STEPHEN D. MCCORMICK

PERSONAL

Born: June 11, 1955 Schenectady, NY | Married Two children | U.S. Citizen

Business Address:

Conte Anadromous Fish Research Center
USGS, Biological Resources Division
One Migratory Way, PO Box 796
Turners Falls, MA 01376 USA
Phone: 413 863-3804 FAX: 413 863-9810
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CURRENT POSITION AND RESEARCH

Current postions: Section Leader, Physiology Laboratory, Conte Anadromous Fish Research Center, USGS
Full Professor (adjunct), Departments of Biology and Natural Resource Conservation, University of Massachusetts, Amherst

Research goals: To determine the environmental and hormonal control of osmoregulation, development, growth and energetics in fish.

Current research:
1) Hormonal control of salinity tolerance and mechanisms of ion transport in anadromous fish (salmon, shad and sturgeon).
2) Environmental regulation of migratory behavior and physiology in anadromous fish.
3) Impacts of climate change, acid rain and endocrine disruptors on fish.

EDUCATION

Ph.D.: Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Biological Oceanography
September 1983

Dissertation: "Effects of size, age and photoperiod on hypoosmoregulation in brook trout, Salvelinus fontinalis."

Undergraduate: Bates College, Lewiston, Maine
B.S., June 1977 Majors: Biology and Economics

TEACHING AND WORK EXPERIENCE

1990-	Section Leader/Physiology, Conte Anadromous Fish Research Center, USGS, Biological Resources Division, Turners Falls, MA.
2005-	Full Professor (adjunct), Department of Biology, University of Massachusetts, Amherst.
2003-2007	Graduate Program Director, Organismic and Evolutionary Biology Program, University of Massachusetts, Amherst.
1990-2005	Associate Professor (adjunct), Department of Biology, University of Massachusetts, Amherst.
1998-1999	Acting Director, Conte Anadromous Fish Research Center, USGS, Biological Resources Division, Turners Falls, MA.
1989-1990	Postdoctoral Researcher, Department of Integrative Biology, University of California, Berkeley.
1989-1990	Research Fellow, Ocean Research Institute, University of Tokyo (with Professor Tetsuya Hirano, 4 months).
1986-1989	National Institute of Health Postdoctoral Fellow (3 years) with Professor Howard A. Bern in the Department of Zoology, Univ. of California, Berkeley.
1986-1988	Instructor, Zoology 220: Special Topics in the Biology of Chemical Mediation University of California, Berkeley. (with Professor Howard A. Bern).
1988	Research Fellow (Swedish Natural Science Research Council), Department of Zoophysiology, University of Goteborg (with Prof B.Th. Bjornsson, July 1988).
1983-1986	Postdoctoral Fellow, Department of Fisheries and Oceans, St. Andrews Biological Station, New Brunswick, Canada.
1983	Postdoctoral Researcher, Department of Biology, Woods Hole Oceanographic Institution (3 months).
1980	Teaching Fellow at Harvard University (Biology of Fishes).Conducted 20 lab sessions, gave laboratory and class lectures and aided students in executing independent research projects.
1977-1978	Administrative Assistant, Food and Drug Research Labs (Waverly, NY), a contract toxicology firm.
1976	Laboratory Assistant, Bates College. Organized and conducted laboratory sessions for microbiology class.

HONORS AND FELLOWSHIPS

Phi Beta Kappa (Bates College)
Graduate cum laude (Bates College)
Milton Lindholm Scholar-Athlete Award (Bates College)
Pre-doctoral Scholarship from Tai Ping Foundation (1980-83, MIT/WHOI)
Natural Sciences and Engineering Research Council of Canada
Postdoctoral Fellowship (1983-86)
NATO Postdoctoral Fellowship (turned down)
NIH, National Research Service Award, 3 year fellowship
Research Fellowship, Swedish Natural Science Research Council,
University of Goteborg
Research Fellowship, Japanese Ministry of Education,
University of Tokyo and Ocean Research Institute
Travel Award, International Congress of Comparative Physiology and
Biochemistry, 1991 (Issued by National Science Foundation)
James Chair Visiting Professor, St. Francis Xavier University, Nova Scotia,
Canada, 1999
Japanese Society for the Promotion of Science (JSPS) Visiting Scientist Fellowship,
University of Hokkaido, 2002

SOCIETAL MEMBERSHIPS

American Association for the Advancement of Science
American Physiological Society
American Fisheries Society
President, Physiology Section (1998-9)
Society of Integrative and Comparative Biology
Chair Elect, Division of Comparative Endocrinology

SCIENTIFIC REFEREE

General and Comparative Endocrinology
(Associate Editor)
Aquaculture (Editorial Board)
Copeia (Editorial Board)
Fish Physiology and Biochemistry
Journal of Comparative Physiology
Canadian Journal of Fisheries and Aquatic
Sciences
Transactions of the American Fisheries
Society
Journal of Endocrinology
American Journal of Physiology

Journal of Experimental Biology
Ecological Applications
Physiological & Biochemical Zoology
Journal of Fish Biology
Aquatic Living Resources
Canadian Journal of Zoology
Journal of Membrane Biology
Endocrinology
North American Journal of Aquaculture
Comparative Biochemistry & Physiology
Aquatic Toxicology
Cellular and Molecular Endocrinology

STUDENTS AND COLLABORATORS

Graduate Students (current position)

Jill Leonard, Ph.D.1997 (Assistant Professor, University of Michigan, Marquette, MI)
Joseph Zydlewski, Ph.D. 1998 (USGS & Asst. Professor, Univ. of Maine, Orono, ME)
Ryan A. Pelis, M.S. 2000 (Postdoctoral Fellow, University of Arizona, Tucson, AZ)
Darren Lerner, Ph.D. 2006 (Assistant Professor, University of Hawaii, Manoa, HI)
Kathy Nieves-Puigdollar Ph.D. 2007 (Postdoctoral Fellow, Amherst College, MA)
Michelle Monette Ph.D. 2007 (Postdoctoral Fellow, Yale University, CT)
Luke Iwanowicz Ph.D. 2008 (Research Virologist, USGS, Leetown Science Center)
Joseph Chadwick Ph.D. candidate (OEB Program, Univ. of Mass, Amherst)

Postdoctoral Fellows (current position)

Gayle Zydlewski (Adjunct Professor, University of Maine, Orono, ME)
Mark Shrimpton, (Full Professor, University of Northern British Columbia, BC, Canada)
Juan Miguel Mancera (Full Professor, University of Cadiz, Spain)
Junya Hiroi (Assistant Professor, Marianna University, Tokyo, Japan)
Dianne Baker (Assistant Professor, Mary Washington College, VA)
John Kelly (Assistant Professor, University of New Haven, CT)
Arne Christensen (Postdoctoral Fellow, University of Massachusetts, Amherst)
Jason Breves (Postdoctoral Fellow, University of Massachusetts, Amherst)
Tom Nilsen (Postdoctoral Fellow, University of Bergen, Norway)

Current Collaborators

Thrandur Bjornsson, University of Goteborg, Sweden
Sigurd Steffansson, University of Bergen, Norway
Mark Shrimpton, University of Northern British Columbia, BC, Canada
Mark Sheridan, University of North Dakota, Fargo
Gordon Grau, University of Hawaii, Manoa
Keith Nislow, US Forest Service, Amherst MA
Takashi Yada, Freshwater Fisheries Agency, Nikko, Japan
Patrick Prunet, INRA, Rennes, France

Graduate Student Committee Member

Judy Shardo, Dept. of Biology, University of Massachusetts, Amherst. Ph.D. May, 1994
Kevin Whalen, Dept. of Forestry and Wildlife, Univ. of Mass., Amherst. Ph.D. Jan. 1998
Adam Summers, Dept. of Biology, Univ. of Massachusetts, Amherst. Ph.D. March 1999
Lisa Yako, Dept. of Forestry and Wildlife, Univ. of Massachusetts, Amherst May 1996
Nathan Henderson, Dept. Natural Res. Cons., Univ. of Mass., Amherst. M.S. April 2000.
Manny Azizi, Organismic and Evolut. Biology, Univ. of Mass. Amherst. Ph.D. June 2005
Nicole Danos, Organismic and Evolut. Biology, Univ. of Mass. Amherst. M.S.April 2005
Christine Buckley, Organismic & Evolut. Biol, Univ. of Mass. Amherst. Ph.D. May 2008
Natasha Kobokov, Organismic & Evolut. Biol, Univ. of Mass, Amherst Ph.D. April 2009
David McMillan, Organismic & Evolut. Biol, Univ. of Mass, Amherst. Ph.D. Sept. 2009
Christine Duncan, Endocrinology and Animal Biosciences, Rutgers University. Ph.D.
Justin Hemingsen, Organismic and Evolutionary Biology, Univ. of Mass, Amherst. Ph.D.

Graduate and Postdoctoral Advisors

Robert J. Naiman, University of Washington
Richard L. Saunders (retired), Dept. of Fisheries & Oceans, St. Andrews, NB Canada
Howard A. Bern (professor emeritus), University of California, Berkeley
Tetsuya Hirano (professor emeritus), University of Hawaii

GRANTS

US Forest Service 1995-1997: $110,000
"Impact of Stream Habitat Improvement on Smolting, Maturation and Survival of Atlantic Salmon."

Sea Grant (Woods Hole) 2002-2004: $120,000
"Developmental Effects of Contaminants on Salinity Preference and Seawater Survival of Atlantic Salmon: Integrating Physiology and Behavior."

US Forest Service 2003-2005: $70,000
"Acidification Impacts on Atlantic Salmon in New England."

US Fish and Wildlife Service \ USGS Quick Response Program 2003-2004: $10,000
"Physiological Development of Atlantic Salmon Smolts on the Merrimac River."

US Fish and Wildlife Service \ USGS Quick Response Program 2005-2006: $30,000
"Detection of acid and aluminum impacts on Maine Atlantic salmon."

US Forest Service 2006-2008: $142,000
"Stream fishes as sentinels for acid-aluminum impacts in New England forested ecosystems."

US Fish and Wildlife Service \ USGS Science Support Program 2005-2006: $99,760
"Acid and aluminum impacts on Maine Atlantic salmon: survey of labile aluminum and its impact on smolt migration and survival."

USDA CSREES, 2008-2010: $273,000
"Ion transport proteins and seawater growth performance of Atlantic salmon"

TEACHING EXPERIENCE

Biology of Diadromous Fish (2002, 2004, 2006, 2008), Univ. of Massachusetts, Amherst
Co-Instructor

Ichthyology (annually, 2005-2009), Univ. of Massachusetts, Amherst
Lectures in Osmoregulation, Respiration, Endocrinology

Comparative Physiology (2003), Univ. of Massachusetts, Amherst
Lecture in Osmoregulation

Endocrine Disruptors (2006), Univ. of Massachusetts, Amherst
Lecture in Endocrine Disruptors in Fish

Environmental Physiology of Fishes (2008, 2005), University of Hawaii, Manoa
Guest Instructor

RESEARCH TECHNIQUES

- Radioimmunoassay and ELISA
- Enzymology and biochemistry
- Electrophysiology (whole-animal and Ussing chamber)
- Animal surgery (e.g. hypophysectomy)
- Organ and cell culture
- Whole animal and tissue oxygen uptake
- Quantitative fluorescence microscopy
- Histology and light microscopy
- Radiolabelled tracers in ion transport
- Quantitative gene expression (qPCR)
- Atomic absorption spectrophotometry, osmometry, chloridometry
- Computer programming (BASIC) and statistics
- Techniques in Fisheries Biology
- Fish and aquatic invertebrate culture

PUBLICATIONS Total: 132

Liebich, T., McCormick, S.D., Kircheis, D., Johnson, K., Regal, R. and Hrabik, T. 2011. Water chemistry and its impacts on the physiology and survival of Atlantic Salmon (Salmo salar) smolts in eastern Maine, USA. **Journal of Fish Biology** (in press).

Yada, T, McCormick, S.D. and Hyodo, S. 2010. Effects of environmental salinity, biopsy, and GH and IGF-1 administration on the expression of immune and osmoregulatory genes in the gills of Atlantic salmon (*Salmo salar*). **Aquaculture** (in press).

McCormick, S.D., Lernrer, D.T., Regish, A.M., O'Dea, M.F. and Monette, M.Y. 2010. Thresholds for short-term acid and aluminum impacts on Atlantic salmon smolts. **Aquaculture** (in press).

Hanson, A. Kittilson, J., McCormick, S.D. and Sheridan, M. 2010. Effects of environmental estrogens on the growth hormone-insulin-like-growth factor and seawater adaptation of rainbow trout. **Aquaculture** (in press).

Steffanson, S., Hangland, M. B.Th. Bjornsson, S.D. McCormick, M. Holm, L.O. Ebbesson, J. Chr. Holst, T.O. Nilsen. 2010. Growth, osmoregulation and endocrine changes in wild Atlantic salmon post-smolts during marine migration. **Aquaculture** (in press).

Björnsson, B.Th., Stefansson, S.O. and McCormick, S.D. 2011. Environmental Endocrinology of salmon smoltification. **General and Comparative Endocrinology** 170: 290-298

Close, D., Yun, S.-S., McCormick, S.D., Wildbill, A.J., Li, W. 2010. 11-deoxycortisol is a corticosteroid hormone in lamprey. **Proceedings of the National Academy of Sciences** 107: 13942-13947.

Monette, M.Y., Yada, T., Matey, V. and McCormick, S.D. 2010. Physiological, molecular and cellular mechanisms of impaired seawater tolerance following exposure of Atlantic salmon, *Salmo salar,* smolts to acid and aluminum. **Aquatic Toxicology** 99: 17-32.

McCormick, S.D., Regish, A.M. and Christensen, A.K. 2009. Distinct freshwater and seawater isoforms of Na^+/K^+-ATPase in gill chloride cells of Atlantic salmon. **Journal of Experimental Biology** 212: 3994-4001.

Husak, J.F., Irschick, D.J., McCormick, S.D., Moore, I.T. 2009. Hormonal regulation of whole-animal performance: implications for selection. **Integrative and Comparative Biology** 46: 349-353.

McCormick, S.D. 2009. Evolution of the hormonal control of animal performance: insights from the seaward migration of salmon. **Integrative and Comparative Biology** 46: 408-422.

Frank, H.J., Mather, M.E., Smith, J.M., Muth, R.M., Finn, J.T. and McCormick, S.D. 2009. What is "fallback"?: metrics needed to assess telemetry tag effects on anadromous fish behavior. **Hydrobiologia** 635: 237-249.

McCormick, S.D., D.T. Lerner, M.Y. Monette, K. Nieves-Puigdoller, and B.Th. Björnsson. 2009. Taking it with you when you go: how perturbations to the freshwater environment, including temperature, dams and contaminants, affects seawater performance of anadromous fish. ***Challenges For Diadromous Fishes in a Dynamic Global Environment.*** **American Fisheries Society Symposium 69,** 195-214**.** Bethesda, Maryland, USA. Editors: Haro, A. J., K. L. Smith, R. A. Rulifson, C. M. Moffitt, R. J. Klauda, M. J. Dadswell, R. A. Cunjak, J. E. Cooper, K. L. Beal, and T. S. Avery.

Denver, R.J., Hopkins, P.M., McCormick, S.D., Propper, C.R., Riddiford, J.C., Sower, S.A. and Wingfield, J.C. 2009. Comparative endocrinology in the 21st century. **Integrative and Comparative Biology** 49: 339-348.

Iwanowicz, L.R., Blazer, V.S., McCormick, S.D., Van Veld, P.A., Ottinger, C.A. 2009. Aroclor 1248 exposure leads to immunomodulation, decreased disease resistance and endocrine disruption in the brown bullhead, *Ameiurus nebulosus*. **Aquatic Toxicology** 93: 70-82.

McCormick, S.D., Keyes, A., Monette, M.Y. and Nislow, K.H. 2009. Impacts of episodic acidification on in-stream survival and physiological impairment of Atlantic salmon (*Salmo salar*). **Canadian Journal of Fisheries and Aquatic Sciences** 66: 394-403.

Smith, J.M., Mather, M.E., Frank, H.J., Muth, R.M., Finn, J.T. and McCormick, S.D. 2009. Evaluation of a gastric radio tag insertion technique for anadromous river herring. **North American Journal of Fisheries Management** 29: 367-377.

Monette, M.Y., Björnsson, B.Th. and McCormick, S.D. 2008. Effects of short-term acid and aluminum exposure on the parr-smolt transformation of Atlantic salmon (*Salmo salar*): disruption of seawater tolerance and endocrine status. **General and Comparative Endocrinology** 158: 122-130.

Hiroi, J., Yasumasu, S., McCormick, S.D, Hwang, P.-P. and Kaneko, T. 2008. Evidence for an apical Na-Cl cotransporter involved in ion uptake in a teleost fish. **Journal of Experimental Biology** 211: 2584-2500.

Stefansson, S.O., Björnsson, B.Th., Ebbesson, L.O.E. and McCormick, S.D. 2008. Smoltification. In: **Fish Larval Physiology** (Finn, R.N. and Kapoor, B.G., Eds). Science Publishers, Inc. Enfield (NH) & IBH Publishing Co. Pvt. Ltd., New Delhi ISBN 978-1-57808-388-6.

McCormick, S.D., O'Dea, M. and Regish, A. Shrimpton, J.M.. 2008. Are we missing a mineralocorticoid in fish? Effects of cortisol, deoxycorticosterone and aldosterone on osmoregulation, gill Na^+,K^+-ATPase activity and isoform mRNA levels in Atlantic salmon. **General and Comparative Endocrinology** 157: 35-40.

Reis-Santos, P., McCormick, S.D. and Wilson, J.M. 2008. Ionoregulatory changes during metamorphosis and salinity exposure of juvenile sea lamprey (*Petromyzon marinus* L.). **Journal of Experimental Biology** 211: 978-988.

Nilsen, T.O., Ebbesson, L.O.E., Kiilerich,P., Björnsson, B.Th., Madsen, S.S., McCormick, S.D. and Stefansson, S.O. 2008. Endocrine systems in juvenile anadromous and landlocked Atlantic salmon (*Salmo salar*). **General and Comparative Endocrinology** 155: 762-772.

Monette, M.Y. and McCormick, S.D. 2008. Impacts of short-term acid and aluminum exposure on Atlantic salmon (*Salmo salar*) physiology: a direct comparison of parr and smolts. **Aquatic Toxicology** 86: 216-226.

Nilsen, T.O.; Ebbesson, L.O.E.; Stefansson, S.O.; Madsen, S.S.; McCormick, S.D.; Andersson, E.; Bjornsson, B.Th.; Prunet, P. 2007. Differential expression of gill Na+,K+-ATPase α- and β-subunits, Na+,K+,2Cl- cotransporter and CFTR anion channel in juvenile anadromous and landlocked Atlantic salmon *Salmo salar*. **Journal of Experimental Biology** 210: 2885-2896.

Mackie, P.M., Gharbi,K., Ballantyne, J.S., McCormick, S.D. and P.A. Wright. 2007. Na+/K+/2Cl- cotransporter and CFTR gill expression after seawater transfer in smolts (0+) of different Atlantic salmon (*Salmo salar*) families. **Aquaculture** 272: 625-635.

Mancera, J.M. and McCormick, S.D. 2007. Role of prolactin, growth hormone, insulin-like growth factor I and cortisol in fish osmoregulation. In: **Fish Osmoregulation** (Baldisserotto B., Mancera J.M., and Kapoor B.G., Eds). Science Publishers, Inc. Enfield (NH) & IBH Publishing Co. Pvt. Ltd., New Delhi ISBN 978-1-57808-447-0.

Hiroi, J., McCormick, S.D. 2007. Variation in salinity tolerance, gill Na+/K+-ATPase, Na+/K+/2Cl– cotransporter and mitochondrion-rich cell distribution among three salmonids *Salvelinus namaycush, Salvelinus fontinalis* and *Salmo salar*. **Journal of Experimental Biology** 210: 1015-1024.

Nieves-Puigdoller, K., Björnsson, B.Th., McCormick, S.D. 2007. Detrimental effects of hexazinone and atrazine on Atlantic salmon (*Salmo salar*) smolt. **Aquatic Toxicology** 84: 27-37.

Lerner, D.T., Björnsson, B.Th., McCormick, S.D. 2007. Larval exposure to 4-nonylphenol and 17β-estradiol affects physiological and behavioral development of seawater adaptation in Atlantic salmon smolts. **Environmental Science & Technology** 41: 4479-4485.

Stefansson, S.O., Nilsen, T.O., Ebbesson, L.O.E., Wargelius, A., Madsen, S.S.;; Andersson, E.; Björnsson, B.Th., and McCormick, S.D. 2007. Molecular mechanisms of continous light inhibition of Atlantic salmon parr-smolt transformation. **Aquaculture** 273: 235-245.

McCormick, S.D., Shrimpton, J.M., Moriyama, S., Björnsson, B.Th. 2007. Differential hormonal responses of Atlantic salmon parr and smolt to increased daylength: a possible developmental basis for smolting. **Aquaculture** 273: 337-344.

Poppinga, J., Kittilson, J., McCormick, S.D., Sheridan, M.A. 2007. Effects of somatostatin on the growth hormone-insulin-like growth factor axis and seawater adaptation of rainbow trout (*Oncorhynchus mykiss*). **Aquaculture** 273: 337-344.

Lerner, D.T., Björnsson, B.Th., McCormick, S.D. 2007. Aqueous exposure to 4-nonylphenol and 17B-estradiol increases stress sensitivity and disrupts ion regulatory ability of juvenile Atlantic salmon, *Salmo salar*. **Environmental Toxicology and Chemistry** 26: 1433-1440.

Lerner, D.T., Björnsson, B.Th., McCormick, S.D. 2006. Effects of aqueous exposure to polychlorinated biphenyls (Arocolor 1254) on physiology and behavior of smolt development of Atlantic salmon. **Aquatic Toxicology** 81: 329-336.

Sakamoto, T. and McCormick, S.D. 2006. Role of prolactin and growth hormone in osmoregulation of teleost fish. **General and Comparative Endocrinology** 147: 24-30.

McCormick, S.D. and Bradshaw, D. 2006. Hormonal control of salt and water balance in vertebrates. **General and Comparative Endocrinology** 147: 3-8.

Rees, C.B., McCormick, S.D. and Li, W. 2005. A non-lethal method to estimate CYP1A expression in laboratory and wild Atlantic salmon (*Salmo salar*). **Comparative Biochemistry and Physiology Part C** 141: 217-224.

Hiroi, J., McCormick, S.D., Ohtani-Kaneko, R. And Kaneko, T. 2005. Functional classification of mitochondrion-rich cells in euryhaline Mozambique tilapia (*Oreochromis mossambicus*) embryos, by means of triple immunoflourescence staining for Na+/K+-ATPase, Na+/K+/2Cl-contransporter and CFTR anion channel. **Journal of Experimental Biology** 208: 2023-2036.

Luo, Q., Matoshi, B., Ando, H., Kitahashi, T., Bhandari, R.K., McCormick, S.D. and Urano, A. 2005. Distinct effects of 4-nonylphenol and estrogen-17β on expression of estrogen receptor α gene in smolting sockeye salmon. **Comparative Biochemistry and Physiology** 140: 123-130.

McCormick, S.D., O'Dea, M.F., Moeckel, A.M., Lerner, D.T. and Björnsson, B.Th. 2005. Endocrine disruption of parr-smolt transformation and seawater tolerance of Atlantic salmon by 4-nonylphenol and 17 -estradiol. **General and Comparative Endocrinology** 142: 280-288.

Reinecke, M., Björnsson, B.Th., Dickhoff, W.W., McCormick, S.D., Navarro, I., Power, D.M. and Guitierrez, J. 2005. Growth hormone and insulin-like growth factors in fish: Where are we and where to go. **General and Comparative Endocrinology** 142: 20-24.

Iwanowicz, L.R., Lerner, D.T., Blazer, V.S. and McCormick, S.D. 2005. Aqueous exposure to Aroclor 1254 modulates the mitogenic response of Atlantic salmon anterior kidney T-cells: Indications of short- and long-term immunomodulation. **Aquatic Toxicology** 72: 305-314.

Jackson, L.F., McCormick, S.D., Madsen, S.S., Swanson, P. and Sullivan, C.V. 2005. Osmoregulatory effects of hyopphysectomy and homologous prolactin replacement in hybrid striped bass. **Comparative Biochemistry and Physiology, Part B** 140: 211-218.

Marshall, W.S., Cozzi, R.R.F., Pelis, R.M. and McCormick, S.D. 2005. Cortisol receptor blockade and seawater adaptation in the euryhaline teleost *Fundulus heteroclitus*. **Journal of Experimental Zoology** 303A: 132-142.

Zydlewdski, G.B., Haro, A.J., and McCormick, S.D. 2005. Evidence for cumulative temperature as an initiating and terminating factor in downstream migratory behavior of Atlantic salmon (*Salmo salar*) smolts. **Canadian Journal of Fisheries and Aquatic Sciences** 62: 68-78.

Handeland, S.O., Wilkinson, E., Sveinsbo, B., McCormick, S.D. and Stefansson, S.O. 2004. Temperature influence on the development and loss of seawater tolerance in two fast-growing strains of Atlantic salmon. **Aquaculture** 233: 513-529.

Zydlewski, J., McCormick, S.D. and Kunkel, J. 2003. Late migration and seawater entry is physiologically disadvantageous for American shad juveniles. **Journal of Fish Biology** 63, 1521-1537.

McCormick, S.D., Sundell, K., Björnsson, B.Th, Brown, C.L. and Hiroi, J. 2003. Influence of salinity on the localization of Na+,K+-ATPase, Na+,K+,2Cl- cotransporter (NKCC) and CFTR anion channel in chloride cells of the Hawaiian goby (*Stenogobius hawaiiensis*). **Journal of Experimental Biology** 206: 4575-4583.

Pelis, R.M. and McCormick, S.D. 2003. Fin development in stream- and hatchery-reared Atlantic salmon. **Aquaculture** 220: 525-536.

Stefansson, S.O., Björnsson, B.Th., Sundell, K., Nyhammer, G. and McCormick, S.D. 2003. Physiological characteristics of wild Atlantic salmon post-smolts during estuarine and coastal migration. **Journal of Fish Biology** 63: 942-955.

Stefansson, S.O., McGinnity, P., Björnsson, B.Th., Schreck, C.B. and McCormick, S.D. 2003. The importance of smolt development to salmon conservation, culture and management: perspectives from the 6th International Workshop on Salmonid Smoltification. **Aquaculture** 222: 15-28.

Shrimpton, J.M. and McCormick, S.D. 2003. Environmental and endocrine control of gill corticosteroid receptor number and affinity in Atlantic salmon (*Salmo salar*) during smolting. Aquaculture 222: 83-99.

Singer, T.D., Finstad, B., McCormick, S.D., Wiseman, S.B., Schulte, P.M. and McKinley, R.S. 2003. Interactive effects of cortisol treatment and ambient seawater challenge on gill Na+,K+-ATPase and CFTR expression in two strains of Atlantic salmon smolts. **Aquaculture** 222: 15-28.

McCormick, S.D., O'Dea, M.F., Moeckel, A.M., Björnsson, B.Th. 2003. Endocrine and physiological changes in Atlantic salmon smolts following hatchery release. **Aquaculture** 222: 45-57.

Magee, J. A., Obedzinski, M., McCormick, S.D. and Kocik, J. F. 2003. Effects of episodic acidification on Atlantic salmon (*Salmo salar*) smolts. **Canadian Journal of Fisheries and Aquatic Sciences** 60: 214-221.

Rees, C.B., McCormick, S.D., Vanden Heuvel, J.P. and Li, W. 2003. Quantitative analysis of CYP1A induction in Atlantic salmon (*Salmo salar*). **Aquatic Toxicology** 62: 67-78.

McCormick, S.D., Shrimpton, J.M., Björnsson, B.Th. Moriyama, S. 2002. Effects of an advanced temperature cycle on smolt development and endocrinology indicate that temperature is not a zeitgeber for smolting in Atlantic salmon. **Journal of Experimental Biology** 205: 3553-3560.

Shrimpton, J.M. and McCormick, S.D. 2002. Seasonal changes in androgen levels in stream- and hatchery-reared Atlantic salmon and their relationship to smolting. **Journal of Fish Biology** 61: 1294-1304.

McCormick, S.D. 2001. Endocrine control of osmoregulation in teleost fish. **American Zoologist** 41: 781-794.

Magee, J.A., Haines, T.A., Kocik, J.F., Beland, K.F. and McCormick, S.D. 2001. Effects of acidity and aluminum on the physiology and migratory behavior of Atlantic salmon smolts in Maine, USA. **Water, Air, and Soil Pollution** 130:881-886.

Zydlewski, J.D. and McCormick, S.D. 2001. Developmental and environmental regulation of chloride cells in young American shad, *Alosa sapidissima*. **Journal of Experimental Zoology** 290:73-87.

Shrimpton, J.M. Zydlewski, J.D. and McCormick, S.D. 2001. The stress response of juvenile American shad to handling and confinement is greater during migration in freshwater than in seawater. **Transactions of the American Fisheries Society** 130:1203-1210.

Zydlewski, G.B., Haro, A., Whalen, K.G. and McCormick, S.D. 2001. Performance of stationary and portable passive transponder detection systems for monitoring of fish movements. **Journal of Fish Biology** 58:1471-1475.

Leonard, J.B.K. and McCormick, S.D. 2001. Metabolic enzyme activity in stream- and hatchery-reared Atlantic salmon (*Salmo salar*). **Canadian Journal of Fisheries and Aquatic Sciences** 58:1585-1593.

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