

## **Developing a Strategic Lake Monitoring Plan Using NHDPlus, ArcGIS, and Python**

### **Idaho Department of Environmental Quality (2012)**

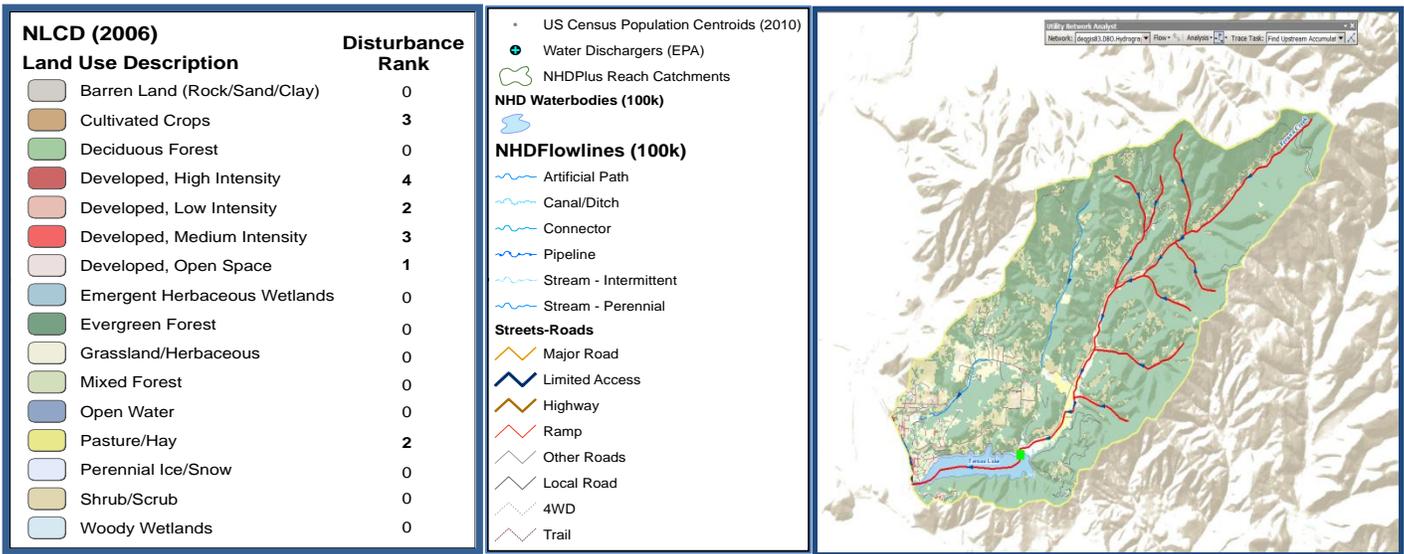
The Idaho Department of Environmental Quality (IDEQ) is required under section 303(d) of the Clean Water Act to develop a Continuing Planning Process that describes the ongoing processes and planning requirements of the state's Water Quality Management Plan (WQMP). The WQMP is not a single plan or document but rather a compilation of the guidance and programs DEQ uses to implement Clean Water Act requirements.

As circumstances change, planning becomes a continual process that evolves with technology and the availability of pertinent data. While IDEQ uses a variety of tools and methods to preserve and enhance the quality of Idaho's waters, NHDPlus and ArcGIS have become invaluable tools in support of the strategic planning processes and statewide water quality monitoring efforts for the State of Idaho.

Idaho has more than 40,000 lakes/ponds and reservoirs contained within approximately 84,000 square miles of mostly rugged terrain. A major component in the development of the strategic planning process and development of water quality standards was identifying and classifying Idaho waters using a Lake Catchment Disturbance Index (LDI) score.

The goal in calculating a disturbance index for each water body was to help define reference sites across Idaho as well as target water bodies for potential monitoring in the future. Land use analysis (GIS) in the catchments of each site was used to assign all portions of the catchments into broad land use categories. To simplify interpretation of the land uses, multiple (16) categories were agglomerated by similar stressor intensities and through calculation of a landscape disturbance index (LDI). The LDI is similar to the one introduced by Brown and Vivas (2005), in which numeric degrees of stressor intensity were assigned to each land use category and then a weighted index was calculated for each catchment. The disturbance ranks specific to this data set were assigned using professional judgment. The LDI is the average disturbance rank weighted by the percent coverage of each land use category in the catchments. Additional requirements for the development of the LDI included water bodies not fully contained in Roadless or Wilderness areas, with a surface area of more than 0.04 km<sup>2</sup> and less than 50 km<sup>2</sup>.

Utilizing NHDPlus feature classes, (Flowlines, Waterbodies, Catchments) within an enterprise geodatabase and generated Geometric Network, we were able to quickly calculate the LDI for each water body meeting the criteria. Readily available GIS data sets used in the calculation of the Disturbance Index included the National Land Cover Dataset (NLCD), EPA NPDES locations, ESRI Street Map data, and US Census Data for population density. While the process was semi-automated using Python within ArcMap, NHDPlus provided the functionality to select upstream catchment areas based on flow direction routing and the relationship class to the NHDPlus catchment areas. The upstream accumulation was generated using the Utility Network Analyst Toolbar in ArcMap. Once the upstream NHDFlowlines were selected, IDEQ's custom Python LDI Toolbox completed the process, calculating and generating the LDI score for the catchment area.



NLCD with Disturbance Rankings

Final Upstream Accumulation Catchment Area with NHDFlowlines

	B	C	D	E	F	G	H	I	J	K	L	M	O
	COMID	REACHCODE	LAKE_NAME	LDI	RD_DENSITY	RDS_KM	POPULATION	POP_DENSITY	NPDES	HUC4CODE	HUC4NAME	BASIN	ACRES
2	23280546	17050101001270	Long Tom Reservoir	0	0.6097	42.689	12	0.1713	0	17050101	C. J. Strike Rese Southwest		17300.9
3	23280570	17050101001276	Mountain Home Reservoir	0.0599	0.5184	48.991	40	0.4232	0	17050101	C. J. Strike Rese Southwest		23352.53
4	23280584	17050101001279		0.0099	0.5056	30.899	4	0.0654	0	17050101	C. J. Strike Rese Southwest		15100.36
5	23280588	17050101001280	Hot Springs Creek Reservoir	0.0199	0.5003	17.669	0	0	0	17050101	C. J. Strike Rese Southwest		8725.89
6	23280596	17050101001282		0	1.4558	73.436	0	0	0	17050101	C. J. Strike Rese Southwest		12464.78
7	23280600	17050101001283	Hot Springs Creek Reservoir	0.0199	0.5755	29.744	0	0	0	17050101	C. J. Strike Rese Southwest		12769.87
8	23280624	17050101001289	Blair Trail Reservoir	0	0.505	42.748	15	0.1772	0	17050101	C. J. Strike Rese Southwest		20917.13
9	23280628	17050101001290	Trail Diversion (Dam)	0	0.5462	38.487	15	0.2129	0	17050101	C. J. Strike Rese Southwest		17409.38
10	23280632	17050101001291		0	1.4558	73.436	0	0	0	17050101	C. J. Strike Rese Southwest		12464.78
11	23280640	17050101001293		1.0099	1.5411	37.275	147	6.0778	0	17050101	C. J. Strike Rese Southwest		5976.476
12	23280652	17050101001296	Morrow Reservoir	0.0099	0.5834	9.502	0	0	0	17050101	C. J. Strike Rese Southwest		4024.857
13	23280656	17050101001297	Cove Arm Lake	0.26	1.1478	3741.309	3157	0.9685	2	17050101	C. J. Strike Rese Southwest		805439.5
14	23280662	17050101001298	Fly H Canal Diversion Pond	1.4299	1.7994	29.053	43	2.6632	0	17050101	C. J. Strike Rese Southwest		3989.676
15	23280666	17050101001299	Rattlesnake Creek Ponds	1.1099	2.8205	484.209	15084	87.8646	0	17050101	C. J. Strike Rese Southwest		42421.21
16	23280674	17050101001301	Rattlesnake Springs Ponds	1.1199	2.8183	492.776	15089	86.299	0	17050101	C. J. Strike Rese Southwest		43205.11
17	23280678	17050101001302	Crane Falls Lake	0.1599	1.425	115.591	29	0.3575	0	17050101	C. J. Strike Rese Southwest		20043.72
18	23280702	17050101001308		0.6	1.4712	109.519	94	1.2627	0	17050101	C. J. Strike Rese Southwest		18394.78
19	23280706	17050101001309	Dunes Lake	0.6	1.4712	109.519	94	1.2627	0	17050101	C. J. Strike Rese Southwest		18394.78
20	23280714	17050101001311	Dunes Lake	0.6	1.4712	109.519	94	1.2627	0	17050101	C. J. Strike Rese Southwest		18394.78
21	23293833	17050102002438	C J Strike Reservoir	0.0099	0.6667	4632.116	238	0.0342	0	17050102	Bruneau Southwest		1716678
22	23293849	17050102002442		0	0.3183	1.461	0	0	0	17050102	Bruneau Southwest		1134.434
23	23293865	17050102002446		0	0.4065	0.864	0	0	0	17050102	Bruneau Southwest		525.464
24	23293893	17050102002453		0	0.8747	3.577	0	0	0	17050102	Bruneau Southwest		1010.553
25	23293905	17050102002456		0	0.5556	2.187	0	0	0	17050102	Bruneau Southwest		972.679
26	23293917	17050102002459	Big Lake	0	1.127	8.099	0	0	0	17050102	Bruneau Southwest		1775.693
27	23293925	17050102002461		0	0.2848	8.339	0	0	0	17050102	Bruneau Southwest		7233.505
28	23293929	17050102002462	Blackstone Reservoir	0.0099	0.9263	226.104	0	0	0	17050102	Bruneau Southwest		60313.89
29	23293933	17050102002463	Jacks Creek Reservoir	0	0.8722	37.204	0	0	0	17050102	Bruneau Southwest		10539.3
30	23293941	17050102002465		0	0.7967	10.741	0	0	0	17050102	Bruneau Southwest		3331.279
31	23293945	17050102002466	Big Lake	0	1.0003	12.878	0	0	0	17050102	Bruneau Southwest		3181.059
32	23293955	17050102002468	Grasmere Reservoir	0.0099	0.8141	18.126	0	0	0	17050102	Bruneau Southwest		5501.718
33	23293959	17050102002469	Inside Lakes	0	0.5451	10.6	0	0	0	17050102	Bruneau Southwest		4805.022
34	23293967	17050102002471		0	0.3889	2.518	0	0	0	17050102	Bruneau Southwest		1599.957
35	23293971	17050102002472		0	0.6953	22.417	0	0	0	17050102	Bruneau Southwest		7965.926
36	23293987	17050102002475	Otter Reservoir	0	1.0161	3.666	0	0	0	17050102	Bruneau Southwest		891.733
37	23293999	17050102002478	Buckhorn Reservoir	0	0.3005	8.135	0	0	0	17050102	Bruneau Southwest		6690.094
38	23310336	17050103002440		1.5999	1.8803	480.841	2021	7.9031	8	17050103	Middle Snake-S Southwest		63189.91
39	23310340	17050103002441		1.6599	1.8876	412.639	1873	8.5682	8	17050103	Middle Snake-S Southwest		54016.21

Final results were merged into a new feature class depicting the final LDI rankings as well as the GIS generated indexes for each parameter used in the LDI GeoProcessing Toolbox.

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[http://mapcase.deq.idaho.gov/wq2014/images/LakeMonitoring\\_NHDPlus.pdf](http://mapcase.deq.idaho.gov/wq2014/images/LakeMonitoring_NHDPlus.pdf) -- PDF Poster

<http://www.deq.idaho.gov/water-quality/planning.aspx> -- IDEQ Water Quality Planning Home Page.