danio rerio	Zebra Danio	Biochemistry	Vitellogenin	LOEC	60	Formulation	1E-005	AI mg/L	2013	166320

Query Filters

Select one or more of each filter to reduce the records.

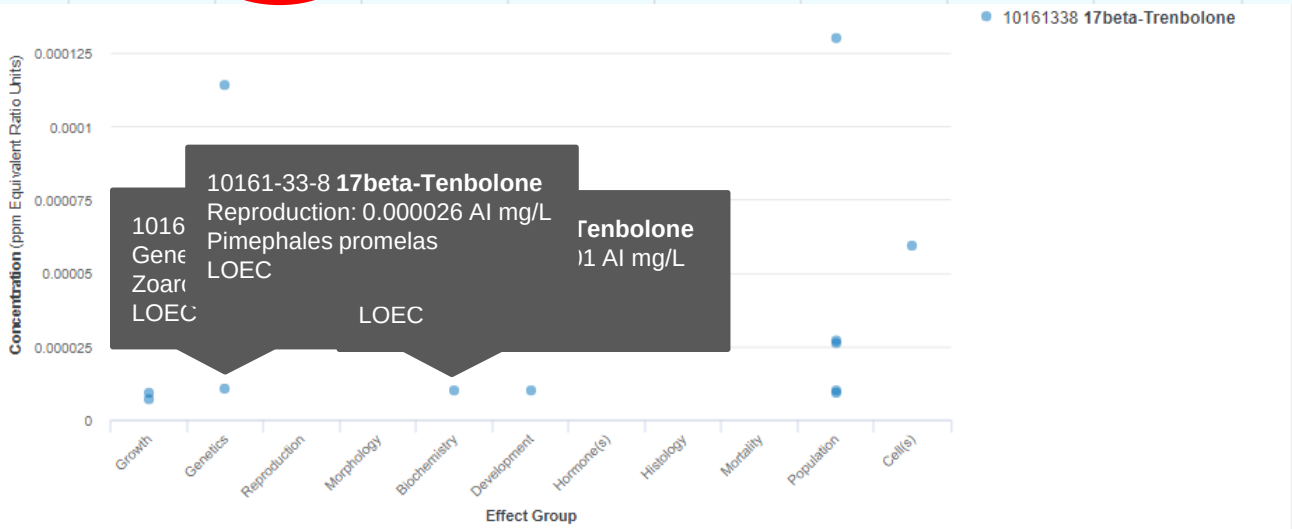
Species (9) — All

Effect Groups (11) — All

Effect Measurements (49) — All

Endpoints (1) — LOEC

Publication Years



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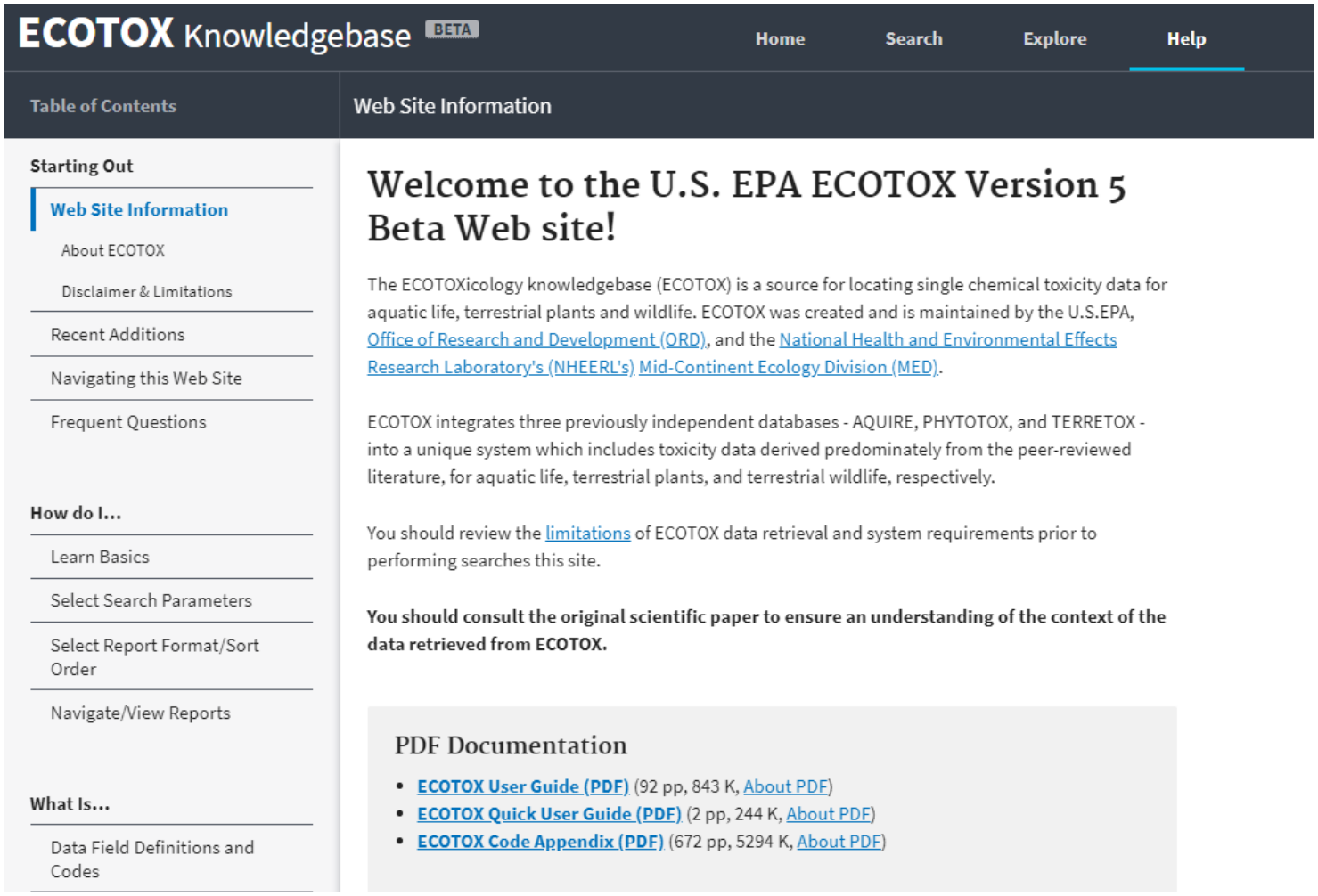
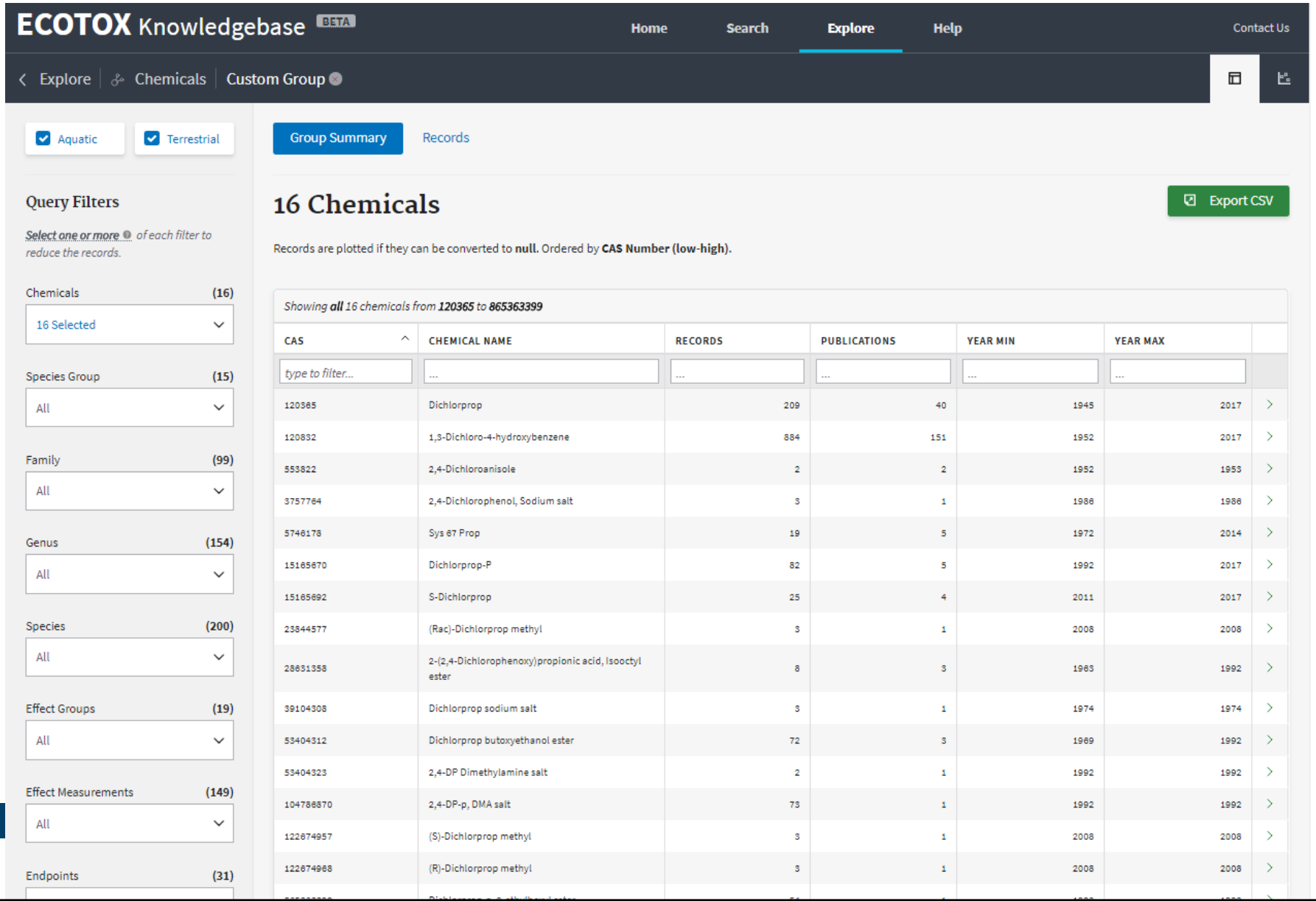
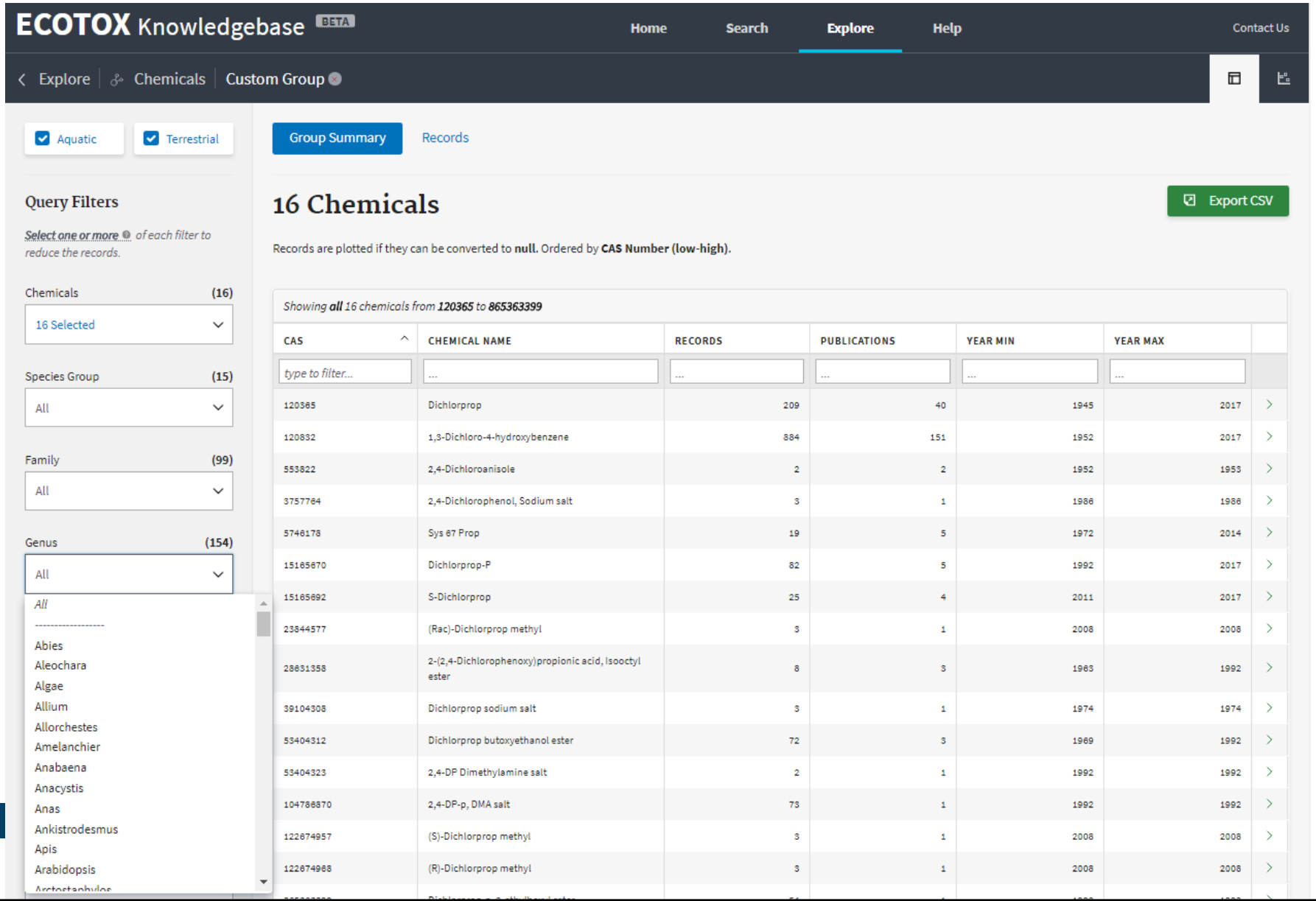


New and Upcoming Changes



New and Upcoming Changes



New and Upcoming Changes

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Explore | Chemicals | Custom Group

Aquatic | Terrestrial

897 Plottable Records — 1,445 Total Records

Records are plotted if they can be converted to **Standardized Concentration Units**. Ordered by **Concentration (low-high)**.

Query Filters

Select one or more of each filter to reduce the records.

Chemicals (16) — 16 Selected

Species Group (15) — All

Family (99) — All

Genus (154) — All

Species (200) — All

Effect Groups (19) — All

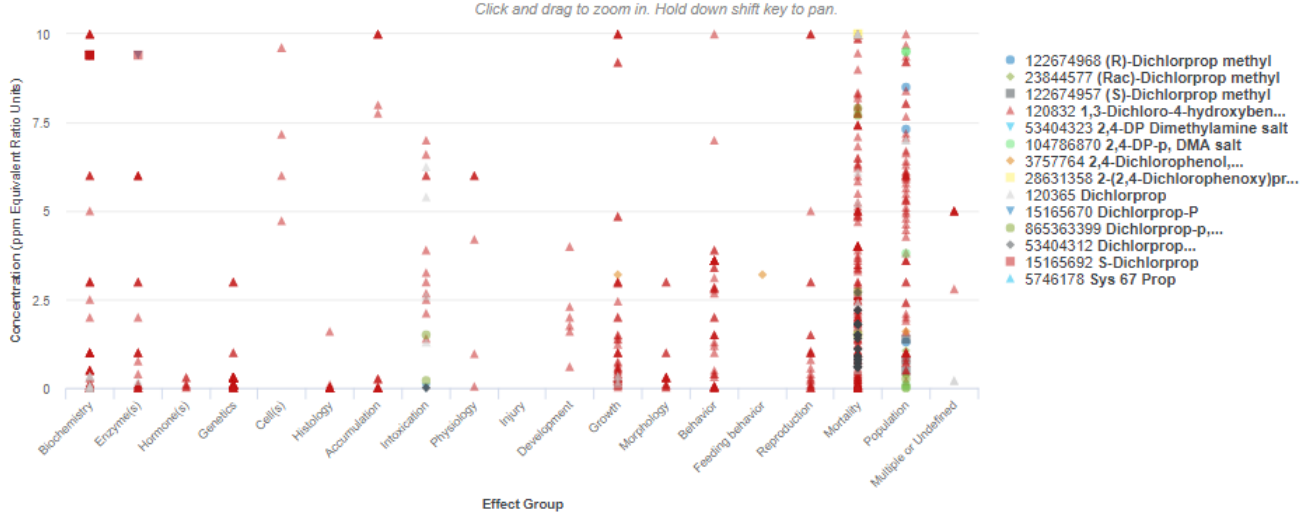
Effect Measurements (149) — All

Endpoints (31)

Effect × Chem | Dur × Chem | Dur × Endpt | Export

*Reduced to **744 records*** × Reset

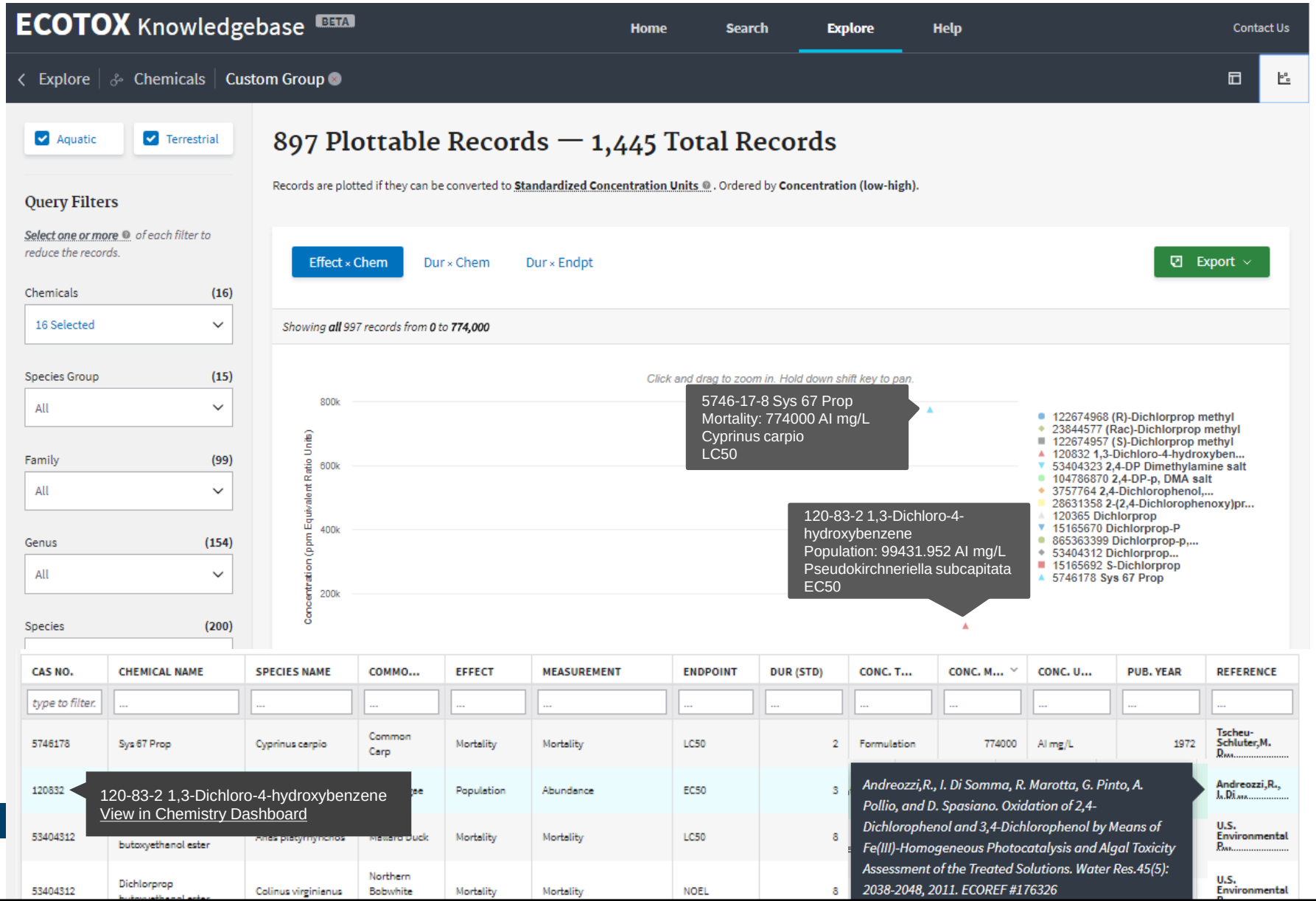
Click and drag to zoom in. Hold down shift key to pan.



Concentration Range: 0.00 **to** 10.00 in **Standardized Concentration Units**

Click and drag slider endpoints to zoom in by concentration value. Click 'Reset' to restore original values.

New and Upcoming Changes



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Get Updates via Email

EPA welcomes your comments on this beta version of ECOTOX. We are particularly interested in feedback from users about how the new functionality and usability compare to your experience with the current version. Did the new functions work well? Were they easy to use? If not, what issues did you experience? Please be as specific as possible in your comments.

For technical questions about the scientific information and data interpretation, you may also use the comment form below, or the contact information in the right side bar, to contact the ECOTOX Support Staff.

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Select an option

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Your E-mail Address

email@example.com

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Thank you!

Questions?

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