

C. ASHTON DREW

KDV Decision Analysis LLC
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RESEARCH & PROFESSIONAL EXPERIENCE

KDV Decision Analysis LLC, North Carolina, USA & Yukon, Canada

Owner, Lead Consultant (2015 – present)

- Facilitate solutions to data collection, management, analysis, and communication challenges
- Decision modeling and decision analysis for strategic planning
- Design decision support tools for adaptive management
- R course development and instruction

Biodiversity and Spatial Information Center, USGS Cooperative Fish and Wildlife Research Unit, Department of Biology, North Carolina State University, North Carolina, USA

Research Coordinator, Environmental Decision Analysis (2011 – 2015)

- Lead research team developing applications of spatial ecological data to support planning decisions
- Integrating expert knowledge into species habitat and management decision optimization models

Postdoctoral Research Associate (2006 – 2011)

- Model vertebrate distribution to support USFWS & USGS Strategic Habitat Conservation
- Field research to validate and improve models in support of adaptive management and monitoring
- Co-develop and teach courses in climate change, conservation planning, and modeling
- Research program advancement: grant-writing, supervise students and technicians

Eastern Carolina University, North Carolina, USA

Adjunct Faculty (2011 – 2014)

- Serve as thesis committee member for ongoing King Rail population ecology research

Marine Ecology & Conservation Laboratory, Marine, Earth & Atmospheric Sciences Department, North Carolina State University, Raleigh, North Carolina, USA

Graduate Research Assistant & NSF Graduate Research Fellow (2000 – 2006)

- Investigate behavioral, population, and community level aspects of reef fish spatial ecology
- Field research for international (Bahamas) and local (Florida, North Carolina) projects

Laboratory Technician (1999 – 2000)

- Laboratory processing of coastal North Carolina benthic invertebrate samples

US Environmental Protection Agency (under contract through the Environmental Careers Organization), Research Triangle Park, North Carolina, USA

Field Biologist and Crew Supervisor (1998-1999)

- Create and deliver training program for research interns (GPS navigation, vegetation identification)
- Coordinate and supervise field research crews
- Survey riparian land cover & vegetation characteristics in Neuse River Basin, NC

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AXYS Environmental Consulting Ltd. Victoria, British Columbia, Canada

Wildlife Biologist and GIS Technician (1996 – 1998)

- Inventory species in terrestrial, freshwater, and marine habitats of British Columbia
- Assess quality of habitat for endangered species, aquaculture potential, urban green space
- Mediate stakeholder meetings to negotiate objectives and elicit knowledge
- Write technical reports and produce maps for government and private clients

EDUCATION

PhD, 2006, Marine Science - North Carolina State University, NC, Department of Marine, Earth & Atmospheric Sciences

- Dissertation: Spatial Ecology of Reef Fish in Back Reef and Reef Habitats (under DB Eggleston)

MMM, 1996, Marine Management - Dalhousie University, NS, Marine Affairs Program

- Thesis: Integrated Aquaculture Systems for Atlantic Canada (under A Chircop and GF Newkirk)

BA Magna Cum Laude, 1995, Environmental Science - Beloit College, WI, including credits from:

- Au Sable Environmental Research Institute, Au Sable, MI
- Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA
- NSF-Research Experience for Undergraduates, Marine Biological Laboratory, Woods Hole, MA
- Global Project, Independent Study, Belarus and Ukraine
- School for Field Studies, South Caicos, British West Indies

GRANTS & CONTRACTS

“Preliminary Data Analysis of Disturbance Features in Eagle Plains” (**YLUPC**, 2018)

“NEPA Solutions Design Sprint” (**Sand County Foundation, Walton Family Foundation**, 2018)

“Advancing Transportation through Linkages, Automation and Screening (ATLAS) Project” (**HDR, NC DOT**, 2017-2018)

“Bayesian Belief Networks for Adaptive Management of Wetlands” (**MO DOC**, 2017)

“Water Quality Data and Statistics with R” (**Environment Yukon**, 2017)

“Introduction to R for Fisheries Science” (**DFO Canada**, 2017)

“Application to Visualize and Report Temporal Trends in Survey Data” (**Team Elements**, 2017)

“Application to Automate Leadership Survey Data Analysis and Reporting” (**Onfoot Consulting**, 2017)

“Generalized Additive Models for Wetland Delineation” (**Honestat**, 2016)

“Recovery Prioritization Data Visualization and Decision Support Tool” (**ASU**, 2016)

“Recovery Action Prioritization Tool Refinement and Deployment” (**NCSU/USFWS**, 2016-2017)

“Strategic Decision Planning for Threatened and Endangered Species Recovery in Puerto Rico” (co-PI with J. Collazo, **USFWS**, 2014-2015)

“Collaborative Conservation Design Project: Science Support for the South Atlantic Landscape Conservation Cooperative Conservation Blueprint” (co-PI with J. Collazo, **USFWS**, 2013-2015)

“Assessment of South Atlantic Landscape Conservation Cooperative Terrestrial Indicators” (co-PI with J. Collazo, **USFWS**, 2013-2014)

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- “Vertebrate Biodiversity of Agricultural Fields: A Database and Metrics to Facilitate Conservation Partnerships in Productive Landscapes” (co-PI with J. Collazo, **NC Wildlife Resources Commission**, 2013-2016)
- “Modeling Impacts of Biomass Production on Landscapes and Wildlife” (co-PI with J. Costanza, J. Collazo, R. Abt, R. Gonzalez, **Biofuels Center of NC**, 2012-2013)
- “Developing an Outcome-Based Biodiversity Metric in Support of the Field to Market Project” (co-PI with A. McKerrow, J. Collazo, **Keystone Institute & TNC**, 2010-2011)
- “Hierarchical Landscape Models for Endemic Unionid Mussels: Building Strategic Habitat Conservation Tools for Mussel Recovery in the South Atlantic Landscape Conservation Collaborative” (co-PI with T. Kwak, G. Cope, T. Augsburger, **USFWS**, 2011-2015)
- “Designing Manatee Protection Areas in Puerto Rico” (co-PI with Jaime Collazo, **USFWS**, 2010-2011)
- “Linking Site Occupancy, Reproductive Success, and Management Outcomes for Strategic Habitat Conservation of King Rail” (co-PI with J. Collazo, **USFWS**, 2010-2011)
- “Field Validation of King Rail Habitat Models in the Roanoke-Tar-Neuse-Cape Fear Ecosystem” (co-PI with J. Collazo; **USGS**, 2007-2009)

PUBLICATIONS

Text Books

Perera AH, Drew CA, Johnson CJ (eds) (2012) Expert Knowledge and its Application in Landscape Ecology. Springer, New York.

- Perera AH, Drew CA, Johnson CJ: Experts, expert knowledge and their roles in landscape ecological applications (Chapter 1)
- Drew CA, Collazo J: Expert knowledge as a foundation for management of secretive species and their habitat (Chapter 5)
- Johnson CJ, Drew CA, Perera AH: Elicitation and use of expert knowledge in landscape ecological applications: a synthesis. (Chapter 14)

Drew CA, Wiersma Y, Huettmann FH (eds) (2011) Predictive Species and Habitat Modeling in Landscape Ecology: Concepts and Applications. Springer, New York.

- Wiersma Y, Drew CA, Huettmann FH: Landscape modeling of species and their habitats: history, uncertainty, and complexity (Chapter 1)
- Laurent E, Drew CA, Thogmartin W: The role of assumptions in predictions of habitat availability and quality (Chapter 5)
- Drew CA, Perera AH: Expert knowledge as a basis for landscape ecological predictive models (Chapter 12)
- Drew CA, Wiersma Y, Huettmann FH: The state of habitat and species modeling today (Chapter 15)

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Research Publications

- Gerber LR, Runge MC, Maloney RF, Drew CA, Avery-Gomm S, Iacona GD, Brazil-Boast J, Crouse D, Epanchin-Niel RS, Hall SB, Maguire LA, Male T, Morgan D, Newman J, Possingham HP, Rumpff L, Weiss KCB, Wilson RS, Zablan MA (In Press) Resources and recovery under the Endangered Species Act. *Science*.
- Drew CA, Eddy M, Kwak T, Cope WG, Augspurger (2018) Hydrologic characteristics of freshwater mussel habitat: novel insights from modeled flows. *Freshwater Science* 37(2):343-356.
- Pickens B, Mordicai R, Drew CA, Alexander-Vaughn L, Keister A, Morris H, Collazo J (2017) Indicator-driven conservation planning across terrestrial, freshwater aquatic, and marine ecosystems of the South Atlantic, USA. *Journal of Fish and Wildlife Management* 8(1):219-233.
- Rogers, SL, Collazo JA, Drew CA (2013) Nest occurrence and survival of King Rails in fire-managed coastal marshes in North Carolina and Virginia. *Journal of Field Ornithology* 84:355-366
- Drescher M, Perera AH, Johnson CJ, Buse LJ, Drew CA, and Burgman MA (2013) Toward rigorous use of expert knowledge in ecological research. *Ecosphere* 4(7):83.
- Rogers, SL, Collazo JA, Drew CA (2013) Occupancy and abundance of King Rails in fire managed coastal marshes. *Waterbirds* 36(2):179-188
- Hightower, JE, Harris JE, Raabe JK, Brownell P, Drew CA (2012) Habitat suitability models for American shad in southeastern rivers. *Journal of Fish and Wildlife Management* 3(2):184-198
- Pijanowski B, Iverson L, Rhemtulla J, Wimberly M, Drew CA, Bartsch A, Bulley H, Peng J (2010) Addressing the interplay between poverty and landscapes: a grand challenge topic for landscape ecologists. *Landscape Ecology* 25:5-16
- Drew CA, Eggleston DB (2008) Juvenile fish densities in Florida Keys mangroves correlate with landscape characteristics. *Marine Ecology Progress Series* 362: 233-243
- Drew CA, Eggleston DB (2006) Currents, landscape structure, and recruitment success along a passive-active dispersal gradient. *Landscape Ecology* 21: 917-931
- Hess GR, Rubino MJ, Koch FH, Eschelbach KA, Drew CA, Favreau JM (2006) Comparing the potential effectiveness of conservation planning approaches in central North Carolina, USA. *Biological Conservation* 128: 358-368
- Favreau JM, Drew CA, Hess GR, Eschelbach KA, Rubino MJ, Koch FH (2006) Recommendations for assessing the effectiveness of surrogate species approaches. *Biodiversity and Conservation* 15: 3949-3969
- Horne CA, McClelland J, Valiela I (1994) The growth and consumption of macroalgae in estuaries: the role of invertebrate grazers along a nutrient gradient in Waquoit Bay, Massachusetts. *Biological Bulletin* 187:279-280

Technical Reports & Book Reviews

- Drew CA, Kwak TJ, Cope WG, Augspurger T (2015) Hierarchical Landscape Models for Endemic Unionid Mussels: Building Strategic Habitat Conservation Tools for Mussel Recovery in the South Atlantic Landscape Conservation Cooperative: Final Report. Prepared for the USFWS South Atlantic Landscape Conservation Cooperative, Raleigh, NC. 106 pp
- Drew CA, Stocking J, Collazo JC (2015) Strategic Decision Planning for Endangered Species Recovery in Puerto Rico: Final Report. Prepared for the USFWS Caribbean Ecological Services

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- Field Office, Puerto Rico by the USGS - North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University. 12 pp + Supplements
- Alexander-Vaughn LB, Collazo JA, Drew CA (2014) Strategic Conservation Planning for the Eastern North Carolina/Southeast Virginia Strategic Habitat Conservation Team. Technical Bulletin 337, North Carolina Agricultural Research Service, College of Agriculture and Life Sciences, North Carolina State University 109 pp +Appendices
- Drew CA, Collazo JA (2014) Bayesian Networks as a Framework to Step-down and Support Strategic Habitat Conservation of Data-poor Species: A case study with King Rail (*Rallus elegans*) in Eastern North Carolina and Southeastern Virginia. Prepared for the USFWS Region 4, Raleigh Field Office, North Carolina by the USGS - North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University. 105 pp +Appendices
- Drew CA, Alexander-Vaughn LB, Collazo JA, McKerrow A, Anderson J (2013) Developing an Outcome-based Biodiversity Metric in Support of the Field to Market Project. Technical Bulletin 334, North Carolina Agricultural Research Service, College of Agriculture and Life Sciences, North Carolina State University. 28 pp +Appendices
- Costanza, JK, Abt R, Drew CA, Gonzales R, Collazo JC (2013) Modeling Impacts of Biomass Production on Landscapes and Wildlife: Final Report to the Biofuels Center of North Carolina. 64 pp.
- Drew CA, Alexander-Vaughn LB, Collazo JA, Reid JP, Slone DH (2012) Science Summary in Support of Manatee Protection Area (MPA) Design in Puerto Rico. Technical Bulletin 330, North Carolina Agricultural Research Service, College of Agriculture and Life Sciences, North Carolina State University. 63 pp.+Appendices.
- Guenard B, Drew CA (2011) Ant Species of MacKay Island and Back Bay National Wildlife Refuges: Results of Opportunistic Sampling in Diverse Habitats in July 2010. Prepared for Back Bay and Mackay Island National Wildlife Refuges, U. S. Fish and Wildlife Service.
- Drew CA, Guenard B (2009) Collection of *Crematogaster atkinsoni* (Wheeler) on Mackay Island National Wildlife Refuge, Knotts Island, North Carolina. Prepared for Mackay Island National Wildlife Refuge, U. S. Fish and Wildlife Service.
- Drew CA (2008) Book Review: 'Age of Complexity' offers opportunity for the multidisciplinary perspective of landscape ecologists. *Landscape Ecology* 23: 629-631
- Drew CA, McKerrow AJ, Earsom S (2006) Stepping down regional habitat and population objectives to individual national wildlife refuges: A pilot project in the Roanoke-Tar-Neuse-Cape Fear (RTNCF) Ecosystem. *Gap Analysis Bulletin* 14: 53-61
- Horne CA, Ethier AE (1998) PreField Planning Report for Kaipit Lake Drainage Fish and Fish Habitat Reconnaissance Inventory. Prepared for Canadian Forest Products Ltd., Englewood Division, Woss, BC
- Ethier AE, Kashino R, Horne CA (1997) A Reconnaissance Survey of the Gordon River and Tributaries, Volumes I & II. Prepared for Ministry of Environment, Lands and Parks, Fisheries Inventory Program, Vancouver Island
- Blyth CA, McDonald JW, Canessa RR, Horne CA, Kashino R (1997) Shellfish Culture Capability Appraisal for Johnstone Strait. Prepared for BC Ministry of Agriculture, Fisheries & Food
- Blyth CA, McDonald JW, Horne CA, Canessa RR, Kashino R (1997) Shellfish Culture Capability Appraisal for Jervis Inlet. Prepared for BC Ministry of Agriculture, Fisheries & Food

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Teaching & Mentoring Publications

- Morzilla AT, Hollister JW, Drew CA, Rocca ME, Baker ME, Bossenbroek JM, Mazzarella CM (2008) A young scientist's guide to gainful employment: recent graduates' experiences and successful strategies. *Bulletin of the Ecological Society of America* 89:193-203
- Hess GR, Drew CA (2004) Inquiry Guided Learning through Collaborative Research. In Lee VS (ed.) Teaching and Learning through Inquiry: A Guidebook for Institutions and Instructors. Sterling, VA: Stylus Publishing.
- Drew CA, Hess GR (2003) Online publication enhances integration of current research in the classroom. *Conservation Ecology* 7(1): r12. [online] URL: <http://www.consecol.org/vol7/iss1/resp12>

SELECTED PARTICIPATION AT PROFESSIONAL MEETINGS

Research Presentations

- “Applications of Biodiversity Metrics on Private Lands for Conservation Outcomes” co-hosted symposium at the North American Congress for Conservation Biology, Montana, 2014
- “Habitat occupancy and effects of prescribed fire on King Rail”, invited community presentation, Restore Currituck Sound Planning Meeting, Barco, NC 2014
- “An Open Standards Recovery Plan for the Antillean Manatee in Puerto Rico”, invited presentation, Manatee Recovery 5 Year Review panel, Jacksonville, NC 2014
- “Eliciting Expert Knowledge in Support of Planning and Adaptive Management”, invited seminar presentation, *Science Community of Practice*, Whitehorse, Yukon 2014 and guest lecture to Decision Analysis for Conservation and Management of Natural Resources graduate class, NCSU 2014
- “Metrics to measure and communicate the biodiversity costs and opportunities in commercial agriculture systems”, oral presentation, North American Congress for Conservation Biology, Montana, 2014
- “Biodiversity metrics for agriculture: Bayesian models link field-scale decisions with species-level responses to advance conservation”, invited seminar, Smithsonian Institute, Washington DC, 2013
- “Hierarchical landscape models for endemic Unionid mussels: Building Strategic Habitat Conservation tools for mussel recovery in the South Atlantic Landscape Conservation Cooperative”, invited oral presentation, *US International Association for Landscape Ecology*, Newport, RI 2012
- “Vertebrate biodiversity in agricultural landscapes: Predicting impacts of alternative row crop production strategies”, poster presentation, *US International Association for Landscape Ecology*, Newport, RI 2012
- “A structured approach to designing protection areas for the Antillean manatee in Puerto Rico”, oral presentation, *International Sirenian Symposium*, Tampa, FL 2011
- “Expert-based BN models to set and update population and habitat objectives” *QUT Symposium on Eliciting Expert Knowledge: Methodology and Applications*, Brisbane, Australia 2011
- “Field validation and updating of an expert-based Bayesian Belief Network model to set population and habitat objectives for King Rail”, oral presentation *US International Association for Landscape Ecology*, Athens, GA 2010

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- “Comparing expert model predictions & field data for King Rail: building better management tools for secretive marsh birds”, oral presentation *Waterbird Society Annual Meeting*, Cape May, NJ, 2009
- “From expert-based to data-based decision support for Strategic Habitat Conservation”, invited plenary speaker, *US Fish and Wildlife Service’s Southeast Regional Biologists’ Conference* Callaway Gardens, GA 2009 and invited presentation, *US Fish and Wildlife Service’s Northeast Regional Project Leaders’ and Biologists’ Conference*, Virginia Beach, VA 2009
- “Expert knowledge and landscape applications”, workshop co-organizer with Ajith Perera *US International Association for Landscape Ecology*, Snowbird, UT, 2009
- “From expert-based to data-based adaptive management using Bayesian Belief Networks”, oral presentation, *US International Association for Landscape Ecology*, Snowbird, UT, 2009 and *INTECOL International Wetlands Conference*, Cuiabá, Brazil, 2008
- “Bayesian Belief Network model of King Rail occupancy of marsh habitats”, invited presentation, *Waterbird Society Annual Meeting*, South Padre Island, TX, 2008
- “Landscape ecology and poverty alleviation”, workshop co-organizer with Louis Iverson and Henry Bulley, *US International Association for Landscape Ecology*, Madison, WI, 2008
- “Bayesian Belief Networks: Linking science and management to better step-down national conservation objectives to regional and refuge levels”, oral presentation, *International Partners in Flight*, McAllen, TX, 2008 and *US International Association for Landscape Ecology*, Madison, WI, 2008
- “Stepping-down national population objectives to regional and refuge levels in North Carolina and Virginia”, oral presentation, *National Gap Analysis Program Conference*, Asheville, NC, 2007
- “Expert opinion & model error: when does fine-scale expert opinion improve large-scale regional species distribution models?”, oral presentation, *US International Association for Landscape Ecology*, Tucson, AZ, 2007
- “Defining and modeling species-habitat associations: challenges across landscapes and seascapes”, workshop co-organizer with Yolanda Wiersma and Falk Huettmann, *US International Association for Landscape Ecology*, Tucson, AZ, 2007
- “Local juvenile fish densities in Florida Keys mangroves correlate with regional landscape characteristics”, oral presentation, *International Symposium on Mangroves as Fish Habitat*, Miami, FL, 2006
- “Juvenile fish in backreef habitats: a landscape ecology perspective”, oral presentation, *Benthic Ecology Meeting*, Williamsburg, VA 2005 and *US International Association for Landscape Ecology*, Syracuse, NY, 2005
- “Walk, swim, or drift? Effects of varying dispersal strategy and habitat patchiness on recruitment success”, poster presentation, *International Association for Landscape Ecology World Congress*, Darwin, Australia, 2003
- “Crayons, focal species and inventories”, oral presentation, *The Wildlife Society*, Raleigh, NC, 2003
- “Dispersal and recruitment in terrestrial versus marine environments”, oral presentation, *Marine Benthic Ecology Meeting*, Orlando, FL, 2002

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TEACHING EXPERIENCE

Professional Development Workshops

- Introduction to R and R Studio (2016-present)
- Data Visualization with R's ggplot2 (2016-present)
- Interactive Data Visualization and Application Development with R Shiny (2016-present)
- Spatial Data in R (2016-present)

Graduate Courses

- Climate Change and Conservation Planning (NCSU, 2009)
- Hierarchical Species-Habitat Analysis and Conservation (NCSU, 2007 & 2008)
- Landscape Ecology (NCSU, 2002)

Undergraduate Courses

- Natural Resource Measurements (NCSU, 2003)

ACADEMIC GRANTS & AWARDS

NASA-MSU Professional Enhancement Award (\$300; 2005)

NSF Graduate Research Fellowship (DGE-0237090; \$79K; 2002-05)

North Carolina State University Graduate Alumni Scholarship (\$1000; 2000)

Dalhousie Graduate Scholarship (\$5000; 1996)

Phi Beta Kappa Scholarship & Honor Society 1995

Association of American University Women Award 1995

Beloit College Ericsson Chemistry Scholarship 1994

PROFESSIONAL SERVICE ACTIVITIES

Graduate Student Committees

Technical Advisor: Kara Dziwulski (NCSU, MS 2016; Samantha Rogers (NCSU, MS 2011)

Committee Member: Carol Brackett (ECU, MS 2013)

Organizational Leadership & Service

Research Triangle Analysts, co-host (2015-present)

New Heights youth climbing program, Board of Directors (2016-present)

USFWS Eastern North Carolina – Southeastern Virginia Strategic Habitat Conservation Team (2006-2014); Recipient of 2009 Regional Director's Strategic Habitat Conservation Leadership Award

US International Association of Landscape Ecologists: Executive Advisory Committee (2008-2012); Student Representative on Executive Committee (2003-2005); Best Student Presentation Judge (2006-present)

NCSU-Marine Earth & Atmospheric Sciences Graduate Student Association Secretary and Webmaster (2001-2003); Marine Conservation and Ecology Lab Webmaster (2001-2006)

Coastal Zone Canada: Executive Planning Committee (1997-1998)

The Beloit Biologist: Managing Editor (1995-1996)

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Working-Group Participation

SESYNC Think-tank: Recovery Under the Endangered Species Act (2015-2017)
USFWS Waterbird Habitat Monitoring Protocols: Wading Bird Sub-Group (2010)
NCWRC Integrating Climate Change into the Wildlife Action Plan (2010)
USFWS Priority Information Needs for Rails and Snipes: A Funding Strategy (2008-2009)

Community Outreach & Service

Presentations & Data Sharing: Yukon-Stikine Regional Science Fair; Friends of Mackay Island NWR; NC Natural Heritage Program; Mackay Island NWR; Back Bay NWR; VA Department of Game & Inland Fisheries; VA Department of Conservation and Recreation; Albermarle-Pamlico National Estuary Program;
Student Mentor & Tutor: Letters to a Pre-Scientist, Wolfpack Women in Science; NCSU-MEAS Grad-Undergrad Mentor Program; Wake County Readers to Achievers Program; Lutheran Family Services Refugee Resettlement Program; North Carolina Ocean Science Bowl; Beloit Girls and Women in Science Weekend; NCSU Expanding Your Horizons in Math, Science and Technology Conference

Manuscript Peer-Review

Landscape Ecology; Marine Ecology Progress Series; Wetlands; Estuarine Coastal and Shelf Science; Partners-in-Flight Proceedings; Hydrobiologia; Estuaries and Coasts; Ecography

Professional Affiliations

International Association of Landscape Ecologists; The Wildlife Society; Ecological Society of America; Society for Conservation Biology; American Fishery Society

CERTIFICATIONS & TRAINING

Master R, R Studio training (2017)
SenseMaker Environments, Signification Design, and Cynefin Framework Workshops (2015)
Analysis of Community Data with PC Ord and R (2014)
Bayesian Network Analysis with Netica (2013)
Introduction to Guidos (2013)
Introduction to R Programming (2012)
Elicitor & Probability Elicitation through Scenario Analysis (2011)
Modeling Patterns and Dynamics of Species Occurrence Workshop (2007)
Model Based Inference in the Life Sciences Workshop (2007)
ArcGIS and Spatial Analyst (2006); Introduction to Arc/Info (1999)
First Aid and CPR Certification, various agencies (1995-present)
Enriched Air Nitrox Diver, International Association of Nitrox & Technical Divers (2000)
National Undersea Research Center Diver Certification (2000)
Electrofishing Crew Supervisor, Malaspina University College (1998)
Essential Wilderness First Aid, Wilderness First Aid and Safety Association of BC (1998) ARC (2013)
PADI Advanced Open Water Diver (1993); PADI Open Water Diver (1988)