Forest Regeneration Trends: Dinosaurs, Political Correctness, and the Future

R.G. Wagner

University of Maine, 5755 Nutting Hall, Orono, Maine 04469-5755

Introduction

In 2004, Wangari Maathai won the Nobel Peace Prize for planting trees in Kenya. Her Green Belt Movement began in 1976 and developed into a broad-based, grassroots organization of women's groups dedicated to planting trees to conserve the environment and improve their quality of life. Over the next thirty years her efforts spread to neighboring African countries and mobilized millions of poor women to plant 30 million trees. Ms. Maathai recognized that regenerating forests was central to achieving sustainable development in Africa.

Since successful regeneration is vital to forest sustainability, how are we doing in North America? What are the trends and where are we going? It is actually very difficult to know how we are doing in successfully regenerating Canadian and US forests since national records of actual reforestation or afforestation success are not kept. Large private landowners and government organizations often collect such data on permanent forest inventory plots, but it is extremely difficult gather these data to identify national trends. It is much easier, however, to find numbers on the amount of regeneration activity (e.g., tree planting, direct seeding, site preparation, tending) that a country is engaged in over a period of time. Although regeneration activity is not a measure of regeneration success, it is an index of commitment to successful reforestation and afforestation.

Trends in US and Canadian Regeneration Activity

Some the longest and best records of forest regeneration activity can be found in records of tree planting. Data describing the area planted each year can be found back to the late 1920s in the US and the mid 1970s for Canada. Since the beginning of record keeping in both countries, there has been a steady increase in the area planted each year. Tree planting in the US increased 7-fold from 197,000 ha/yr in 1950 to 1.37 million ha/yr in 1988. From 1975 to 1990, tree planting in Canada increased almost 4-fold from 128,000 ha/yr to 476,000 ha/yr.

During the late 1980s and early 1990s, however, there was a significant shift in this trend. Tree planting declined in both countries for the first time during the 20th century. Canada also has records of the area of annual site preparation and tending, which are often vital for ensuring successful artificial and natural regeneration. Site preparation and tending trends follow similar patterns as tree planting. From the 1975 to about 1989, there was a steady increase in annual site preparation (from 162,662 ha to 487,140 ha) and tending (from 37,382 ha to 376,132 ha) activities. From 1990 to 2002, Canada shows a consistent decline in the area site prepared (only 292,497 ha in 2002). Tending continues to increase, but the rate of increase declines substantially after 1990.

To interpret whether these trends reflect a change in reforestation commitment, however, it is important to understand what was happening with harvest trends. Regeneration activity can simply increase or decrease with the area harvested. Changing methods of harvest also can influence regeneration activity. For example, even-aged systems (such as clearcutting) are often followed by tree planting or direct seeding to achieve successful regeneration. In contrast, many uneven-aged or partial cutting approaches rely solely on natural regeneration. The viability of even-aged and uneven-aged silvicultural systems varies among forest types and regions, so are not equally applicable everywhere.

Changes in harvest patterns

Canada's National Forestry Database Program provides harvest records by province from 1990 to present. Canadian harvesting increased slightly during the 1990s and dipped back down a bit after 1999, but has remained relatively stable at about 1 million ha per year. Of this harvest, the proportion of clearcutting has been relatively constant on about 85% of the area harvested. Other even-aged methods (shelterwood, seed tree, and commercial thinning) have had relatively minor use. Selection harvesting, an uneven-aged method, has been relatively stable during this period on only about 100,000 ha per year.

Records on forest harvesting in the U.S. are not nearly as complete as those for Canada. Available data from the U.S. Forest Inventory and Analysis Program indicate that harvesting during the 1980s and 1990s was dominated by unspecified partial cutting systems (62%) and by clearcutting (38%). Trends in total harvest area on all

U.S. public and private lands appear to not be available, but harvested wood volumes from the mid 1970s to 2002 indicate a relatively stable annual harvest of 14 to 16 million cubic feet.

Excellent harvest data are available for U.S. Forest Service lands, however. These data indicate a substantial shift in the type of forest harvesting in the late 1980s. After 1988, shelterwood cutting and clearcutting began a continuous decline as a proportion of total harvest area, while the proportion of intermediate cutting (thinning, improvement, sanitation) rose substantially. However, the proportional shift in harvesting method was less impressive than the total reduction in area harvested on U.S. Forest Service lands. From 1990 to 2003, there was 75% reduction in harvest area on U.S. Forest Service lands. The reduction in harvesting resulted from litigation by special-interest groups and a resulting major shift in U.S. federal policy about harvesting on National Forest lands. This event was significant for Canadian public lands because U.S. National Forest lands contain about 48% of the U.S. softwood supply. This shift in harvesting on U.S. federal lands coincides in 1990 with a significant increase in U.S. softwood imports from Canada. The U.S. public essentially transferred softwood demand from U.S. to Canadian public lands.

Based on the above harvest data, there appears to have been little change in the amount or method of harvesting in either the U.S. or Canada that might account for a shift in the amount of regeneration activity seen around 1990. The Canadian data clearly show no mass movement away from clearcutting or the total area harvested during the 1990s. Although the data are not as clear for U.S. private and public forests, there was no apparent large-scale shift in the amount or type of harvest activities from available data. Even though U.S. Forest Service lands make up about 25% of total U.S. forestland and harvesting started to decline dramatically around 1990, there is little evidence of a change in overall wood volume harvested on state and private forestlands, nor a shift in the type of harvesting that was being used.

Regeneration activity as a proportion of clearcut harvesting

One way to examine changes in regeneration activity and reduce uncertainty about the effect of changing harvest area or methods is to express regeneration activity as a proportion of clearcut harvest area in each country. Clearcutting in most North American forests requires some level of tree planting and tending to meet accepted regeneration standards in most jurisdictions.

Without good annual harvest data on U.S. forestlands, several assumptions are required, but it is possible to generate a tree planting area to clearcut area trend line for industry, non-industrial private and federal forestlands combined (Figure 1). From the mid 1970s until about 1988, there was a steady increase in this ratio from 0.49 to 0.91. From 1988 to 1996, however, the ratio declines 29% to 0.64. Using much more complete data from Canada, annual tree planting and seeding area to clearcut area ratios for all Canadian forestlands can be calculated for 1975 to 2002 (Figure 2). The resulting trend for Canada is strikingly similar to that of the U.S., but with a three-year lag in the peak ratio of 0.70 in 1991. From 1991 to 2002, Canadian tree planting and seeding (as a proportion of clearcut area) declined 19% to 0.54. The proportion of clearcut area where site preparation and tending treatments were applied (keys to successful artificial and natural regeneration) also steadily increased from 1975 to 1991 in Canadian forests (Figure 3). After 1991, when site preparation was being applied to 61% of clearcut lands, the ratio declined 42% to only 0.35 in 2002. The trend for tending also makes a substantial shift after 1990. After a steady increase from 0.06 in 1975 to 0.50 in 1990, the rate declines and then comes up again showing a nearly level trend from 1990 to 2002.

What caused the change in regeneration behavior?

It is clear when expressing tree planting, site preparation, and tending activities as a ratio of clearcut area that there was a dramatic shift in regeneration behavior in both Canada and the U.S. around 1990. Why would artificial regeneration and tending have fallen into less favor in Canada and the U.S.? It is difficult to know the exact reasons for such trends. It is likely that the causes vary from jurisdiction to jurisdiction, but it is noteworthy that such similar trends and timing can be seen at the national level for both North American countries. Something significant must have happened.

Potential factors that might drive such a significant trend reversal around 1990 include: 1) artificial regeneration before 1990 was discovered to be not as successful as was hoped, 2) natural regeneration was found to be adequate in many places and at far less cost, 3) changes in harvest area or method that reduced reliance on artificial regeneration, 4) reduced commitment by government and private landowners to pay for regeneration, and 5) reduced advocacy by forest managers for investments in artificial regeneration.

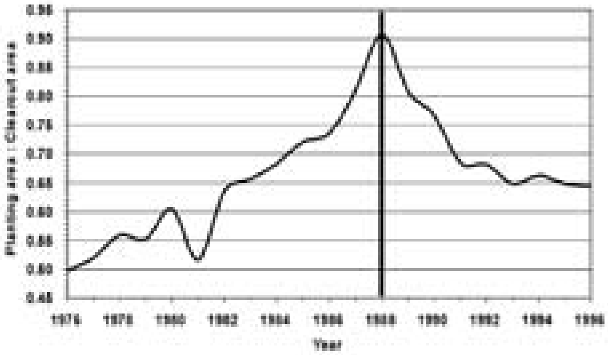

Figure 1. *Ratio of planted area to clearcut harvest area in the U.S. (1976-1996). Vertical line indicates year of a major shift in the trend. Source: Smith et al. 2003. Forest Resources of the United States, 2002. Gen. Tech. Rep. NC-241.; U.S. Forest Planting Report (USDA, FS, Washington, DC); and recent data in Tree Planters' Notes, Volume 49, No. 2. Assumes mean annual harvest area from 1980-92, annual harvest area over period was 9.8 million acres, and 38% of harvest area was by clearcutting.*

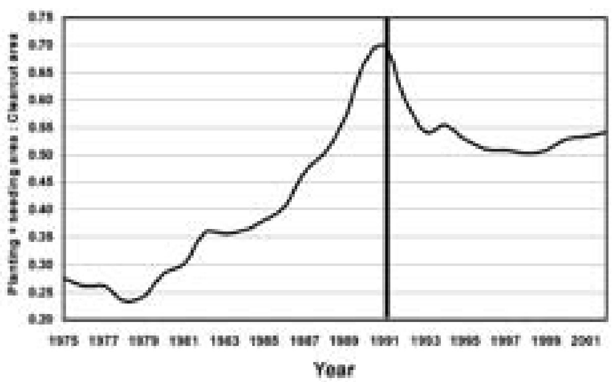

Figure 2*. Ratio of planted and seeded area to clearcut harvest area in Canada (1975-2002). Vertical line indicates year of a major shift in the trend. Source: National Forestry Database Program, Canadian Council of Forest Ministers and Canadian Forest Service.*

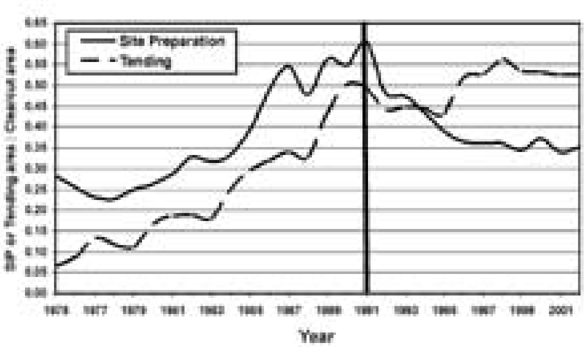

Figure 3. *Ratio of site prepared and tended area to clearcut harvest area in Canada (1975-2002). Source: National Forestry Database Program, Canadian Council of Forest Ministers and Canadian Forest Service.*

Let's evaluate each of these potential causes. I must reject the first potential cause since forestry research and operational experience across North America and the world have clearly demonstrated the value of artificial regeneration. The success and need for artificial regeneration is what prompted the rapid increase in tree planting during most of the 20th century. Natural regeneration certainly costs less, but I have yet to see data from studies in the 1980s demonstrating that natural regeneration was adequate to meet legislative, policy, or wood supply needs in most North American forest types. After all, it was the general inadequacy of natural regeneration across the U.S. and Canada that led to the rapid increase in tree planting during most of the 20th century. So, I must reject the second possible cause as well. As shown above, there were no significant changes in harvest area or method in Canada or the U.S., at least none sufficiently large enough or occurring at the same time to account for the patterns shown in Figures 1 to 3. So, I also must reject the third reason as a possible cause. This leads me to the final two possible causes – reduced commitment by landowners to pay and less advocacy by foresters for artificial regeneration (factors 4 and 5). For those of us whose forestry careers spanned the 1970s to present, however, it would not be surprising if these final two factors were indeed driving these national trends. Something significant clearly happened to forest management about 1990.

New forestry paradigm and stigmatized reforestation technology circa 1990

I can vividly recall this period. In fact, I had just moved from Oregon to Ontario and had a chance to witness what was happening nationally in U.S. and Canadian forestry. There was a "paradigm shift" in North American forestry about this time. Clearcutting was controversial throughout the 1980s. The spotted owl and old growth controversies were raging in the Pacific Northwest. "New forestry" and "ecosystem management" were new terms being introduced and debated. The 1987 Brundtland Report (*Our Common Future*) introduced the term "sustainable development," which struck a chord in Canadian forest policy. E.O. Wilson's 1988 *BioDiversity* book made the term popular with the environmental community and created a new pressure in forest management. Landscape ecology was a new concept in forest management, and we were beginning to discuss emulating natural disturbance through forest management.

Much of this debate suggested that what we had been doing previously in North American forestry was not "sustainable." Since forest research and management effort during the previous decades had focused on improving forest regeneration success (especially artificial forms), the debate seemed to cast doubt on the correctness of forest regeneration itself. Many of us in the forestry profession were afraid of being called "dinosaurs" if we failed to adopt the new paradigm. Doing so, however, meant challenging or deemphasizing that reforestation technology we were all taught and were able to make work so effectively. Many with forestry degrees from universities before 1990 can also probably recall a trend during the early 1990s when forestry faculties, departments, schools, and colleges began to change their names to include more ecological sounding terms.

The forestry paradigm was not all that had changed. During much of the 1980s, many of the technologies that had been developed to solve many reforestation problems during the previous decades became controversial. Pesticides (herbicides and insecticides) became viewed by much of the public as environmentally risky and a threat to public health. Heavy site-preparation and the use of fertilizers were being questioned. Tree improvement (and the dreaded genetic engineering) was being challenged. Forest plantations themselves were being debated as a potential threat to biodiversity. Despite strong scientific evidence to the contrary for many of these issues, it was too late. Much of the time-tested reforestation technologies of the previous decades had become stigmatized. Advocating such treatments was (and continues to be today) politically incorrect in many circles, and are thus to be avoided.

If I am correct with the above suppositions, it would be truly ironic if the 1990s movement to increase the "sustainability" of forests resulted in a reduced commitment to forest regeneration success among forestland owners (public and private) and forestry professionals. Prompt and successful regeneration following harvest is the first principle of forest sustainability. It was this very need that created the forestry profession following European timber famines in the first place.

Factors Likely to Influence Regeneration Trends in Coming Years

It is unclear where forest regeneration trends will go next. We can be confident, however, that we will not likely return to the pre-1990s era. The context and pressures for forest management have evolved in the U.S. and Canada. Just as emergent trends and needs forced forest managers to critically evaluate regeneration practices before and after 1990, the changing global context and complexity for forest management will drive where we go next.

As I look at these emergent trends, I suspect that several global pressures could become dominant forces pushing forest harvesting and regeneration practices in North American forests in particular directions. These emergent pressures include: (1) wood supply demands, (2) global markets, (3) the end of cheap oil, (4) invasive plants and climate change, and (5) high-yield conservation.

Wood supply demands

Human population growth and global wood demand have historically tracked very closely and will likely do so in the future. Based on current estimates, the global wood harvest is likely to increase about 35 million m^3 annually as the world population climbs to around 10 billion or so by 2050. Although the global forest has a tremendous capacity to produce wood, the amount of forestland available for wood production has been shrinking by about 0.22% per year (FAO 2001). The net loss of global forest area between 1990 and 2000 was 94 million ha – an area larger than Venezuela. Assuming that the annual per-capita global consumption of wood (0.6 m^3) remains relatively constant and the human population reaches 10 billion, Sutton (1999) projected an annual 2.2 billion m^3 deficit in the global wood supply by 2050. If the world's population reaches 10 billion by 2050, the 0.22% annual rate of forest area decline continues, and global per-capita consumption remains constant, per ha wood fiber productivity will need to need to increase by 87% (Wagner et al. 2004). If the global per-capita consumption rate for wood increases with living standards in countries such as China and India, or if forest production area declines accelerate above current levels, increases in forest productivity may need to double or more by 2050.

If this scenario comes to pass, the implications for regenerating North American forests (if they are still available and economical for wood production) are clear. Rapid and successful regeneration following harvest will be a requirement on all wood producing lands. Once regenerated, these stands will need to be intensively managed throughout their life to ensure the required forest-level wood flows. There is evidence that meeting increased global wood demands from intensive silviculture is already occurring (Sedjo 2001). Forest plantations currently produce more of the world's commercial timber (34%) than old-growth forests (30%), managed second-growth forests (22%), or minimally managed second-growth forests (14%) (Sedjo and Botkin 1997).

Global markets

There is much discussion today about the long-term influence of global markets on the North American wood products industry. I am not qualified to speculate much on directions here, but it is clear that whatever happens in this regard, the future of forest regeneration will be strongly affected. As described above, productivity of the global forest (at least where wood production is occurring) will likely need to increase. The only question is what regions of the North American forest (if any) will be fulfilling the global demand for wood.

We have all been reading about a mass shift of forestland ownership and wood producing facilities to tropical and sub-tropical regions of the world. In countries like Brazil, Chile, South Africa, and Indonesia, 50 to 70 m^3/ha/yr rates of stand productivity can be achieved, forest laborers will work for only a few dollars a day, and there is substantially less environmental regulation. Depending on the expert that one chooses to believe, it is easy to become either encouraged or discouraged about the future of the North American wood products industry, and thus the future of traditional forest management and regeneration.

Northern forests (North American and European) clearly have some distinct advantages regarding production of certain tree species and especially the close proximity to the largest wood consuming markets. How these advantages will balance favorably or unfavorably against higher operating costs, higher risk from environmental regulation, and lower rates of forest productivity is anyone's guess.

End of cheap oil?

The movement of cheaper wood to global markets will require oil. As the June 2004 issue of National Geographic was aptly titled, it is *The End of Cheap Oil*. I can recall during the last gasoline crisis of the early 1970s planting experiments of hybrid poplar to address the needs of the coming forest biomass markets. As we all know now, the forest biomass markets really never took hold as the price of oil declined over the next three decades. Here we are again. Many experts believe that this time it might actually be true.

There is clearly a renewed interest in the market opportunities for using forest biomass to compete with oil. Forest bioproducts research and business proposals are being discussed across Canada and the U.S. right now. Just as with predicting future directions of the global wood market, it is unclear how the forest bioproducts industry might develop. If it develops in certain regions of North America as some are now speculating, it could have substantial implications for forestry practice in those regions. There will probably be increased demand for large volumes of low quality and small dimension material that would place pressure on silviculture in ways that forest managers have not yet seen. With this new market would likely come an increase in ecological debates about the implications for biodiversity, and a new round of regulatory and policy conflicts for North American forestry.

Invasive plants and climate change

It is hard to find literature about environmental concerns these days where invasive species and climate change are not centerpieces of the discussion. Although it is difficult to predict how these issues will specifically impact forest management in North America during the coming decades, I am struck by how these issues have the potential to influence public perceptions about the reforestation technologies and silviculture in general. Over the past several years interest has been developing by many in the environmental community about regeneration silviculture.

As I have spent much of my career in forest vegetation management, I have been receiving regular inquiries about how to control invasive plants in ecological reserves. Environmental organizations (such as The Nature Conservancy) are now dealing with the practical problems of managing forestlands to achieve specific management objectives. Although the objectives are generally ecological in nature, these organizations are beginning to find valuable information in old reforestation research and operational experience that can help achieve goals of ecological restoration. For example, several invasive exotic shrubs are competitively excluding natural forest regeneration on conservation lands around the eastern U.S.. As the overstories of existing stands begin to decline, there is a high probability that formerly natural forests in some of these areas will be replaced by monocultures of invasive exotic plants. As a result, interest in how to use herbicides to promote successful forest regeneration is growing among some conservation groups.

Similarly, discussions about how to rapidly sequester carbon in forests are bringing greater attention to silvicultural methods and the role that they might play in meeting targets for balancing greenhouse gas emissions. If forests and forestry become increasingly perceived as part of the solution to global climate change by helping achieve targets associated with treaties (such as the Kyoto Protocol), government policies, or carbon credit investments in an emerging marketplace, then much of the research and experience associated with reforestation developed over the past decades may become viewed by the public as important for helping solve a perceived global environmental crisis.

High-yield conservation

Much of the new forestry paradigm and stigmatized reforestation technology that appeared to stimulate (or at least coincide with) the substantial changes in Canadian and U.S. reforestation behavior around 1990 were associated with the rejection of high-yield silvicultural objectives and practices, as much as it was an embrace of new ideas around preserving biodiversity and ecological sustainability. One only needs to read the literature of that time and look at the new standards for North American forestry established by organizations like the Forest Stewardship Council, to see that high-yield silvicultural practices have become viewed by many as inconsistent with the principles of sustainable forestry.

In recent years, however, there is evidence of a shift in thinking about the compatibility of high-yield agriculture and forestry with the conservation of nature. In 2002, a new high-yield conservation movement was initiated by a broad group of food, environmental, farming and forestry experts -- including two Nobel Peace Prize laureates. These experts, including Drs. Norman Borlaug (Nobel Peace Prize winner, Father of the Green Revolution, and forester), Oscar Arias (Nobel Peace Prize winner and Former President of Costa Rica), Patrick Moore (Co-founder of Greenpeace), James Lovelock (author of *The Gaia Hypothesis*), and several other notable leaders invited their colleagues worldwide to co-sign a declaration in favor of high-yield agriculture and forestry. The declaration states that *"…additional high-yield practices, based on advances in biology, ecology, chemistry, and technology, are critically needed in agriculture and forestry not only to achieve the goal of improving the human condition for all peoples but also the simultaneous preservation of the natural environment and its biodiversity through the conservation of wild areas and natural habitat."* Hundreds of supporters of this declaration have now signed up on their web page (http://www.highyieldconservation.org/).

The basic premise of the high-yield conservation movement is that substantial increases in per hectare agricultural yields have not only fed a growing human population, but have conserved millions of hectares of land for biodiversity that would otherwise have fallen to cultivation. As a measure of how much high-yield agriculture has contributed to land conservation, Borlaug (2000) estimated that if the per ha rate of global cereal yields in 1950 had been held constant through the end of the 20th century, three-fold more farmland would have been needed by 1999 (i.e., 1.8 billion ha instead of the 600 million ha that was actually cultivated worldwide). In this regard, the advent of high-yield agriculture over the last century has been by far the world's most successful biodiversity conservation program. Borlaug and his colleagues believe that high-yield forestry will be equally important to conserving forestland for purposes of biodiversity conservation.

If the high-yield conservation idea becomes a dominant natural resource management principle in the coming decades, then much of the work over the past half century by forest researchers and managers to find ways of improving wood fiber yields will be vital to helping conserve land and associated biodiversity.

Conclusion

In discussing the topic of this paper with several of my colleagues, I was impressed with how we can each recall the changes that occurred in forestry education, research, policy, and practice around 1990. The forestry profession in North America experienced a revolution of sorts, especially on public lands. If the trends in regeneration activity described above are accurate, it is clear that the paradigm shift substantially altered the approach and/or commitment to forest regeneration and early stand tending in Canada and the U.S.. While the new concepts introduced during that period (particularly biodiversity and landscape ecology) have contributed substantially to improving the management of North American forests, it would be ironic and disappointing if these ideas also forced forest managers to diminish their resolve in achieving successful regeneration. Prompt and successful regeneration following harvest is the first principle of sustainable forestry.

As the forestry profession moves into the future, it is vital that we examine and debate the trends, implications, and obligations of these reforestation trends. If the "revolution" of 1990 has indeed caused foresters and landowners (public and private) to become lax or lose sight of their obligation for regeneration success, then it is time for a professional "wake-up call". If several of the potential pressures facing forest management and regeneration outlined above are realized in the coming years, then the reforestation expertise and technologies developed over the past decades will be vital to serving human needs and protecting the natural environment. There may yet be a place in the future where politically-incorrect “dinosaurs” can help save the world.

References

Borlaug, N.E. 2000. The green revolution revisited and the road ahead. Special 30th Anniversary Lecture, The Norwegian Nobel Institute, Oslo, Norway. 8 September 2000. (http://www.nobel.se).

FAO (Food and Agriculture Organization of the United Nations). 2001. Global Forest Resources Assessment 2000: main report. FAO Forestry Paper No. 140. Rome, Italy. (http://www.fao.org/forestry/fo/fra/main/index.jsp).

Sedjo, R.A. 2001. The role of forest plantations in the world’s future timber supply. Forestry Chronicle 77:221–225.

Sedjo, R.A., and Botkin, D. 1997. Using forest plantations to spare natural forests. Environment 39:14–20, 30.

Sutton, W.R.J. 1999. Does the world need plantations? Paper presented at intersessional expert meeting on the role of planted forests, 6–9 April 1999, Santiago, Chile.

Wagner, R.G., Newton, M., Cole, E.C., Miller, J.H., and Shiver, B.D. 2004. The role of herbicides for enhancing forest productivity and conserving land for biodiversity in North America. Wildlife Society Bulletin 32(4): 1028-1041.