

Environmental Institute Pre-proposal

**Managing Puget Sound Ecosystem Health: A Natural and
Human Dimensions Approach**

Steven B. Roberts: Assistant Professor, School of Aquatic and Fishery Sciences

Stanley T. Asah: Assistant Professor, School of Forest Resources

Marc L. Miller: Professor, School of Marine Affairs

Managing Puget Sound Ecosystem Health: A Natural and Human Dimensions Approach

Abstract

The sustainability of Puget Sound is an important issue to resource managers, diverse interest groups, and the public. Successful Puget Sound ecosystem management is facilitated by assessments of ecosystem health, public attitudes, and effective diffusion of scientific results. This multidisciplinary proposal is attuned to the goal of improving Puget Sound ecosystem health by linking activities across the College of the Environment while incorporating strong collaborations with stakeholders outside of the University. This research focuses on a coupled social-ecological system by taking a natural and human dimensions approach. Specifically, 1) the biological agenda concerns assessment of Puget Sound's health using the Pacific oyster as a water quality indicator, 2) the social agenda concerns assessment of attitudes and perceptions of stakeholders regarding ecosystem health, and 3) the public engagement and outreach agenda concerns the design of a strategy for affecting positive changes in attitudes and personal conduct. The significance of the research will lie in an enhanced understanding of ecosystem health and the ability to engage the public to consider environmental ramifications in decision making processes. Furthermore, the novel approaches along with the truly integrative collaboration among biological and social sciences will lay the foundation for similar activities both regionally and globally.

DESCRIPTION OF THE INVESTIGATION

It is increasingly evident that human activities both influence and are influenced by coastal ecosystems. In some instances the problematic nature of these influences are obvious and in others they lay hidden. The local population significantly contributes to the cumulative health of Puget Sound. The beauty and vastness of the system, which attracts people to the area, also provides a false sense of security that the system can withstand the stressors such as the addition of toxins, excess nutrients, and pharmaceuticals. This research proposal regards Puget Sound and its people as a prime exemplar of a "social-ecological system" (SES) amenable to resilience analysis, adaptive resource management, and adaptive governance (Beatley, 2009, Walker and Salt, 2006, and Walker *et al.*, 2004). To improve management of Puget Sound ecosystem health it is useful to have an understanding of the biological and ecological conditions of the Sound, and public attitudes of Puget Sound health. These understandings can then be used to design a strategy to engage the public in a manner that will ultimately transform behavior and support policy.

The specific questions to be addressed in the current proposal are:

- I. What does the Pacific oyster tell us about the health of Puget Sound?
- II. What are public attitudes towards, and perceptions of, the health of Puget Sound?
- III. How can we influence positive public behavior to improve ecosystem health in Puget Sound?

In order to address these questions an interdisciplinary natural and human dimensions approach (see, for example, National Centers for Coastal Ocean Science, 2007) will be taken with groups from several entities within the College of the Environment—the School of Aquatic and Fishery Sciences, the School of Forest Resources, and the School of Marine Affairs—working together with stakeholders. The remainder of this section will describe specific methods that will be used to answer these three research questions.

I. Assessing the Health of Puget Sound (Biological Component)

This section describes the Pacific oyster as an indicator of Puget Sound ecosystem health as well as discussing methodologies for evaluating the biological condition of Pacific oysters at multiple field sites. The methods include (i) gene expression analysis and (ii) epigenetic characterization.

The Pacific oyster is an exceptional environmental monitor as i) they are common; ii) widely distributed; iii) immobile with high site fidelity; iv) reasonably resistant to contaminants; and v) continuously filter the water that they live in. These characteristics, coupled with the economic prominence and genomic resources available for this species, will allow us to characterize biological effects, identify environmental threats, and actively engage the public in the project. Two separate genomic approaches will be taken to examine the biological condition of oysters at multiple field sites across Puget Sound. Firstly, gene expression analysis on select genes will allow for the detection of threats organisms face in a particular habitat. The second approach will examine the epigenetic effects associated with environmental condition.

Gene Expression Analysis: To elucidate physiological responses and identify environmental threats expression analysis will be carried out on a suite of Pacific oyster genes responsive to a variety of ecological threats. The threats and corresponding genes (in parentheses) include estrogenic-like compounds (vitellogenin), xenobiotics (CYP1A1), heavy metals (metallothioneins), and hypoxia (hypoxia inducible factors). Samples (gill tissue) will be processed and analyzed using quantitative RT-PCR as previously described (Roberts *et al.*, 2008).

DNA Methylation Analysis: Epigenetics refers to heritable changes to physiological responses that are not reflected at the nucleotide level, such as DNA methylation. DNA methylation is the addition of a methyl group to DNA (commonly a cytosine), which inhibits gene transcription. Environmental conditions can non-specifically alter DNA methylation patterns with severely detrimental effects (Crews and McLachlan, 2006). For example, in mammals, environmental factors (e.g. BPA, toxins, diet) have been shown to alter reproductive physiology, promote tumors, and alter development, all of which can persist through multiple generations. Our preliminary work has shown differential methylation patterns in oysters exposed to toxic compounds (phenols) as well as variations across natural populations. To our knowledge, this is the first examination of the epigenetic effects of water quality on any marine invertebrate. Here we propose to characterize differences in DNA methylation patterns in Puget Sound.

II. Social Constructions of Puget Sound Ecosystem Health (Social Component)

This section describes a series of social science methodologies for the: (i) identification of the prevailing social perspectives/constructions regarding the health of Puget Sound ecosystem, and (ii) assessment of the prevalence of those constructions.

We note that a vital issue in environmental management and policy is the identification of how diverse stakeholders ‘think about’ environmental issues. This is of central importance because until we know about what and how the public thinks about the health of the Puget Sound, it is hard to judge what and whether policies will be socially and politically acceptable, and therefore implementable. We argue that it is both normatively and politically imperative to know how diverse stakeholders subjectively understand and construct their worlds around the health of the Puget Sound ecosystem. Additionally, obvious economic ramifications of the Pacific oyster and marine management might play a role in shaping public perceptions and acceptance of management and policy initiatives geared towards maintaining and/or improving the health of the Puget Sound ecosystem.

Interviewing Methodology: Interviews will be conducted using semi-structured, open ended research interviews (Anderson and Killenburg, 2009, Kvale, 1996, and Fontana and Frey, 1994) designed to identify key stakeholders from whom we will gather perspectives about, and attitudes toward, the health of Puget Sound ecosystem.

The goal is to elicit prevailing social constructions for several stakeholder groups (fishermen, recreationists, natural resource managers, the business community, etc.), and to see how these differ across stakeholder groups and research sites. To give structure to those constructions, procedures will be implemented collectively known as Q-methodology (Devaney *et al.*, 2009, Webler *et al.*, 2009, Brown, 2004, Adams and Proops, 2000, Stephenson, 1953). The basic steps of Q-methodology relevant to this study are as follows:

- Step 1: Determine objectives: Establish the relevant topic and sub-segment of the population.
- Step 2: Use interview transcripts to create a concourse.
- Step 3: Thematic analysis of the concourse and representative sampling of themes
- Step 4: Design conditions of instruction and sorting procedures.
- Step 5: Identify and recruit stakeholders to be Q participants
- Step 6: Conduct Q sorts with stakeholders.
- Step 7: Analyze the Q sort data using factor analysis techniques to arrive at social perspectives.
- Step 8: Report findings (management and policy implications) and use social constructs as the basis for survey instrumentation.

Questionnaire Development and Administration: The constructs emerging from Q-methodology will inform development of psychometric scales (DeVellis, 2003, and Spector, 1992). These scales will be administered as a survey questionnaire assessing the degree and prevalence of those constructs among stakeholders (Dillman *et al.*, 2009). Questionnaires will elicit relevant socio-demographic characteristics of participants, and the salience and prevalence of Q-identified constructs within and across characteristic groups.

III. Improving Puget Sound Health (Public Engagement Component)

By utilizing the biological and social science data associated with the two sections above, we will unite the research teams to design and implement public engagement mechanisms aimed at promoting positive behavior towards managing the health of the Puget Sound. The elicited constructs, and the salience and prevalence of those constructs across various stakeholder and socio-demographic groups will also inform management and policy options.

We will embark on disseminating public engagement mechanisms, primarily via communication strategies (Corbett, 2006, and Cox, 2006) using social norms and the psychology of persuasion (Golstein *et al.*, 2008, and Cialdini, 2007). Public engagement efforts will aim to influence desirable attitudes and behaviors towards efforts to manage for the health of the Puget Sound ecosystem using the Pacific oyster as an indicator species (McKenzie-Mohr and Smith, 2006). This effort will also assess management and policy compliance and the success of public engagement initiatives. That assessment will involve comparative analyses between recipients and non-recipients of public engagement initiatives. For specific examples of engagement strategies see “Anticipated Results” section below.

PROJECT PARTNERS

This multidisciplinary project will involve the expertise and assistance of individuals and entities apart from the principal investigators and their students. At the pre-proposal stage we have been in conversation with several entities that are excited about moving forward with the proposed project. These groups and others that we intend to incorporate into project development and implementation include; Washington Sea Grant, Pacific Shellfish Institute, Puget Sound Partnership, Pacific Coast Shellfish Growers Association, Association of Women in Science, Seattle Chapter, Girls in Engineering, Math and Science (GEMS) Program; Washington State Parks, Washington State Department of Health: Office of Shellfish and Water Protection, and Drayton Harbor Shellfish Protection District’s Citizens Advisory Committee.

ANTICIPATED RESULTS

From a biological perspective, this project will provide valuable data on the health of the coastal ecosystem through the complementary application of established biomarkers as well as novel investigations into epigenomic effects. This information will aid resource managers, policy makers, and scientists in assessing remediation efforts, restoration activities, and allow for informed predictions of risks associated with changes in habitat quality. These data will also be immediately relevant for projecting the status of shellfish into the future. This will be one of the first times global DNA methylation patterns have been used to assess environmental impacts on aquatic organisms, thus our experiences with this approach will be of value to other researchers.

From a social perspective, we will have a comprehensive view of the social constructions regarding the health of Puget Sound, which will in turn allow us to share our biological data effectively. The data we gain regarding perceptions of the status of the Puget Sound ecosystems as well as the perceptions of the Pacific oyster will be valuable to other groups as well. This would include non-profit organizations, regional aquaculture industry groups, other researchers, educators, citizen advisory committees, and municipalities. We have been in conversation with several of these groups and will be involving them in the development and implementation of a full proposal to insure for the most effective use of our combined activities.

From a public engagement perspective, upon the completion of the current proposal we will have an improved protocol for translating scientific information. A simplified example of how our human dimension component will influence outreach is that if we find certain segments of the population that readily identify with the oyster – we would discuss the health of ecosystem and direct, long-term effects on shellfish populations. Conversely, if another segment of the population values shellfish (or aquatic organisms) to a lesser degree - increased effort will be placed in translating the scientific findings in a value-attached manner. For instance, we could highlight similarities in biological process in oysters and mammals, which would more likely influence perceptions. Not only will the information be tailored to a target audience but we will also be able to optimize the format. Mechanisms for public engagement will include conventional paper media, industry trade publications, social media, as well as direct education in the public school system. The effectiveness of engagement will also be of value to our collaborators outside the University. These same collaborations will likewise be important in offering direct access to specific contingencies.

Finally, and from an intellectual perspective, this research effort will contribute to the refinement of the social-ecological system research paradigm within the College of the Environment. Ultimately, the true integration of biological and social sciences within the University, in collaboration with a diverse group of stakeholders, will lay the foundation for the success of research and education efforts in the new College.

TIMELINE

During the first half of year 1, laboratory assays and sampling procedures will be validated. Oyster sampling will occur during the second half of year 1 and the first half of year 2 to best characterize any seasonal variation. Assessments of public perceptions of the health Puget Sound will be carried out during year 1 primarily through interviews and small meetings. During year 2, the social constructions will be identified, a survey of the prevalence of those constructions will be conducted and data analyzed, and these information integrated into effective dissemination of scientific results. During the last half of year two we will also meet with collaborators (e.g. industry organizations, non-profits, municipalities) to share what we have discovered about social constructions.

REFERENCES

- Adams, H. and J. Proops (eds.). 2000. *Social Discourse and Environmental Policy: An Application of Q Methodology*. Edward Elgar, Cheltenham, UK. 224pp.
- Anderson, R. and G. M. Killenberg. 2009. *Interviewing: Speaking, Listening, and Learning for Professional Life*. Oxford University Press, New York. 402pp.
- Beatley, T. 2009. *Planning for Coastal Resilience: Best Practices for Calamitous Times*. Island Press, Washington, D.C.
- Brown, M. 2004. *Illuminating Patterns of Perception: An Overview of Q Methodology*. Technical Note: CMU/SEI-2004-TN-026. Carnegie Mellon University, Pittsburgh, PN. 22pp.
- Ciladini, R.B. 2007. *Influence: The Psychology of Persuasion*. HarperCollins Publishers, New York, USA. 320 pp.
- Corbett, J.B. 2006. *Communicating Nature: How we create and understand environmental messages*. Island Press, Washington, DC., USA. 350 pp.
- Cox, R. 2006. *Environmental Communication and the Public Sphere*. Sage Publications, London, UK. 455 pp.
- Crews D. and J.A. McLachlan, Epigenetics, evolution, endocrine disruption, health, and disease, *Endocrinology* 147 (Suppl. 6) (2006) S4–S10
- DeVaney, L.A., S.T. Asah and D.N. Bengston. 2009. *Q Methodology: An Underutilized Technique for Analyzing Social Discourses on Environmental Issues*. University of Minnesota, St. Paul, MN.
- DeVelis, R.F. 2003. *Scale Development: Theory and Applications*. Sage Publications, California, USA.
- Dillman, D.A., J.D. Smyth & L.M. Christian. 2009. *Internet, Mail, and Mixed-Mode Surveys: The tailored design method*. John Wiley & Sons Inc. Hoboken, New Jersey.
- Makenzie-Mohr, D. & W. Smith. 2006. *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing*.
- Fontana A. and J.H. Frey. 1994. *Interviewing: The Art of Science*. From: *Handbook of Qualitative Research*, N.K. Denzin and Y.S. Lincoln (eds.). Thousand Oaks, CA. pp 361-376.
- Goldstein, N.J., S.T. Martin & R.B. Cialdini. 2008. *YES: 50 Scientifically Proven Ways to be Persuasive*. Free Press, New York, USA. 258 pp.
- Kvale, S. 1996. *InterViews: An Introduction to Qualitative Research Interviewing*. Thousand Oaks, CA: Sage. 344pp.
- National Centers for Coastal Ocean Science. 2007. *National Centers for Coastal Ocean Science Human Dimensions Strategic Plan (FY2009-FY2014)*, Silver Springs, MD, National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Science. 46. pp.
- Roberts S.B.**, Goetz G, White S, Goetz F (2009) Analysis of genes isolated from plated hemocytes of the Pacific Oyster, *Crassostrea gigas*. *Marine Biotechnology*. 11:24-44
- Spector, E.P. 1992. *Summated Rating Scale Construction: An Introduction*. Sage Publications, California, USA.
- Stephenson, W. 1953. *The Study of Behavior: Q-Technique and Its Methodology*. University of Chicago Press, Chicago, IL. 376pp.
- Webler, T., S. Danielson, and S. Tuler. 2009. *Using Q Method to Reveal Social Perspectives in Environmental Research*. Social and Environmental Research Institute, Greenfield, MA. 54pp. <http://www.seri-us.org/pubs/Qprimer.pdf>
- Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society* 9(2): 5. [online] URL: <http://www.ecologyandsociety.org/vol9/iss2/art5>
- Walker, B. and D. Salt. 2006. *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. Island Press, Washington D.C.

BUDGET

We are requesting \$180,000 over 24 months to carry-out the objectives of the proposed project. This will partially support three graduate students from three different schools and partial summer salary of respective faculty. Other costs include supplies and reagents for field sampling, laboratory analysis, and generation of outreach materials.

CURRICULUM VITAE – STEVEN BEYER ROBERTS

Contact Information University of Washington
School of Aquatic and Fishery Sciences
1140 NE Boat Street | Seattle, WA 98195
phone: 206.600.4495 | email: sr320@u.washington.edu

Academic Experience Ph.D. – University of Notre Dame (South Bend, IN) – 2002
Integrative Cell and Molecular Physiology

Professional Experience 2006-Present · Assistant Professor
University of Washington, Seattle, WA

2006-Present · Adjunct Assistant Scientist
Marine Biological Laboratory, Woods Hole, MA

Select Publications

Defaveri J, Smolowitz R, Roberts S (2009) Development and validation of a real-time quantitative PCR assay for the detection and quantification of *Perkinsus marinus* in the Eastern oyster, *Crassostrea virginica*. Journal of Shellfish Research (in press)

Roberts SB, Goetz G, White S, Goetz F (2009) Analysis of genes isolated from plated hemocytes of the Pacific Oyster, *Crassostrea gigas*. Marine Biotechnology. 11:24-44

Roberts SB, Gueguen Y, de Lorgeril J, Goetz F. (2008) Rapid accumulation of an interleukin 17 homolog transcript in *Crassostrea gigas* hemocytes following bacterial exposure. Developmental and Comparative Immunology. Volume 32, Issue 9, Pages 1099-1104

Roberts, SB (2008) USDA-NRAC Technical Report: "Development of genetic markers to assess disease resistance in the eastern oyster" 29 pages URL: <http://tinyurl.com/23c7my>

Lyons MM, Lau Y-T, Carden WE, Ward JE, Roberts SB, Smolowitz R, Vallino J, Allam B. (2007) Characteristics of marine aggregates in shallow-water ecosystems: Implications for disease ecology. EcoHealth. 4, 406–420

Roberts SB, McCauley LAR, Devlin RH, Goetz FW. (2004) Transgenic salmon over-expressing growth hormone exhibit decreased myostatin transcript and protein expression. Journal of Experimental Biology. 207(Pt 21):3741-8

Kim H-W, Mykles DL, Goetz FW, Roberts SB. (2004) Characterization of an invertebrate myostatin homologue from the bay scallop, *Argopecten irradians*. BBA – Gene Structure and Expression. 1679(2):174-9

Select Invited Presentations

Overview of Shellfish Activities at the University of Washington. USDA-WERA099: Broodstock Management, Genetics and Breeding Programs for Molluscan Shellfish. March 21, 2009. Savannah, GA

Analysis of genes isolated from plated hemocytes of the Pacific Oyster. National Shellfisheries Association Conference. March 24, 2009. Savannah, GA

Disease tolerance and immune response in oysters. WA Resource Agencies: WA Department of Fish and Wildlife, WA Department of Natural Resources, and WA Department of Ecology. Olympia, WA. March 26, 2008

Professional Activities

Pan American Marine Biotechnology Association – Board of Directors
American Fisheries Society
National Shellfisheries Association

Courses Taught

FISH310: Biology of Shellfishes
FISH507: Bioinformatic Approaches in Fisheries Science
FISH510: Innovations in Molecular Techniques
FISH414: Integrative Environmental Physiology

Asah-BioSketch

Address(es)

School of Forest Resources, College of the Environment
Box 352100, University of Washington,
stasah@u.washington.edu

Present Position:

Assistant Professor, School of Forest Resources, University of Washington

Education:

- 2006 Ph.D. University of Minnesota, Minneapolis/St. Paul, Human Dimensions of Natural Resources Management
Ph.D. Minor: Development and Social Change
2003 M.Sc. University of Minnesota, Minneapolis/St. Paul, Water Resources Science
1999 B.Sc. University of Dschang, Dschang-Cameroon, Agricultural Mechanization and Operations Management

Previous Positions:

- 2007-2009 Senior Researcher: Human Dimensions of Natural Resources Management,
Minnesota State Department of Natural Resources
2006-2009 Research Associate: University of MN

Ongoing Research

Childhood Exposure to Nature, Constraints Negotiation, and Environmental Stewardship in Later Life. *Funded by the US Forest Service, Northern Research Station.*
Social Construction and Assessment of Cultural Ecosystem Services: Case of the Deschutes National Forest: *Funded by the US Forest Service, Pacific North West Region.*

Memberships:

International Union of Forest Research Organizations
International Association for Society & Natural Resources
International Society for the Scientific Study of Subjectivity
Society for Human Ecology
Society for Conservation Biology
Toastmasters International: Communication & Leadership track

Selected Publications

- Asah, S.T. 2008. Empirical Social-Ecological System Analysis: From Theoretical Framework to Latent Variable Structural Equation Model. *Environmental Management*, 42: 1077-1090.
Asah, S.T., K.C. Nelson, & D. Bengston: 2008. Managing Social-Ecological Change and Uncertainty: Floodplain Agriculture and Conservation in Dryland Northern Cameroon. *Conservation & Society*, 6(2): 166-178.
Bengston, D.N., B.J. Butler, and S.T. Asah. 2008. Values and Motivations of Private Forest Owners: A Framework Based on Open-Ended Responses in the National Woodland Owner Survey. *Proceedings of the Northeastern Recreation Research Symposium*, GTR-NRS-P-42, pp. 60-66.

MARC L. MILLER
Biosketch

Address

School of Marine Affairs, College of the Environment
Box 355685, University of Washington,
mlmiller@u.washington.edu

Present Position:

Professor, School of Marine Affairs (SMA), University of Washington (UW)
Adjunct Professor, School of Aquatic and Fishery Sciences, UW
Adjunct Professor, Department of Anthropology, UW
Visiting Professor, Department of Development Studies, Nelson Mandela Metropolitan University,
Port Elizabeth, South Africa

Education:

1974 Ph.D. University of California, Irvine, Cultural Anthropology;
1972 M.A. University of California, San Diego (UCSD), Social Anthropology
1971 B.A. University of California, Irvine, Social Sciences

Previous Positions:

1997-1998 Acting Director, SMA
1990- present Professor, SMA; Adjunct Professor, Dept. Anthropology; Adjunct Professor, School of Aquatic and Fishery Sciences, UW.
1986-1990 Associate Professor, SMA; Adjunct Associate Professor, Dept. Anthropology; Adjunct Associate Professor, School of Fisheries, UW
1984-86 Assistant Professor, SMA, UW; Adjunct Assistant Professor, Dept. of Anthropology, UW; Assistant Professor (Courtesy) Dept. of Sociology, Univ. of Oregon.

Special Positions:

Associate Series Editor *Qualitative Research Methods Series*, [50+ titles], Sage Publications, (1986 - present)
Commentary and Research Notes Editor, *Tourism and the Marine Environment* (2003- present)
Coordinating Editor, *Annals of Tourism Research* (2006 – present)
Associate Editor (*Coastal Zone Management Journal* 1983-1993); Acting Co-Editor-in-Chief, 1987. Editorial Advisory Board 1993-present.
Editorial Board, *Silliman Journal* (Philippines) (2003 – present)
Member of the Scientific and Statistical Committee (Pacific Fishery Management Council), 1982-1990.
Member of the Scientific and Statistical Committee (North Pacific Fishery Management Council), 1990 - 1998.

Selected Publications

1986 Jerome Kirk and Marc L. Miller. *Reliability and Validity in Qualitative Research*. (Qualitative Research Methods Series: Number 1, 10 printings) Beverly Hills: Sage.
2008 Marc. L. Miller, Mark .B. Orams, Michael. Lück, Jan. Auyong, and Alice. Gräupl, Guest (Eds.) The 5th International Coastal and Marine Tourism Congress. Special Double Issue of *Tourism in Marine Environments*. Volume 5, Numbers 2 & 3: 75-87.
2007 Michael Lück, Alice Gräupl, Jan Auyong, Marc L. Miller and Mark B. Orams, (Eds.) *Proceedings of the 5th International Coastal and Marine Tourism Congress: Balancing Marine Tourism, Development, and Sustainability*. School of Hospitality & Tourism and the New Zealand Tourism Research Institute, AUT University: Auckland, New Zealand. (658 pages)
2008 Donald R. Gunderson, Ana m. Parma, Ray Hilborn, Jason M. Cope, David L. Fluharty, Marc L. Miller, Russell D. Vetter, Selina s. Heppell and H. Gary Greene, "The Challenge of Managing Nearshore Rocky Reef Resources," *Fisheries* 33: 4: 172-179 (April)
2008 R.B. Pollnac, S. Abbot-Jamieson, C. Smith, Marc .L. Miller, P. M. Clay, B. Oles, "Toward a Model for Fisheries Social Impact Assessment," *Marine Fisheries Review* 68: 1-4: 1-18.
2006 Melissa S. Andersen and Marc L. Miller, "Onboard Marine Environmental Education: Whale-watching in the San Juan Islands, Washington." *Tourism in Marine Environments*, 2: 2: 111-118
2006 B. Oyles, C. M. Wahle, S. Fischer, Marc L. Miller, and Patrick Christie, Using Regional Workshops to Understand the Human Dimension of MPAs," [MPA Perspective], *MPA News* 7:10: 7.
2008 Marc L. Miller, "Marine Wildlife Tourism Management: Mandates and Protected Area Challenges," (Chapter 13 in *Marine Wildlife and Tourism Management*, J. Higham and M. Lück, eds.; CABI Publishing: Oxford.) pp. 233-256
2007 Marc L. Miller, "Remarks on Innovation in Marine Tourism Systems," (Chapter 4 in *Nautical Tourism: Concepts and Issues*, M. Lück, ed.; Cognizant Communications: Elmsford, New York). pp. 37-58.