THE IRAQI MARSHLANDS: IS ENVIRONMENTAL REHABILITATION POSSIBLE?

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1. INTRODUCTION

The Iraqi marshlands—originally twice the size of the Everglades in Florida—has been the major wetland area in the Middle East, served as an important habitat for migratory birds and has been home to the unique culture of the Marsh Arabs. Until 1990, little had changed in the area for centuries. Then, within a decade, 90 percent of the wetland area was turned into barren drylands by a large drainage scheme planned by Saddam Hussein and his regime. The drainage has had devastating consequences for the ecosystem and its inhabitants. While scientists appealed for international attention for years, it was not until the Second Gulf War in 2003 that the global public became aware of the destruction of the marshlands and the plight of the Marsh Arabs. This caused a plea for immediate action: the marshlands should be rehabilitated.

While drainage of the marshes was a deliberate government policy, desiccation and pollution of the area can be also ascribed to hydrological decisions made at a larger geographical scale in the whole catchment area of the Euphrates and Tigris Rivers. The purpose of this paper is to show how the public understanding of the causes of destruction changed from having a regional perspective in the 1990s to having a local outlook after the war. This is done in order to show how the different discourses of destruction affect our understanding of the future of this area. If the perspective is local and Saddam and his regime are regarded as the only cause of the environmental problem, then removal of Saddam and his regime becomes the solution. This is, however, an oversimplified image of what is needed to rehabilitate the area. It appears that a regional perspective should be applied as the changes of the ecosystem also have taken place at a larger geographical scale. The situation is further hampered by the security situation in Iraq, which means that few researchers have been there after the demise of the ecosystem. Eyewitness accounts, especially from NGOs, and satellite imagery provide the best available data for assessing the post-war situation. The paper uses this information to discuss which approach should be applied, if rehabilitation of the marshes is to stand a chance.

To that end, the remainder of the paper is organised as follows. First, an introduction to the marshlands and the inhabitants is provided. The second section demonstrates the change from wetlands to drylands. Following this account, the third section outlines two different discourses of the destruction of the marshes as they can be found in newspaper articles. In the fourth section, implications of the two ‘discourses of destruction’ are discussed in relation to the rehabilitation ideas. Finally, some concluding remarks are given.
2. THE MARSHLANDS

The marshlands are located at the confluence of Euphrates and Tigris, just before they flow into the Persian Gulf. The marshlands contain an area of 15-20,000 km². Historically, the area has been inhabited by the Marsh Arabs, who are claimed to be descendants of the Sumerians, and their way of life is considered to be one of the oldest living cultures—celebrated by Thesiger and other travellers almost half a century ago (Maxwell, 1957; Thesiger, 1964; Young, 1977). The Marsh Arabs livelihood was tuned to the flood environment and consisted of a combination of fishing and rice cultivation mixed with livestock breeding of buffalos. Swamp reed was used to build houses and for centuries this self-sufficient way of life hardly changed.

Both the Euphrates and Tigris rise in the Anatolian mountains in Turkey and snowfall there is the major precipitation source. Hence, the rivers gather their water resources in climates rich in precipitation and traverse hundreds of kilometers through arid lands where they are the main source of livelihood (Kliot, 1996). Consequently, changes in the water flow upstream can have profound effects on the marshes. Conflicts over Euphrates and Tigris have been common for centuries (Beaumont, 1996; Biger, 1989; Naff and Hanna, 2003). Iraq, Syria, Iran, and Turkey share the waters of the Tigris and Euphrates, and Iraq and Syria especially are highly dependent on the water due to their arid climates and policies of food self-sufficiency (Carkoglu and Eder, 2001).

Since the 1950s, regulation of the river has altered the ecology of the river basin. The spring floods, which sustained the marsh ecosystem, disappeared with the building of dams notably in Turkey, but also in the other downstream countries (UNEP, 2001). Already in the early 1980s, travellers noticed that the marsh area was shrinking due to upstream dams and irrigation projects as well as draining for agricultural purposes at the fringes of the marshes (Spencer, 1982). Until the mid-1980s, Turkey prioritized hydroelectric development, which did not cause concern for the other riparian states as the dams only regulated the river flow but not the water amount. In the mid-1980s, Turkey changed approach from a largely hydroelectric program to an integrated regional development program including irrigated agriculture. The country’s biggest dam project, The Southeastern Anatolia Irrigation Project or GAP (its Turkish acronym), was extended. Today, it combines 22 dams in a giant irrigation and energy project (Carkoglu and Eder, 2001). This change caused concern in downstream countries. It has been estimated that a fully functioning GAP will reduce the flow from Tigris by one-third and the inflow from Euphrates will be halved (Kliot, 1996). Irrigation agriculture in drylands carries a constant risk of soil salinization. Often insufficient water will be available thus causing salinization.

In the 1980s, the effects of these upstream projects began to show in the marshes. The water flow diminished, while the remaining water in the rivers was saline or polluted from the pesticides used for upstream agriculture. In turn drinking water became polluted and desiccation of the marshes increased. While, to some extent, this was an unwanted although predictable effect of a project such as GAP, the later destruction of the marshes was intended.

3. FROM WETLANDS TO DRYLANDS

Under the pretext of reclaiming wetlands for agricultural purposes and furthering development, the Iraqi government let the marshes drain in the 1970s. The project was based on British ideas from the 1950s, when the British engineer Frank Haigh made a report published by the Iraqi Irrigation Development Commission. Haigh proposed to construct a series of canals, embankments, and sluices on Euphrates and Tigris in order to divert salty and polluted water away from the irrigated area between the two rivers. Thereby, the marshlands could be reclaimed for agriculture. In Haigh’s view, precious water was wasted by letting it seep away into the marshes instead of exploiting the water for irrigation (Pearce, 1993).
A positive side effect of this project was that it would be a means to obtain control over this ‘wild’ area. The marshes were perceived as an inaccessible area escaping government control, thereby giving refuge to regime opponents. By draining the marshes, it would be difficult to for opponents of the regime to hide there. As well, the land itself could be reclaimed as arable land. Hence, these plans concerned drainage and construction of irrigation channels in order to increase the arable area; the plan was not to destroy livelihood opportunities (Mitchell, 2003).

The marshes were viewed from a user perspective with little concern for conservation of the wildlife habitat or the ancient culture of the Marsh Arabs. To view the marshes from a protection perspective is a later idea.

Usually, Saddam Hussein’s plans for the marshes are thought to be an outcome of the 1991, First Gulf War. But in fact they date back to the 1980-88, Iran-Iraq war. This was evident when the Kurds obtained official Iraqi documents after the ‘liberation’ of Iraqi Kurdistan in 1991. Among the 40 cubic meters of documents, which the regime did not get time to destruct, there was correspondence concerning a so-called ‘Plan of Action for the Marshes’ from 1987 (Mitchell, 2003). Physicaly, the plans had a striking resemblance to Haigh’s plans, and the official Iraqi justification was that the project would ‘wash away the salt-encrustation on millions of hectares of over-irrigated farm land, to reclaim new land for much needed food production and to increase the amount of water available for irrigation’ (North, 1993: 11). Nevertheless, Saddam Hussein’s plans for the marshes were related to marshes’ use as a hiding ground for Iraqi outlaws, dissidents, and opponents of the regime. The ‘Plan of Action for the Marshes’ was in fact linked to the wish to control Iranian intruders, who entered Iraq through the marshes (Mitchell, 2003). Thus, the plan was similar to the British idea of controlling the area and it was legitimized by reference to the increase arable land, as suggested in the Haigh report (Pearce, 1993).

The ‘Plan of Action for the Marshes’, however, went far beyond the British ideas. The British plans for the area from the 1950s had included a 565-km long canal linking the Euphrates and Tigris in order to desalinate the Euphrates water and create fertile land (Schulz, 1995). However, Saddam Hussein’s project did not create arable land. During the 1990s, still bigger parts of the marshes were drained beyond use. Prior to the outset of the Second Gulf War in March 2003 an estimated 93 percent of the marshes had been destroyed (UNEP, 2001). The only partly intact marsh straddled the Iran-Iraq border and was fed by river flows beyond Iraqi control. The majority of the former marsh area had dried out and turned into thick salt crusts. The effects for human and animal life were devastating (UNEP, 2001). Within a decade, the former marshes had almost disappeared. Much of the marshland was now barren, and the livelihood of the Marsh Arabs was gone.

Though the outcome was different, the British and the Baath-regime built upon the same view of the environment – a view that is generally abandoned today. Dryzek (1997, 3) stated that

Once areas of marshy land were called swamps. The only sensible thing to do with swamps was to drain them, so the land could be put to some useful purpose. Governments subsidized landowners to drain swamps. Today, we call the same areas wetlands, and the governments have enacted legislation to protect their recognized value in providing habitat for wildlife, stabilization of ecosystems, and absorption of pollutants.

The former approach provided by Dryzek can be seen in the attitude towards the Iraqi marshes employed by the British in the 1950s (see e.g. Davies, 1957) and later by the Iraqi regime: The marshes were perceived as swamps; they could be utilized after draining. This is an

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1 The Iraq Research and Documentation Project (IRDP) has translated the documents into English and made them accessible via Harvard University’s homepage: http://www.fas.harvard.edu/~irdp/
environmental discourse in which natural resources are considered from a user perspective and not from a protection perspective. Likewise the people inhabiting these areas were regarded as backward – after all, they were said to have had the same way of life for 5,000 years. The approach was part of a modernity discourse arguing that people should be ‘developed’. Also, the draining of the marshes and subsequent change of lifestyle for the Marsh Arabs was part of the growth economy discourse that considered the Marsh Arabs primitive and living in an unexploited area. This was further emphasized by the fact that large oil reserves are located in the area, and undrained areas are difficult to access. The first draining of the marshes for oil exploitation began in 1985 when the Iraqi government drained the eastern section of the Al Hammar marsh to exploit an oilfield there (North, 1993).

This is an illustration of the discourses that Saddam Hussein applied, discourses that he had adapted from the British just like the first draining plans. Saddam Hussein used these discourses to legitimize the ‘developments’ in the marshes. Yet, as we have seen, the draining of the marshes did not make the land arable, but destroyed it, and similarly the living conditions of the Marsh Arabs were not improved, but ruined.

4. DISCOURSES OF WETLAND DESTRUCTION

While Saddam Hussein used a certain environmental discourse to legitimize draining the marshes, different environmental discourses were used in the West, where draining was seen as destruction. The following analysis is based on Burgess’ idea that mass media are an integral part of the cultural processes that produce environmental meanings (Burgess, 1990). The two discourses are called the ‘Mesopotamia discourse’ and the ‘Eden discourse’. The history, content, and implications of these discourses are discussed and it is shown how discourses changed shortly before the Second Gulf War. The latest discourse conveys a locally-based understanding of the destruction, an understanding that may influence on future plans for the area.

4.1 THE MESOPOTAMIA DISCOURSE

The Mesopotamia discourse relies on the metaphor ‘Mesopotamia’. While the utilization of the marshes and the special way of life, which could be found there until recently, can be dated back to 3,000 BC, this way of life is not the common image of Mesopotamia. Usually, Mesopotamia is linked with the ‘cradle of civilization’, with the invention of cultivation and taming of animals. Hence, Mesopotamia includes taming of the wild or manipulation of ‘nature’, while the marshes are ‘natural’ areas, wild lands to which humans have adapted.

The Mesopotamia discourse can be dated back to UNEP’s report from May 2001 titled ‘Mesopotamian marshlands: the demise of an ecosystem’. This report gained public attention, and subsequently in newspaper and magazine articles the term ‘Mesopotamian marshes’ was reproduced. In these articles, Mesopotamia was often used a synonym to the marsh area. The term, however, is a Greek word meaning ‘between the rivers’, and therefore Mesopotamia rightly refers to a much larger area than the marshlands. In newspaper articles, a link to the historical Mesopotamia has been made by making references to the ancient history of Iraq as if this had taken place in the very marshes (McCarthy, 2001; Kirby, 2001; National Geographic Society, 2001). The Mesopotamia discourse conveyed an image of the marshes as the very centre of the ancient Mesopotamia, but it had its source in an environmental organization and the environment was indeed at the core of the argument. The Mesopotamia discourse can be seen as part of the environmentalism discourse of the 1990s (e.g. Milton, 1996, 1997; Scoones,

2 It should be noted that the term ‘Mesopotamian Marshes’ has been used before, for instance in a publication by Bird Life International (Stattersfield et al., 1998), but the term is used to cover a much larger area.
What is worth noticing is that Saddam Hussein is not mentioned. The destruction of the marshes is described without any reference to the regime *per se*. Instead emphasis is on the sophisticated utilization of the wetland resources that the Marsh Arabs had invented and refined over millennia. The UNEP report emphasizes sustainable resource use and looks to the whole Euphrates-Tigris river basin for obtaining sustainability (UNEP, 2001). In this way, it builds upon what Dryzek (1997) has labelled ‘the quest for sustainability’, which has a global outlook in finding solutions to environmental problems.

Consequently, in the Mesopotamia discourse, the metaphor Mesopotamia has gained a new meaning. By using the term Mesopotamia, a link is made to the glorious past of this area, but not to the famous utilization and ‘taming’ of natural resources. Instead the emphasis is on the continuous use of the wetlands, because this continued use is considered a symbol of sustainability. In this way, the Mesopotamia discourse links into the ideas of ‘primitive ecological wisdom’. According to Milton (1996), this is an assumption that human beings have a ‘natural’ ability to live in harmony with their environment as long as they are ‘untouched’ by economic development. Hence, within the Mesopotamia discourse, the Marsh Arabs are perceived to have ecological wisdom and to live in harmony with nature. This gives them a symbolic importance as a people who have maintained a sustainable way of life. Further, the destruction of the marshes is illegitimate because continuity creates legitimacy. Here, the metaphor Mesopotamia and references to the past make the destruction illegitimate without even mentioning Saddam Hussein. At a different level, the discourse’s focus on the Marsh Arabs’ continued use of the natural resources implies that this sophisticated – sustainable – utilization should be achieved again. In line with environmentalism discourses of the 1990s, the solution to the environmental problem is found by looking at the marshes in a regional perspective including the upstream actions such as the construction of dams.

4.2 THE EDEN DISCOURSE

An alternative perspective on the marshes can be termed the ‘Eden discourse’. The discourse applies Eden as a metaphor. This may not be the most obvious metaphor for swaps and marshes with plenty of reeds but few apple trees. The ‘Garden of Eden’ terminology is usually connected to the exotic flora and fauna found in ancient near east gardens of the rich and powerful (Foster 1998). Even though it has become widely accepted to associate Eden with southern Iraq, the myth about Eden has little resemblance with the marshes of southern Iraq. Nonetheless, Eden is used as a metaphor in this most recent and dominant discourse of the destruction of the marshes.

From early 2003, a number of newspaper articles described the marshes as ‘The Garden of Eden’ (Campbell, 2003, Spindle, 2003). This discourse can be traced back to Iraq Foundation, a group of expatriate Iraqis, who funded the organization in 1991 to work for democracy and human rights in Iraq. With the ‘Eden Again’ project, the organization wants to draw attention to the destruction of the marshes and the persecution of the Marsh Arabs and to raise money for restoration of the marshlands (Iraq Foundation, 2003). The project idea dates back to spring 2002, but real public attention was not gained until a year later – just before the outbreak of the Second Gulf War. At that time, however, the discourse became dominant and references to Eden or Paradise became commonplace.

The discourse is different from the Mesopotamia discourse in a number of ways. Firstly, even though the area is precious and has an Eden-like status, people and politics not the environment is at the core. Secondly, the environmental problems are not seen in a regional or geo-political perspective, the perspective is local focusing on humanitarian problems. Thirdly, Saddam Hussein is ascribed to whole responsibility for the destruction.
The change of discourse may be ascribed to changes in the international geopolitical agenda. Two years passed from the Mesopotamia discourse until the Eden discourse developed. In the meantime, Iraq became part of President Bush’s ‘axis of evil’ and Bush enlisted Saddam Hussein alongside the worst dictators of the world such as Hitler and Stalin. The implication of the discourse is that attention is moved from the environmental and humanitarian problems to the political arena. When articles state that Saddam Hussein is responsible for the destruction of the ‘Garden of Eden’ the reader is left with the impression that Saddam Hussein is the devil personified. In this way, the discursive construction of environmental destruction can be seen part of the legitimizing process for the ‘liberation of Iraq’. Furthermore, the discourse implies that the removal of Saddam Hussein is the solution to the problems (see e.g. Campbell, 2003; Nordlinger, 2006). Therefore, rehabilitation of the area should be possible with Saddam Hussein and his regime out of the way.

5. IMPLICATIONS OF THE DISCOURSES

Until the publication of the Mesopotamia report by UNEP in 2001, only a few newspaper and magazine articles on the issue can be found. Some exceptions can be found in *Middle East Report* (Hilterman, 1993) and *The Middle East* (North, 1994). UNEP’s report, however, received relatively wide newspaper coverage. As mentioned, UNEP’s emphasis was on the environmental destruction of the marshes. The recommendations made reflect this focus. UNEP suggests international pressure in order to catalyze regional cooperation between the riparian countries. In the report, the demise of the marshes is perceived as a transboundary problem necessitating geo-political solutions (UNEP, 2001). This perspective is reflected in much of the media coverage of 2001 (Radford, 2001; Pearce, 2001).

Within 2002-2003, the focus and politics changed—both in the media and in the wider debate—from the environment to the people (e.g., Spindle, 2003). What happened was that the Eden discourse gradually took over from the Mesopotamia discourse and hence has become the dominant discourse in post-war tales of the marshes. The Eden discourse was able to absorb the ideas of sustainability and ‘living in harmony with nature’ as expressed in the Mesopotamia discourse – after all this is what we perceive the Garden of Eden to be like; a sustainable environment where the first people lived in harmony with nature. Both discourses are constructed outside the media but it is the media that reproduce and reconstruct them in new contexts. When the terms ‘Eden’ and ‘Mesopotamia’ are used, references are made to a deeper past, implying both pastoral idyll and high culture, as a way to criticize the present destruction of the marshlands and eviction of its inhabitants.

Today, headlines and hearings mainly concern the Marsh Arabs and not the marshlands. When the perspective changes in this way—from the environment to the people—the whole problem complex changes too. While desiccation of the marsh environment can be ascribed to a number of the hydro-political decisions made in the catchment area of the Euphrates and Tigris Rivers, the responsibility for the atrocity against the Marsh Arabs is Saddam Hussein’s. In this way, Saddam and his regime come up front and the regional perspective is toned down both in terms of responsibility and in terms of possible solutions.

5.1 FROM WETLANDS TO DRYLANDS AND BACK AGAIN?

Can this unique marshland ecosystem be rehabilitated? The two discourses provide different perspectives on this. The Mesopotamia discourse had a regional perspective and therefore regime change was not seen as enough to ensure environmental rehabilitation. The Eden discourse, on the other hand, had a focus on local scale and therefore the fall of Saddam Hussein was seen as the first step towards rehabilitation. And indeed the removal of Saddam changed the marshlands. The first re-flooding took place in April-May 2003. Already by March 2004, 20 percent of the area was re-flooded (Richardson et al., 2005). While the popular
coverage of the marshland situation in the summer of 2003 appeared optimistic, scientists were more cautious. Re-flooding is not the same as rehabilitation as the ecosystem is not recreated simply by re-flooding and because pollution and salinization in the area are not simply removed by flooding. Prior to the war, scientists had made plans for rehabilitating the area. These had a regional perspective and were based on the premise that flooding should be very careful and highly controlled in order to avoid spreading pollution through water (UNEP, 2001). When the local population began to re-flood the area by deconstructing the draining system, hydrologists warned that this spontaneous ‘rehabilitation’ effort in fact might aggravate the problem. The former marshlands were not only dried out, the soil itself was polluted and many areas had thick salt crusts. Sudden flooding of these areas meant that polluted water was running through the area and into the sea. But this is not the only problem; lack of water might be another. After Saddam Hussein’s drainage of the marshes, another 10 years of GAP development took place in Turkey. Given the limited hydrometric data available during the Baath regime, it has been difficult to assess the relative balance of on-site and off-site water supply and river diversion schemes (Brasington, 2003). This means that the consequences for the marshes of GAP and other projects are unknown and hence rehabilitation efforts are faced with serious lack of information. Hence, there are a number of interrelated issues that affect the chances to rehabilitate the Iraqi marshes:

1. Problems regarding pollution, salt buildup in soils in the marshlands
2. Lack of water and poor quality of water in the Euphrates and Tigris
3. Iraqi policy concerning food self-sufficiency
4. Large oil reserves in the marsh area

Although the two first issues are interlinked, they can be solved at different scales. The first problem is local and often recognized by proponents of the Eden discourse. Solutions to the pollution of the marsh soils may be found in the area.

The second problem, however, is regional and calls for a regional approach as seen in the Mesopotamia discourse (e.g. UNEP 2001). A number of studies have pointed to the fact that the quantity and the quality of the water from the Euphrates and Tigris may be lacking. The marshlands were a unique wetland ecosystem created by the yearly flooding following the snow melt in Anatolia. Up-stream dams hamper the yearly flooding into the marshes. Hence, even without changes in the annual water flow, the dams have a significant influence on the marsh ecosystem. Furthermore, as the Iraqi marshes are located at the end of this river basin, pollution and salt from upstream irrigation schemes affect the marshes (Carkoglu and Eder, 2001). Therefore, some environmental experts note that rehabilitation of the marshes is a geo-political issue and involves the whole river basin of the Euphrates and Tigris (e.g. Naff and Hanna, 2003). Some scientists believe that the first two problems are so severe that only 15-20 percent of the drained marshes can be restored. Pollution, salt buildup and lack of water will prevent further rehabilitation (Richardson et al., 2005).

Finally, the two latter issues—food self-sufficiency and the oil—are not brought up in either of the discourses. But both issues affect the interests in rehabilitating the area and are related to decisions made at national scale.

The issue of food self-sufficiency became prominent after UN sanctions following the First Gulf war in 1991. This added a new dimension to the drainage and water diversion plans for rivers. Two-thirds of Iraq is desert land and highly dependent on Euphrates and Tigris for irrigation water. This dependency increased with the UN sanctions after the First Gulf War and the Iraqi attempts to become self-sufficient in terms of food. Iraq has claimed that the river diversion schemes which drained the marshes were made in an attempt to increase the agricultural area. By means of satellite imagery, Nielsen and Adriansen (2005) have made long-term trend analysis of vegetation changes (integrated Normalized Difference Vegetation
Index, iNDVI) in the catchment areas of Euphrates and Tigris rivers. Their analysis shows that upstream from the marsh areas, significant increases in iNDVI are noticed for large areas. This increase in vegetation productivity in southern Iraq indicates that water consumption along the river system has increased in past 20 years. This may lend credence to Iraqi claims of upstream irrigation and extension of the agricultural area as a means to feed the population after the sanctions. The water use for agriculture is not likely to decrease in the near future and less water will therefore reach the marshlands.

The fourth problem is the oil. For decades, it has been known that there are potential oil fields in the marsh area. According to the U.S. Department of Energy, the two largest fields in the marsh area contain an estimated 10-30 billion barrels and 15 billion barrels respectively (Human Rights Watch, 2003). The estimated production is 3m barrels per day, equal to Iraq’s current total production. It is believed that building the infrastructure of roads, pipelines, and power lines will undermine the ecology of the marshes (Schifferes, 2003). The question is whether the new Iraqi government can afford to leave those large oil reserves untouched.

6. CONCLUDING REMARKS

In spite of available information about the destruction of the marshlands and the plight of the Marsh Arabs, the international community failed to act throughout the 1990s (Human Rights Watch, 2003). The first attention came with the release of the UNEP report in 2001. Without mentioning Saddam Hussein, the report argued that a regional perspective was necessary for rehabilitation to stand a chance. With the Eden discourse, the focus changed to Saddam. Thereby, it can be argued that human suffering is used directly or indirectly to legitimise the war without questioning the role of the international community during the preceding twelve years. This provides a static and local understanding of the problem complex.

Moreover, by changing the focus from the ecosystem to the people the solutions to the problems changes from being regional to being local or at best national. Some of the environmental issues can be solved at a local scale, but rehabilitation of the Marsh Arabs and the question concerning oil exploitation in the marsh area are national issues. Last but not least, the marshlands as a wetland ecosystem is dependent on water from two large river basins. Rehabilitation of the ecosystem should therefore be seen in a regional perspective. The Eden discourse may lead us in the wrong direction when we are looking for ways to rehabilitate the Iraqi marshlands.

7. REFERENCES


Carkoglu, A., and M. Eder. 2001. Domestic concerns and the water conflict over the Euphrates-


University Press.

Transformation of Middle Eastern natural environments: Legacies and lessons, eds. Coppock, J. and J.A. Miller, 320-329. Bulletin Series, No 102, Yale School of
Forestry and Environmental Studies.


