Can field courses provide monitoring data for protected areas?

M.L. Reid[1], A. Appleby, M. Hola, A. Parent, J. Phelan, T. Sun
BSc Environmental Science Program
University of Calgary
Calgary, AB, T2N 1N4
[1] Author for correspondence: phone 403-220-3033, email mreid@ucalgary.ca

1. Introduction

The main purpose of parks and protected areas is to preserve the natural heritage and ecological integrity representative of Alberta's and Canada's diverse environment (Alberta Government 2000a; Alberta Government 2000b, Alberta Government 2000c, Government of Canada 2000). To satisfy this purpose, management plans are made that incorporate the specific objectives of the protected area and that specify how these are to be met. Monitoring is not directly mentioned in any of the legislation that governs parks and protected areas, but this is implicit in the notion of preservation. To fulfill this mandate, monitoring programs exist on a variety of spatial scales and scopes and provide managers with the essential data needed for assessing the condition of protected areas and making appropriate management decisions.

Although there is an unquestionable need for it, monitoring can be too expensive to be sustainable if only professional scientists are used to collect the data (ter Braak et al. 1994; Danielsen et al. 2005). This has led many monitoring programs to involve volunteers from the general public to collect monitoring data. With sufficient training, well defined and standardized collection protocol, and in combination with professional resources/systems, non-professionals can not only collect useful monitoring data but also alleviate some costs and make a program more sustainable (Yarnell and Gayton 2003, Danielsen et al. 2005). Many university field courses collect extensive amounts of environmental data for educational purposes or as part of independent research initiatives. These data may be useful in protected area monitoring programs, but such a collaboration rarely, if ever, occurs. It is the purpose of this paper to determine whether university field courses can provide useful data to fulfill these needs.

A successful monitoring program has number of essential characteristics including a long term goal or purpose which is carried out using a structured, repeatable and standardized protocol (Yarnell and Gayton 2003). Also, monitoring programs need to be sustainable over the long term, where "long

term" is essentially long enough to collect meaningful data useful for management purposes (Urquhart et al. 1998). Finally, data must be collected so that they are of such quality that analysis yields reliable information that is useful to managers and decision makers. Here, we use the University of Calgary Environmental Science 401 (ENSC401) Field Course and its work in the Evan Thomas Provincial Recreational Area of Kananaskis Country as a case study in the analysis of the potential for synergies between field courses and monitoring of protected areas.

2.0 Methods

2.1 Study area

The Evan Thomas Provincial Recreational Area (ETPRA) is part of the Alberta parks and protected area network and is located in Kananaskis Country on the eastern slopes of the Rocky Mountains where it is surrounded by other parks and protected areas (Alberta Community Development 2004). It is approximately 75 km west of Calgary, a rapidly growing city of more than 1 million people. The management plan states that the purpose of the ETPRA is to provide high quality outdoor recreational opportunities for the public while at the same time maintain the integrity of the natural ecosystem (Alberta Community Development 2004). Monitoring under the ETPRA management plan is carried out by the Alberta Natural Heritage Information Centre (ANHIC). In their report on the state of Alberta's parks and protected areas, the Canadian Parks and Wilderness Society argues that the AHNIC's sparse human resources (seven employed staff) limits their ability to effectively monitor and manage Alberta's protected areas (Reeves and Walsh 2007).

2.1 Field course

The field course ENSC401 has been conducted in and around the Evan Thomas Provincial Recreation Area since 1997. The course takes place just prior to the start of the regular fall semester, with field data generally collected in the first week of September. Typically, approximately 35 students are in the course each year (range 21-51). For field instruction and data collection, students are divided into three or four groups that rotate through different field modules. Each module is led by an instructor with at least some professional expertise in the pertinent subject area (e.g. vegetation or water sampling). Most, but not all, instructors have been consistent through most years of the course, as has the overall course coordinator (M.L. Reid).

The pedagogical goal is to teach the basic field methods and data analysis for major components of ecosystems. The context for the study has been to investigate the impacts of recreational activity on these ecosystem components. Originally the study sites were selected with respect to a proposed golf course on the Evan Thomas Creek floodplain immediately east of Highway 40. When that proposal was withdrawn, some sampling areas were changed to focus more on the impacts of current recreational activity within the ETPRA. This results in different number of sampling years for different types of data. Here we report on the more consistently sampled data that include vegetation, wildlife (ungulate) abundance, water chemistry and stream benthic macroinvertebrates.

2.3 Vegetation and wildlife

Vegetation and wildlife sampling occurred in the same study areas in and around Mt. Kidd RV Park. The sampling design compares 'disturbed' areas (within the RV Park on the west side of Highway 40) and 'undisturbed' areas on the east side of the highway across from the RV Park. The undisturbed areas were sampled from 20 to 100 m from the highway for logistical ease. Within each disturbance category, two types of habitat were sampled. The floodplain habitat was within approximately 50 m south of Evan Thomas Creek, while the forest (mature lodgepole pine, *Pinus contorta*) habitat was 100 m or more south of the creek.

Students measured the percent coverage of ground vegetation and shrubs. For ground vegetation, a 50cm x 50cm frame quadrat for each randomly chosen sampling spot was placed on the ground, all species were identified, and the estimated percent coverage of each species present in the quadrat was recorded. For shrubs, 30 m long transects were laid out from a random starting point and in a random direction. Students measured the length of the transect covered by each shrub or small tree species.

Each year, 10-20 quadrats and 5-12 transects were sampled in each site. A different group of students sampled each site.

Ungulate abundance was estimated using fecal pellet groups. Randomly placed plots with 5 m radius were surveyed for pellet groups that were identified as deer (*Odocoileus* spp.), elk (*Cervus elaphus*), or moose (*Alces alces*). Generally six to eight groups of two to four people sampled two plots in each of the four sites: the undisturbed floodplain, the undisturbed forest, the disturbed floodplain, and the disturbed forest. Each year, six to 16 plots were sampled in each site.

2.4 Stream water chemistry and macroinvertebrates

Two sites along the Kananaskis River were continuously sampled over eight years; other sites were sampled less often. One site was downstream from the waste water treatment plant near Kananaskis Village. The other site was located upstream of the ETPRA at the Opal day use area.

To determine water chemistry, 250 mL to 1 L grab samples were obtained from each site for subsequent lab analyses. HACH spectrophotometry analyses were performed by students in the field station lab for ferrous iron (Fe_{2+}), NH_3, PO_{43-}, SiO_2, and SO_{42-} in mg/L. One to three samples were analyzed at each site in each year. Other parameters were measured at the river's edge or using ion chromotography by a professional technician. Macroinvertebrates were collected from random sites in riffles using a Surber sampler (30 cm x 30 cm sampled area) and a standard procedure to disturb the river substrate. They were later identified to Family (for insects) by students in a third year aquatic ecology class. On average, six samples were taken in each site in each year.

2.5 Analyses

Inferential statistics were used to detect differences among study sites (to infer sensitivity of our methods) and among years (to assess consistency). Assumptions of parametric analyses were examined, and data were transformed as necessary to meet the assumptions. If assumptions could not be met, non-parametric analyses were used. For water chemistry data, we also compared student analyses with known standards.

3.0 Results

3.1 Vegetation and wildlife

Significant differences between sites were found for five of six species of shrubs examined and for all six species of ground vegetation examined. No significant differences in coverage between years were found for any species of shrubs. Significant differences between years were found for four of the six species of ground vegetation, only one to two years significantly differed from other years for each of these species. The observation that differences were detected between sites but not between years suggests that student data are consistent from year to year.

The sensitivity and consistency of ungulate data varied among species. We found moose were most abundant in the undisturbed floodplain site and rare in the other sites, and this result was significant in seven of nine years. In this case, the data were consistent, and also suggest that a single year of sampling could be sufficient to document habitat use. The elk data were more variable. With data pooled across nine years, elk were significantly most common in the disturbed floodplain site and least common in the disturbed forest site. This trend was evident in all years, but within any single year these distinctions among study sites were often not detectable statistically. Consequently, multiple years of field course data would be required for this species. Deer were the most abundant species. Significant differences among study sites were found in eight of nine years, but the patterns differed among years as indicated by a three-way statistical interaction between habitat, disturbance and year. In five of the years, the effect of disturbance differed between habitat types (disturbance * habitat interaction), while in three years only habitat was important with deer preferring floodplain habitat regardless of disturbance. Where there was an interaction, deer pellet groups were most common in the disturbed floodplain and least common in the disturbed forest. Overall, the ungulate data suggest that student data can detect significant differences in habitat use, and that multiple years of data are informative.

3.2 Stream chemistry and macroinvertebrates

Accuracy of water chemistry analyses can be determined in part by the analysis of known standards, and this was done in two years. Percent error on standard values indicated ranged from 5% to 21.95%, depending on parameter and year. Overall, most parameters analyzed were often close to detection limits of our instruments. Through statistical analyses of the available data, we found that differences between the two sites differed among years (significant interactions), and that overall there was not a strong indication of site differences in nutrients associated with wastewater.

Macroinvertebrate data appeared to be more consistent than water chemistry data. The site downstream of the wastewater treatment plant had significantly higher densities of macroinvertebrates than the upstream site over all years (no interaction), while average densities did differ among years. The differences among sites were detected in only three of eight individual years, due to the small sample sizes in each year. Similar results were found if only the major taxonomic categories were considered, such as Ephemeroptera, Trichoptera and Plecoptera (EPT) or only Ephemeroptera and for indices of pollution, which combine tolerance values for each taxon. Although the greater abundance of macroinvertebrates could be due to increased nutrients arising from the wastewater treatment plant, the direct measurements of those nutrients were not clear (see above) and there may be other reasons for differences among sites. Nevertheless, these data appear to be consistent and sensitive enough to detect site differences.

4.0 Discussion

The ENSC401 field course data often met the requirements of a monitoring program. Protocols were structured, repeatable and standardized (Yarnell and Gayton, 2003). These protocols are likely to stay consistent as they are chosen to reflect standard sampling practices that students in every year should be taught. The water chemistry data were the most variable and could benefit from more rigorous sampling and analysis procedures (e.g. consistent analysis of standards). However, they are also the most labour-intensive and technically difficult to obtain with reasonable sample sizes in the context of our course. Macroscopic elements, such as plants, pellet groups, and stream macroinvertebrates, are more reliable within field courses.

Another important element of a monitoring program is that it is relatively long term (Urquhart et al, 1998). Our field course has accumulated up to nine years of data (ungulate pellet groups on the same study sites). However, sampling sites among years did change among years as the focus of the course and as limitations of certain sites became apparent. For example, we obtained eight years of data for only two sites on the Kananaskis River, because the other sites varied in location among years. The possibility of changing study sites is to be expected for field courses, whose first priority is teaching, but may still be small given that there will be a finite number of sites within a given geographic area that meet educational and logistical requirements. On the other hand, instructors may deliberately choose to vary the content among years to minimize the transmission of assignments among years of students. However, because field courses focus on skills and data analysis, the risk of plagiarism may be small. This can allow consistency of sampling techniques and study sites among years.

The major concern for using field course data for a real monitoring program is the quality of the data. Our data revealed detectable differences among study sites that were consistent among years, suggesting reliability. This was clearest for the vegetation data, where the perennial nature of shrubs in particular leads us to expect year-to-year consistency, as was observed. Moose pellet group abundance also showed consistent differences among years, which in this case is attributable to the strong habitat preference of moose. For some data, such as elk pellet groups and stream macroinvertebrates, consistent site difference were evident across all the years of data, but often not statistically detectable in a given single year. Here, sample sizes were often too small in a given year relative to magnitude of difference among years (low power). However, sampling over several years alleviates the sample size issue while also providing information about annual differences, yielding a more powerful overall experimental design than intense sampling in one year. Other data, namely deer pellet groups and some

water chemistry parameters, suggested that site differences were inconsistent among years (significant site by year interactions). These differences may be real or an artifact of error. In the case of deer pellet groups, the change in importance of different sites is likely real because pellets groups are abundant and easily detected, because other ungulate data were consistent over years, and because the statistical significance was generally either very significant or not. Here, the multi-year data of field courses can provide insights into deer ecology. The interpretation of yearly differences in water chemistry is not so clear because accurate data were harder to obtain. Thus, we again suggest that vegetation, pellet groups and stream macroinvertebrates are valuable data from field courses for monitoring purposes, while our water chemistry data should not be relied upon. We also note that the format of field courses, where many students collect data each year, may be advantageous by limiting observer bias that can occur when a few professional observers collect data (Sykes et al. 1983, Leps and Hadincova 1992).

In conclusion, data collected by students in university field courses can be a good source of monitoring data. Many sorts of data, but not all, may be reliable enough to detect real trends. However, it would be more desirable from a manager's point of view to have complete certainty in the consistent collection of data, so a formal discussion between managers and field course leaders should be held before relying on field courses. Moreover, it is a significant task to assemble all the data from a field course and get it into an appropriate form for managers, and some support from external agencies would be helpful. Despite these caveats, field courses can provide a valuable yet inexpensive source of data for parks and protected areas that have a mandate to maintain ecological integrity but limited capacity to collect the data necessary to do so.

5. Acknowledgements

6. Literature Cited

Alberta Community Development. 2004. Evan Thomas Provincial Recreational Area Management Plan. Available at http://www.tpr.alberta.ca/parks/managing/managementplans.asp#download . Last accessed April 21, 2008.

Alberta Government 2000a Queens Printer. Provincial Parks Act. R.S.A. 2000, c. P-35, http://www.qp.gov.ab.ca/Documents/acts/P35.CFM. Last accessed April 21 , 2008.

Alberta Government 2000b. Queens Printer. Wilderness Areas, Ecological Reserves and Natural Areas Amendment Act, R.S.A. 2000, c. 34 (Supp), http://www.qp.gov.ab.ca/documents/acts/W09.cfm. Last accessed April 21, 2008.

Alberta Government 2000c. Queens Printer. Willmore Wilderness Park Act, R.S.A. 2000, c. W-11, http://www.qp.gov.ab.ca/documents/acts/W11.cfm. Last accessed April 21, 2008.

Danielsen, F., N.D. Burgess, A. Balmford. 2005. Monitoring matters: examining the potential for locally-based approaches. *Biodiversity and Conservation* **14**: 2507-2542.

Leps, J., V. Hadincova. 1992. How reliable are our vegetation analyses? *Journal of Vegetation Science* **3**: 119-124.

Reeves, R. and H. Walsh. 2007. The State of Alberta's Parks and Protected Areas: an analysis of the challenges and opportunities for ensuring ecological integrity. Canadian Parks and Wilderness Society (CPAWS) Northern Alberta, 1-42.

Sykes, J.M., A.D. Horrill, M.D. Mountford. 1983. Use of Visual Cover Assessments as Quantitative Estimators of Some British Woodland Taxa. *The Journal of Ecology* **71**:437-450.

ter Braak, C.J.F., A.J. van Strien, R. Meijer, T.J. Verstrael. Analysis of monitoring data with many missing values: which method? In: E.J.M. Hagemeijer & T.J. Verstrael (eds.), Bird Numbers 1992. Distribution, monitoring and ecological aspects. Proceedings 12th International Conference

of IBCC and EOAC, Noordwijkerhout, The Netherlands. Statistics Netherlands, Voorburg/Heerlen; SOVON, Beek-Ubbergen; 663-673.

Urquhart, N.S., S.G. Paulsen, D.P. Larsen. 1998. Monitoring for policy-relevant regional trends over time. *Ecological Applications* **8**: 246-257.

Yarnell, P. and D.V. Gayton. 2003. Community–based ecosystem monitoring in British Columbia: A survey and recommendations for extension. FORREX-Forest Research Extension Partnership, Kamloops, B.C. FORREX Series 13.