Resource Packet: Communicating Accurately and Concisely

This packet includes all documents you will be using to answer questions and learn vital concepts in the "Communicating Accurately and Concisely" module. Feel free to print this packet now, so that you can make notes as you go, or print each document as it becomes available during your progress through the course. The title of the page the document will appear on is noted in the top left corner of each document in this handout.

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Understanding Science

The logic of scientific arguments

Taken together, the expectations generated by a scientific idea and the actual observations relevant to those expectations form what we'll call a scientific argument. This is a bit like an argument in a court case—a logical description of what we think and why we think it. A scientific argument uses evidence to make a case for whether a scientific idea is accurate or inaccurate. For example, the idea that illness in new mothers can be caused by doctors' dirty hands generates the expectation that illness rates should go down when doctors are required to wash their hands before attending births. When this test was actually performed in the 1800s, the results matched the expectations, forming a strong scientific argument in support of the idea—and hand-washing!

Scientific idea + Expectations + Observations = **Scientific argument**

Though the elements of a scientific argument (scientific idea, expectations generated by the idea, and relevant observations) are always related in the same logical way, in terms of the process of science, those elements may be assembled in different orders. Sometimes the idea comes first and then scientists go looking for the observations that bear on it. Sometimes the observations are made first, and they suggest a particular idea. Sometimes the idea and the observations are already out there, and someone comes along later and figures out that the two might be related to one another.

Assembling a scientific argument

Testing ideas with evidence may seem like plain old common sense—and at its core, it is!—but there are some subtleties to the process:

- **Ideas can be tested in many ways.** Some tests are relatively straightforward (e.g., raising 1000 fruit flies and counting how many have red eyes), but some require a lot of time (e.g., waiting for the next appearance of Halley's Comet), effort (e.g., painstakingly sorting through thousands of microfossils), and/or the development of specialized tools (like a particle accelerator).
- **Evidence can reflect on ideas in many different ways.**
- **There are multiple lines of evidence and many criteria to consider in evaluating an idea.**
- **All testing involves making some assumptions.**

Despite these details, it's important to remember that, in the end, hypotheses and theories live and die by whether or not they work—in other words, whether they are useful in explaining data, generating expectations, providing satisfying explanations, inspiring research questions, answering questions, and solving problems. Science filters through many ideas and builds on those that *work*!

Exercise: Developing a Persona

Developing a persona helps you to understand your audience and to communicate more effectively with your audience. One way to understand your audience is to develop a persona.

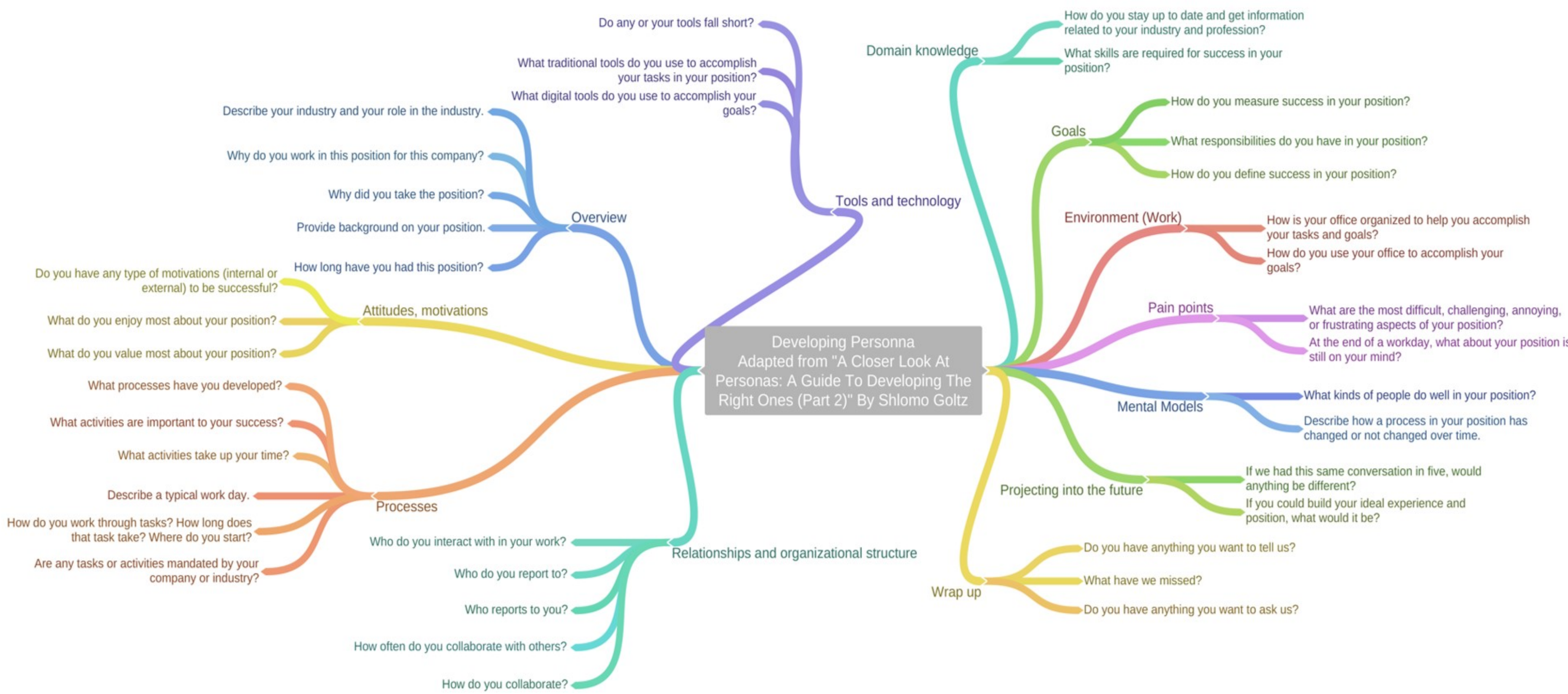
Persona

1. List **YOUR** audience's geographical, demographic, psychographic, and behavioral characteristics. To identify this information, use the categories below.

Geographical	Demographic	Psychographic	Behavioral
Continent	Age	Lifestyle	Occasions
Country	Gender	Social class	Degree of loyalty
Country region	Family size	AIOs (activity, interest, opinion)	Benefits sought
City	Occupation	Personal values	Usage
Density	Income	Attitudes	Buyer readiness stage
Climate	Education		User status
Population	Religion		
Subway station	Race		
City area	Nationality		

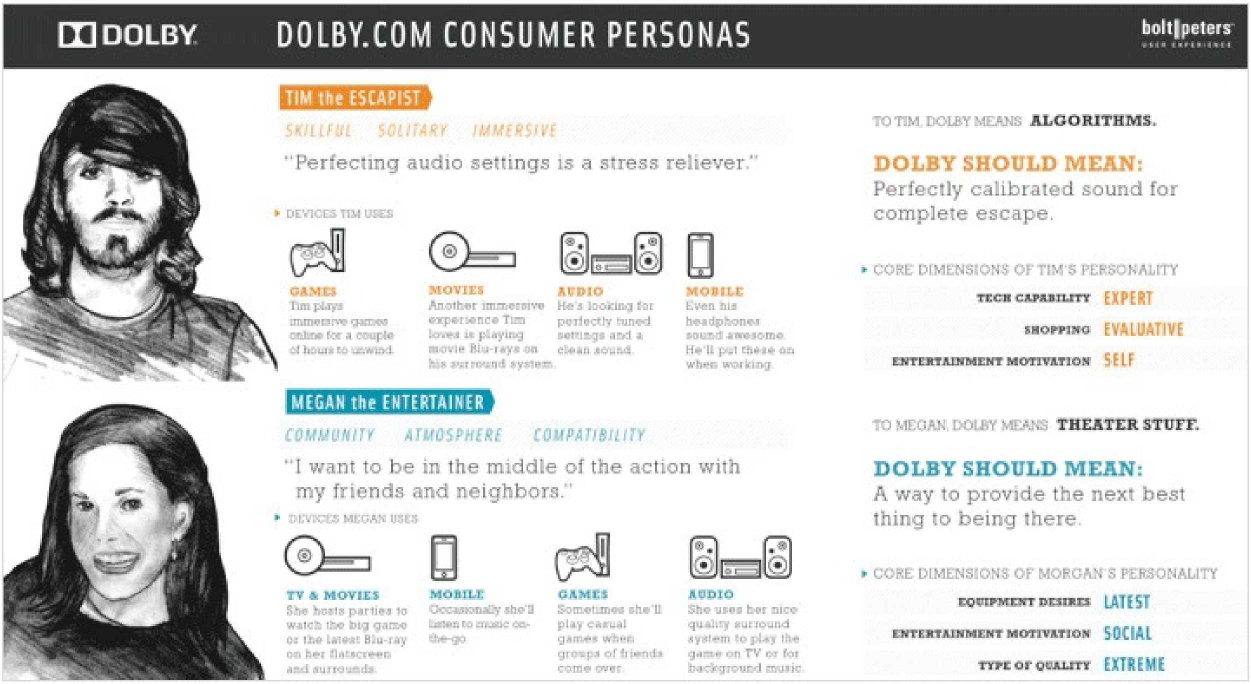
Source: http://www.smashingmagazine.com/2014/08/a-closer-look-at-personas-part-2/

2. Use questions listed in the mind map on the next page as a starting point for understanding your audience.



Source: http://www.smashingmagazine.com/2014/08/a-closer-look-at-personas-part-2/

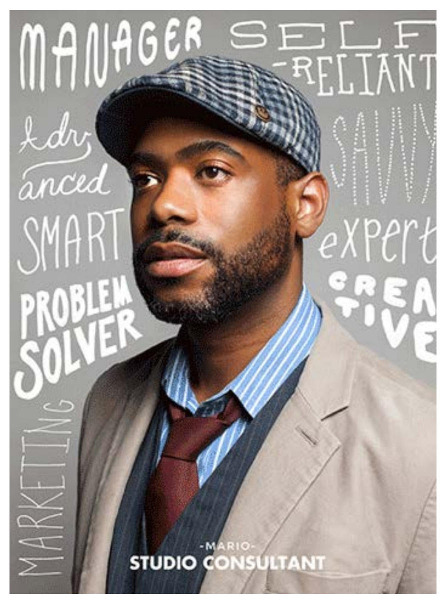
3. Use the information from Parts 1 and 2 to synthesize a model similar to the one below. The person you are describing in this model is a typical member of your audience, so keep that in mind. Make sure and include your audience's geographical, demographic, psychographic, and behavioral characteristics.



Source: http://boltpeters.com/clients/dolby/

4. Use the information from Parts 1, 2, and 3 to socialize your persona. From the information you have gathered during this process, you will develop a persona similar to the one below. Identify descriptive adjectives derived from the information you have collected to use in the development of a persona for your audience. When you are finished, your persona should look similar to the one at right.

Source: http://blog.mailchimp.com/new-mailchimp-user-persona-research/



HOW TO READ SCIENTIFIC PAPERS

Much of a scientist's work involves reading research papers. Because scientific articles are different from other texts, like novels or newspaper stories, they should be read differently. Here are some tips to be able to read and understand them.

1 SKIM

First get the "big picture" by reading the title, key words and abstract carefully; this will tell you the major findings and why they matter.

- Quickly scan the article without taking notes; focus on headings and subheadings.
- Note the publishing date; for many areas, current research is more relevant.
- Note any terms and parts you don't understand for further reading.

RE-READ 2

Read the article again, asking yourself questions such as:

- What problem is the study trying to solve?
- Are the findings well supported by evidence?
- Are the findings unique and supported by other work in the field?
- What was the sample size? Is it representative of the larger population?
- Is the study repeatable?
- What factors might affect the results?

If you are unfamiliar with key concepts, look for them in the literature.

3 INTERPRET

- Examine graphs and tables carefully.
- Try to interpret data first before looking at captions.

- When reading the discussion and results, look for key issues and new findings.
- Make sure you have distinguished the main points. If not, go over the text again.

SUMMARIZE 4

- Take notes; it improves reading comprehension and helps you remember key points.
- If you have a printed version, highlight key points and write on the article. If it's on screen, make use of markers and comments.

- Lenny Rhine. "How to Read a Scientific Paper." Research4Life Training Portal.
- Valerie Matarese, PhD (Ed). "Using strategic, critical reading of research papers to teach scientific writing." *Supporting Research Writing: Roles and Challenges in Multilingual Settings*. Chandos Publishing, Elsevier (2013).
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- Mary Purugganan, PhD, and Jan Hewitt, PhD. "How to Read a Scientific Article." *Cain Project in Engineering and Professional Communication*, Rice University.
- "How to Read and Review a Scientific Journal Article." Writing Studio, Duke University.
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IMPACT OF GRAZING MANAGEMENT ON THE CARBON AND NITROGEN BALANCE OF A MIXED-GRASS RANGELAND

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Abstract. Rangeland grazing management strategies have been developed in an effort to sustain efficient use of forage resources by livestock. However, the effects of grazing on the redistribution and cycling of carbon (C) and nitrogen (N) within the plant–soil system are not well understood. We examined the plant–soil C and N balances of a mixed-grass rangeland under three livestock stocking rates using an area that had not been grazed by domestic livestock for more than 40 years. We established nongrazed exclosures and pastures subjected to continuous season-long grazing at either a light stocking rate (20 steer-days/ha) or a heavy stocking rate (59 steer-days/ha, ~50% utilization of annual production). Twelve years of grazing under these stocking rates did not change the total masses of C and N in the plant–soil (0–60 cm) system but did change the distribution of C and N among the system components, primarily via a significant increase in the masses of C and N in the root zone (0–30 cm) of the soil profile. The mass of soil C (0–60 cm) under heavy grazing was comparable to that of the light grazing treatment. Grazing at the heavy stocking rate resulted in a decrease in peak standing crop (PSC) of aboveground live phytomass, an increase in blue grama (*Bouteloua gracilis* [H.B.K.] Lag. Ex Steud.), and a decrease in western wheatgrass (*Pascopyrum smithii* [Rydb.] A. Love) compared to the light grazing treatment. The dominant species under light grazing was western wheatgrass, whereas in the nongrazed exclosures, forbs were dominant and appeared to have increased at the expense of western wheatgrass. The observed increase of soil C and N in the surface soil where roots dominate indicates a greater opportunity for nutrient availability and cycling, and hence enhanced grazing quality.

Key words: *C and N balance; carbon; mixed-grass prairie; nitrogen; rangelands.*

Introduction

Rangeland grazing management strategies have been developed in an effort to sustain efficient use of the forage resource by livestock. However, these management practices affect many ecosystem components besides livestock and forage production. Grazing can also influence plant community structure, soil chemical and physical properties, and the distribution and cycling of nutrients within the plant–soil system. This paper examines the effects of grazing on C and N distribution within a semiarid, mixed-grass plant–soil system.

Historically, most grazing studies have focused on the effects of management practices on forage production and animal response, although a few researchers have evaluated the effects of grazing on soil C and N (Smoliak et al. 1972, Bauer et al. 1987, Frank et al. 1995). Grazing of the northern mixed prairie reduces canopy biomass by depressing the vigor of cool-season grasses and causing the replacement of mid-grasses by warm-season short grasses (Coupland et al. 1960, Dormaar and Willms 1990). The degree to which this shift in species composition occurs depends on the density and duration of stocking (Coupland 1992). Grazing also partially controls the quantity and chemical composition of soil organic matter and the distribution of C and N in the soil profile (Rosswall 1976, Smoliak et al. 1972, Dormaar and Willms 1990, Dormaar et al. 1990, Frank et al. 1995), thus influencing the largest reservoir of N and C in the perennial grass plant–soil system. Since plant-available N is usually the limiting nutrient to grass production in the semiarid Great Plains (Power 1977), the quantity and chemical composition of soil organic matter is of critical importance to N and C cycling and primary productivity (Power 1994), and thus to overall ecosystem function. Aboveground plant productivity and composition also influence C and N inputs. Grazing has been shown to influence litter accumulation and depletion (Christie 1979, Hart et al. 1988, Naeth et al. 1991), its rate of decomposition (Shariff et al. 1994), and its subsequent effects on herbage production (Willms et al. 1993).

Milchunas and Lauenroth (1993) reviewed a worldwide 236-site data set and found no clear relationship between species composition, root biomass, soil organic C, or soil N of grazed vs. ungrazed grasslands. These cited studies clearly indicate the variance of findings on the effects of grazing on soil organic C and N. We believe that much of the variance noted in earlier

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research results from soil variations within the studies, differences in the depth of the soil profile being evaluated, and a lack of thorough evaluation of the C and N distribution within the system. For example, a significant number of past studies only evaluated the surface 5–10 cm of the soil profile. We feel that careful evaluation of the effects of grazing on ecosystem C and N balance can be a useful indicator of the effects of grazing management on rangeland health (National Research Council 1994). Therefore, the objective of this research was to quantify the effects of 12 yr of livestock grazing at three stocking rates on plant biomass, plant community composition, and the C and N balance of a mixed-grass prairie.

METHODS

Study sites

The research was conducted at the High Plains Grasslands Research Station near Cheyenne, Wyoming, on a native mixed-grass rangeland with rolling topography and elevations ranging from 1910 to 1950 m. The climate is semiarid, with an annual frost-free period of 127 d, and average annual precipitation (1971–1994) of 384 mm, of which 70% occurs from 1 April through 30 September (National Oceanic and Atmospheric Administration 1994). Dominant soil series are Ascalon and Altvan sandy loams (mixed, mesic, Aridic Argiustoll; Stevenson et al. 1984).

Vegetation is predominantly grasses (55% cool-season species and 23% warm-season species), forbs, sedges, and half-shrubs. Dominant cool-season species are western wheatgrass (*Pascopyrum smithii* (Rydb.) A. Love) and needleandthread (*Stipa comata* Trin & Rupr.), and the dominant warm-season species is blue grama (*Bouteloua gracilis* (H.B.K) Lag. Ex Steud.). Legumes comprised <2% of the plant community of this mixed-grass ecosystem. Prior to establishment of the grazing management and stocking rate phase of this research, the area had not been grazed by domestic livestock for >40 yr.

Treatment pastures were established in 1982 in a randomized block design with two replicate blocks (pastures) for each of seven grazing strategy–stocking rate treatment combinations. Three of the treatments were evaluated in this study: (1) EX, nongrazed exclosures, (2) CL, pastures with continuous season-long grazing at a light stocking rate of 0.16 to 0.23 steers/ha (mean of 20 steer-days/ha), and (3) CH, pastures with continuous season-long grazing at a heavy stocking rate of 0.56 steers/ha (mean of 59 steer-days/ha). The light stocking rate was ~35% below the stocking rate recommended by the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) for the condition of the site, whereas the heavy stocking rate, which utilized slightly <50% of annual production, was ~33% higher than the NRCS recommended rate (Hart et al. 1988). Further details of the grazing treatments and pasture design are given in Hart et al. (1988) and Manley et al. (1995).

Field sampling

In 1982, prior to initiation of grazing treatments, a 50-m permanent transect was established in each replicate pasture on near-level sites on the Ascalon soil series. The A horizon and solum (A + B horizons) of the Ascalon soil have mean (±1 SD) depths of 15 ± 2 cm and 100 ± 7 cm, respectively. The soil ranges from 6.4 to 7.3 pH. In July 1993, soil and plant samples were collected to measure the C and N content in the various components of the plant–soil system. Five sample locations were established at 10-m intervals along the 50-m transect in each pasture. Soil samples (4.6 cm diameter) were collected to 90-cm depth with a hydraulic soil sampling machine. All plant litter was removed from the soil surface before the samples were taken. Soil samples were segregated into 0–3.8, 3.8–7.6, 7.6–15, 15–30, 30–45, 45–60, and 60–90 cm increments. The first three segments, 0–15 cm, encompass the soil A horizon; the 15–90 cm segments represent the various components of the soil B horizon. Because the soil profile was extremely dry below 60 cm, we were unable to collect a complete set of soil samples at the 60–90 cm depth; therefore, soil C and N and root biomass were only assessed to the 60-cm depth. Two cores were taken at each sample site and composited by depth increment to provide adequate sample for analyses. Samples were placed in sealed plastic bags and transported to the laboratory in coolers. Separate soil cores were collected at the second and fourth sampling sites along each transect to assess bulk density as described by Blake and Hartge (1986). The bulk density data were used to convert soil C and N concentrations (in milligrams per kilogram) to C and N mass (in kilograms per hectare) in the soil. These soils contain <1% fine gravels that are generally found in the C horizon; therefore, no adjustment of the bulk density was necessary.

Five additional cores were collected at 10-m intervals along each transect to assess root biomass and root C and N. The surface 30 cm were sampled with a 9.9 cm diameter core, and the 30–60 cm depth was sampled with a 4.6 cm diameter core. Soil cores were separated into 0–15, 15–30, and 30–60 cm increments. The smaller diameter core was required to obtain the lower depth samples because of low soil moisture levels. Root core increments were placed in sealed plastic bags and stored at 5°C until roots could be washed from the soil.

Surface litter and standing dead plant biomass were estimated along each transect with five 0.18-m^2 quadrats, spaced at 10-m intervals. Estimates of annual aboveground biomass production were obtained at peak standing crop from three 1.5 × 1.5 m temporary exclosures randomly located throughout each treatment pasture; two 0.18-m^2 quadrats were sampled within each of the temporary exclosures. In the nongrazed

TABLE 1. Comparison of total biomass of vegetation components as affected by stocking rate (NS = not statistically significant).

System components	Exclosure (kg/ha)	Continuous light grazing (kg/ha)	Continuous heavy grazing (kg/ha)	Least significant differences	
				$P = 0.10$	$P = 0.05$
Above ground					
Live biomass	1 330	1 224	816	270	325
Standing dead	472	492	0	155	187
Litter	2 872	1 647	1 271	1018	1227
Total above ground dead	3 344	2 139	1 271	1054	1270
Total above ground biomass	4 674	3 363	2 087	1176	1418
Roots					
0–15 cm	31 474	21 695	27 319	6500	NS
15–30cm	5 516	6 971	5 289	NS	NS
30–60cm	1 618	1 779	1 162	NS	NS
Total roots:	38 608	30 445	33 770	NS	NS
Root : shoot ratio	28.4	26.9	41.6	10.4	12.5
Total plant biomass	43 282	33 808	35 857	NS	NS

permanent exclosures (EX), five 0.18-m^2 quadrats were sampled at 10-m intervals along the 50-m transect for all aboveground plant components.

Laboratory analysis

Soil samples intended for C and N analysis were passed through a 2-mm screen to remove plant crowns and visible roots and root fragments. Each sample was mixed and a 10-g field-moist subsample removed for NH_4^+ and NO_3^- extraction; the remaining soil was air-dried and stored at 4°C until analyses for total C and N were completed. Root separation from root cores was accomplished by hand with the washing method described by Laurenroth and Whitman (1971). Vegetation components were dried at 60°C, weighed, and the final biomass estimates converted to a kilogram per hectare basis using the area of the sample quadrat, or in the case of the roots, the surface area of the root core. Ash content of all components of the vegetation was used to calculate/adjust the C and N masses.

Plant samples were analyzed for organic C and N with a Carlo-Erba automated combustion analyzer. Organic N concentrations of soil samples were determined with a modified micro-Kjeldahl procedure (Schuman et al. 1973). Soil organic C was determined with the Walkley-Black dichromate oxidation procedure (Nelson and Sommers 1982). Soil NH_4^+ and NO_3^- were extracted from field moist soils with 1 mol/L KCl at a 1:10 soil : solution ratio; extracts were filtered and analyzed with a Technicon autoanalyzer (Environmental Protection Agency 1983).

Statistical analysis

Analysis of variance was used to test stocking rate effects on soil and plant component C and N masses and on plant component biomass data using a randomized complete block design with two blocks. Individual system components (litter, standing dead, live biomass, root by depth, and soil by depth) were each tested with a separate analysis of variance with replicate pastures treated as blocks. Least-significant-differences (LSD) procedures were used for treatment mean separation (Steel and Torrie 1980). All statistical evaluations and discussion are based upon $P \leq 0.10$. While we believe that the 10% probability level is very appropriate to test and evaluate the effects of management alternatives on grassland C and N balance, we present LSD values for both the 5 and 10% probability levels in each table. Only 20% of the statistical test accomplished did not meet the 5% probability.

RESULTS

Vegetation components

Twelve years of grazing at the heavy stocking rate resulted in decreased peak standing crop (PSC) of aboveground live phytomass (Table 1), as well as shifts in the plant composition of the PSC (Table 2). Western wheatgrass declined from 45 to 21% of PSC (mass

TABLE 2. Proportional botanical composition of peak standing crop biomass as affected by stocking rate (NS = not significant).

Taxon	Exclosure	Continuous light grazing	Continuous heavy grazing	Least significant differences	
				$P = 0.10$	$P = 0.05$
Blue grama	0.165	0.170	0.272	0.092	NS
Western wheatgrass	0.290	0.448	0.214	0.124	0.149
Needleandthread	0.129	0.068	0.111	NS	NS
Other grasses	0.026	0.046	0.116	0.046	0.068
Sedges	0.060	0.105	0.071	NS	NS
Forbs	0.330	0.163	0.216	0.124	NS

TABLE 3. Mass of C from vegetation components and soil (0–60 cm profile) as affected by stocking rate (NS = not statistically significant).

System components	Exclosure (kg/ha)	Continuous light grazing (kg/ha)	Continuous heavy grazing (kg/ha)	Least significant differences	
				$P = 0.10$	$P = 0.05$
Above ground					
Live biomass	587	535	355	119	143
Standing dead	206	209	0	65	79
Litter	809	533	394	240	29
Total aboveground dead C	1 015	742	394	255	307
Total aboveground C	1 602	1 277	749	252	371
Roots					
0–15 cm	7 166	6 011	5 763	1 073	NS
15–30 cm	1 244	1 646	1 312	NS	NS
30–60	379	504	346	NS	NS
Total root C	8 789	8 161	7 421	NS	NS
Total plant C	10 391	9 438	8 170	1 259	1517
Soil profile					
0–3.8 cm	9 595	12 675	12 000	1 309	1929
3.8–7.6 cm	5 906	7 457	8 478	660	793
7.6–15 cm	12 662	15 009	15 472	1 573	1896
Total soil C (0–15 cm)	28 163	35 141	35 950	2 188	3224
15–30 cm	19 761	22 847	22 348	2 485	NS
Total soil C (0–30 cm)	47 924	57 988	58 298	2 463	3629
30–45 cm	22 932	20 353	25 281	NS	NS
45–60 cm	17 291	13 595	17 689	NS	NS
Total soil C (0–60 cm)	88 147	91 936	101 268	11 853	NS
Total ecosystem C					
(to 30 cm)	58 315	67 426	66 468	4 334	6565
(to 60 cm)	98 538	101 374	109 438	NS	NS

basis), and blue grama increased from 17 to 27% of PSC, under CH compared to CL grazing (Manley et al. 1997). The PSC under CL grazing was comparable to that in the EX, but the plant compositions of the two treatments differed. The dominant species under CL grazing was western wheatgrass (45% of PSC), whereas in the EX, forbs were dominant. Surface litter biomass was significantly greater in the EX compared to both grazing treatments. Standing dead biomass was comparable in the EX and CL grazed pastures, but absent under CH grazing (Hart et al. 1988). Root biomass in the surface soil (0–15 cm) of the EX and CH grazed pasture was similar, and the EX had significantly greater root biomass than the CL grazing treatment (Table 1).

Trends in the distributions of C and N in the aboveground vegetation components (Tables 3 and 4) were similar to the trends seen for total aboveground biomass, i.e., decreasing masses of C and N with increasing grazing pressure. However, the masses of root C and N in the 0–15 cm depth were significantly higher in the EX than with either grazing treatment (Tables 3 and 4).

Soil response

Total organic C and N masses in the surface 30 cm of the soil profile were significantly lower in the EX than in either grazing treatment (Tables 3 and 4). In the 30–60 cm soil depth, soil organic C and N concentrations were low, and C and N masses were quite variable. The lower masses of C and N in the surface 30 cm of the soil profile of EX were due both to the significantly lower surface soil (0–7.5 cm) bulk density in the EX compared to the grazed pastures (1.00 vs. 1.14 and 1.17 g/cm^3 in the EX, CL, and CH treatments, respectively) and to lower concentrations (milligrams per kilogram) of C and N in the surface 15 cm of the soil profile in the EX than in the grazing treatments (data not shown). Mean bulk densities for the 7.5–30 cm depth were 1.37, 1.31, and 1.44 g/cm^3 in the EX, CL, and CH, respectively. Bulk densities for the 30–60 cm depth averaged 1.39, 1.26, and 1.47 g/cm^3 in the EX, CL, and CH, respectively.

The inorganic N content of the soil profile at the July sampling was low and did not vary significantly among treatments. Nitrate-N concentrations were consistently <1 mg/kg in the soil profile, while NH_4-N concentration were <5 mg/kg. While these data represent a single measurement in time, they are consistent with past studies that have demonstrated that nitrate and ammonium levels in unfertilized grassland soils are almost universally very low (Richardson 1938, Walker 1956, Woodmansee et al. 1978).

Total C and N masses of the system

An evaluation of total C and N masses in the surface 30 cm of plant–soil system, the depth that includes $>90\%$ of the root biomass, revealed that (1) total C and N were significantly lower in the EX than in either grazing treatment, and (2) total mass of C was comparable under the two grazing treatments, but total mass of N was significantly larger under CL grazing than

TABLE 4. Mass of N from vegetation components and soil (0–60 cm profile) as affected by stocking rate (NS = not statistically significant).

System components	Exclosure (kg/ha)	Continuous light grazing (kg/ha)	Continuous heavy grazing (kg/ha)	Least significant differences $P = 0.10$	Least significant differences $P = 0.05$
Above ground					
Live biomass	18	15	12	5	NS
Standing dead	5	4	0	1.4	1.6
Litter	33	20	15	7	11
Total above ground dead N	38	24	15	6	9
Total above ground N	56	39	27	8	13
Roots					
0–15 cm	308	237	233	50	60
15–30 cm	44	56	52	NS	NS
30–60 cm	10	14	11	NS	NS
Total root N	362	307	296	54	NS
Total plant N	418	346	323	59	71
Soil profile					
0–3.8 cm	684	939	840	26	39
3.8–7.6 cm	488	673	665	95	115
7.6–15 cm	1171	1460	1298	191	230
Total soil N (0–15 cm)	2343	3073	2802	488	636
15–30 cm	1936	2442	2005	233	329
Total soil N (0–30 cm)	4279	5515	4807	204	301
30–45 cm	1865	1736	1692	NS	NS
45–60 cm	1510	1091	1260	273	329
Total soil N, 0–60 cm	7654	8342	7760	NS	NS
Total ecosystem N					
(to 30 cm)	4697	5861	5130	254	362
(to 60 cm)	8072	8688	8083	NS	NS

under CH grazing (Tables 3 and 4). However, when the full 0–60 cm soil depth was evaluated, 89–93% of the system C and 95–96% of the N were stored in soil organic matter within the soil profile. Less than 10% of the C was found in the vegetation component, and 85–91% of vegetation C was in the root mass. Less than 5% of the system N was found in the vegetation component, with 87–92% of vegetation N in the roots. When the soil and plant components were combined for C and N accounting, statistically significant differences across grazing treatments were no longer evident, primarily because C and N concentrations were low and highly variable in the 30–60 cm depth of the soil profile.

DISCUSSION

We found that 12 yr of livestock grazing, after >40 yr of exclusion of both fire and livestock, resulted in a significant increase in the masses of soil C and N in the root zone (0–30 cm) of the soil profile. The surface 30 cm of the soil was 6000–9000 kg/ha higher in C and 450–700 kg/ha higher in N in the grazed treatments than in the EX (Tables 3 and 4). These increases in soil C and N with grazing are probably due to redistributions of C and N within the plant–soil (0–60 cm) system, increases in C and N cycling rates between system components, and reduced losses of C and N from the plant–soil system.

The heavy stocking rate, 135% of that recommended by the Natural Resources Conservation Service, could be expected to affect soil C negatively because of plant physiological responses to the increased grazing pressure. Grasses can respond to defoliation by increasing C allocation to new leaves while decreasing allocation to roots (Detling et al. 1979). Repeated and frequent grazing results in decreased root elongation and biomass (Schuster 1964, Davidson 1978), and hence lower C inputs into the soil from the roots (Holland and Detling 1990). Simulation models also have predicted decreasing soil C levels with increased grazing rates (Parton et al. 1987). In contrast, our data indicate that 12 yr of grazing increased the total mass of soil organic C in the 0–30 cm profile, but did not affect the total mass of C in the plant–soil system to 60 cm depth (Table 3). The heavy stocking rate altered plant composition, which may account for a portion of the change in the distribution of C among the system components. Blue grama, with a typically dense but shallow rooting system, increased under heavy grazing. This change is reflected in the higher root : shoot biomass ratio under the heavy grazing treatment (41:6) compared to the other treatments (Table 1), but it is not reflected in the root biomass or root C or N masses. Coupland and Van Dyne (1979) reported that blue grama-dominated grasslands transfer more of the energy contained in net primary production to underground plant parts than does mixed-grass prairie. Likewise, Frank et al. (1995), who reported similar findings on a North Dakota mixed-grass prairie, suggested that blue grama may partition more C belowground than other species in a mixed-grass ecosystem. Other research has shown that grazing stimulates greater aboveground phytomass production

(Mutz and Drawe 1983, Dodd and Hopkins 1985), increased tillering (Floate 1981), and increased rhizome production (Schuman et al. 1990), and possibly stimulates root respiration and root exudation rates (Dyer and Bokhari 1976). Increased production rates and greater C allocation to the belowground portions of the system may explain the patterns we observed.

Although the mass of soil (0–30 cm) organic C under CH grazing was comparable to that under CL grazing, the mass of organic N was lower (Table 4). Carbon lost from the plant–soil system by herbivory can be replenished by increased photosynthesis and production, but N losses by defoliation are replaced primarily by increased atmospheric N_2 fixation; in our study nitrogen-fixing species represent an extremely small component (<2%) of the mixed-grass ecosystem and did not change with grazing. In the EX, 72% of the aboveground phytomass was in the form of litter and standing dead plant material. Bauer et al. (1987) found lower mass of soil N in relict (nongrazed) than in grazed grasslands and suggested that there is an increased potential for volatilization of NH_3 from plants, and increased opportunity for denitrification in the cooler and more moist conditions of the nongrazed soil profile. Coupland and Van Dyne (1979) reported that ~15% of net primary production of a Canadian mixed-grass prairie was not transferred to litter, but rather was lost via decomposition within the dead-shoot component of the canopy. They also reported losses in the litter layer from photochemical decomposition. Such C losses from the system should be greater in the exclosures where a large aboveground plant C pool exists.

Grazing stimulates C and N cycling from aboveground plant components to the soil. The apparent annual rate of turnover of shoots in the exclosures is 28% (PSC production of 1330 kg/ha divided by mean aboveground standing crop of 4673 kg/ha), compared to 36 and 39% with light and heavy grazing. Animal traffic in the grazed treatments may be enhancing physical breakdown, soil incorporation, and rate of decomposition of litter. Aboveground immobilization of C and N in standing dead plant materials in the EX treatment may also contribute to the lower soil C and N observed. Compared to the grazed treatments, ~275–675 kg/ha more C and 15–25 kg/ha more N are immobilized in the dead plant material of the exclosures instead of being recycled back into the surface soil. These levels of immobilized C and N account for 8% or less of the C deficit, and 6% or less of the N deficit in the surface 30 cm of the exclosure soil profiles. However, over a period of 12 yr of livestock grazing, the enhanced transfer of litter C and N into the soil has resulted in a significantly higher accrual of C and N in the soil of the grazed treatments than in the exclosures.

Grazing of these northern mixed-grass rangelands has not resulted in a reduction of soil C and N resources. In fact, grazing has led to increased levels of soil C and N through enhanced incorporation and decomposition of the litter and standing dead plant material. Transfer of net primary production to belowground plant parts may also account for a portion of the observed increase of soil C and N in the 0–30 cm soil depth, even though root biomass has not exhibited the significant increase typically observed when species composition is changed in response to grazing. The observed increases in soil C and N in the 0–30 cm soil zone have important implications in determining management strategies for these grasslands. Removing livestock from these lands could over the long term reduce soil C and N cycling and potentially the productivity of the systems. These ecosystems developed under grazing; the fact that soil resources are enhanced with grazing suggests that grazing is an important part of ensuring long-term sustainability of these grassland systems.

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REVIEW ARTICLE

Critiquing a research article

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KEYWORDS
Critical reading;
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Abstract This article explores certain concepts relating to critiquing research papers. These include considering the peer review process for publication, demonstrating the need for critiquing, providing a way to carefully evaluate research papers and exploring the role of impact factors. Whilst all these features are considered in this article, the focus is on presenting a systematic and comprehensive way of critiquing research papers. The information provided should be of use to the many radiographers, associated health professionals and undergraduate and postgraduate students embarking on research projects.

Why critique peer reviewed research articles?

The peer review process is integral to the functioning of all scientific journals and plays a pivotal role in the publication of new scientific material.[1] The "invisible hand" of peer review is what is claimed to maintain the quality of refereed i.e. peer reviewed, journal literature.[2] The publication of a research article in a peer reviewed journal may thus appear to be a measure of its worth.[3] However, the process of peer review has attracted its share of criticisms from academics over the years[4] with one author going as far as to say

"those that review essays for inclusion in scholarly journals know what they are supposed to do. Their function is to take innovative and challenging work by young scholars and find reasons to reject it".[5]

Furthermore reviewers need not necessarily have expert knowledge of the subject matter they review[3] as even experts have gaps in their knowledge.[6] Peer review is notoriously unreliable and subject to bias and conflict of interest. Publication bias, the tendency of editors and reviewers to accept manuscripts submitted by investigators based on the strength and direction of their own research findings,[7] means that what is published may not be representative of the research in an area which may mislead the reader. Consequently, publication bias can reduce the intellectual value of the research. The problems associated with the peer review process seem difficult to overcome, as even training peer reviewers does not increase the quality of their reviews to a level of editorial significance or in a way that is maintained long term.[8]

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Critical evaluation of research articles

This is necessary so that you do not take what you read at face value but consider the work with a critical mind in order that you can decide on the value of the article. This empowers you to decide whether to change your practice based on what you have read[9] or whether the work is a worthwhile study to base future research around. Critical evaluation is defined as

"a systematic way of considering the truthfulness of a piece of research, the results and how relevant and applicable they are".[10]

How to critically evaluate research articles is a topic addressed by a plethora of books on research methodology[11–13] and by various articles.[6,9,14,16] Set out below is a way of systematically critiquing such articles in a structured way. This is the method for critiquing the literature taught to undergraduate and postgraduate students in this institution. It should be remembered that a critique will often be positive and should not be seen as just negative. If negative, the implications of any weaknesses in the study, need to be considered.[9]

In the context of this paper, a research article is a written published report of original research presented in a peer reviewed journal, to allow it to be judged in the context of the body of knowledge. The article will allow an assessment by readers of what observations were made, how the research was conducted and its intellectual value or "so what" factor, for example an article describing a method of recording blood pressure to six decimal places may be scientifically robust but have little application to practice.

An article should be considered under the following headings.

Title

The title may be better judged after reading the article.[6,9] It should precisely and concisely reflect the content of the work, but does not necessarily give an indication of the quality of the article. Whilst it should not contain jargon or buzz words that are not directly relevant, the title should stimulate the interest of readers and encourage them to read it.[6]

Key words

These are drawn not from the title but from the body of the work. Three to six is a common number of key words, but the number presented should be consistent with the "Guide for Authors" of the specific journal. These key words should encapsulate the main topics of the research and should allow the article to be accessed when searching the literature using key words as search terms.

Introduction

This usually contains (i) evidence of a literature review, (ii) background information to the study to orientate the reader to the problem, (iii) the hypothesis or aims of the study and (iv) the rationale for the study. These elements should be logically presented and well written.[6,14]

A literature review should be present that is relevant and recent, unless the article has a historical focus. Older articles acknowledged as seminal works in the area should be cited. It should contain few if any secondary sources but should confine itself to a review of primary sources.[14] It should be comprehensive and even handed in its selection of both theoretical and research information on the topic, and should be presented in an objective way. The literature review should be critical in its appraisal of other works, rather than merely descriptive of them. To assess how comprehensive and balanced the literature review is, a literature search can be done by the reader to ensure the breadth of the literature cited and that, in instances where there are conflicting opinions, that they are represented. It is clearly tempting for authors to supply only background literature that supports their own premise or research findings. From the literature reviewed and thus the background information provided, a rationale for the current work should evolve, justifying the need for the current work, for instance, to explore an uninvestigated gap in the literature.[14]

The purpose or aim of the study and the research hypothesis, if provided, should be defined so that the research problem can be clearly identified. The research objectives by which the aim will be achieved are also commonly stated in the introduction.

Materials and methods

The materials and methods form the precise recipe for the research so that another worker could exactly replicate the study elsewhere, usually to allow disproof of findings. This section should include, for example, precise technical specifications of equipment used, procedure utilised, selection criteria, sample size, response rate and statistics used. The justification of why such a recipe was used is the methodology i.e. the study of the method, which explains the rationale for the research method used including aspects such as sample size selected, exclusion criteria and statistics used. The design of the research must have this justification to show that the study is capable of achieving its aims[14] e.g. the use of a postal questionnaire sent a month after an MRI examination would be a dubious way to assess the anxiety provoked prior to an MRI scan.

Things to consider when reading this section are:

- What sort of sampling technique and sample size was used?
- What proportion of an eligible sample participated?
- Were all eligible groups sampled e.g. was the questionnaire, if used, only provided in English?
- Can the results be generalised to a wider population?
- What are the strengths and weaknesses of the study?
- Are there any threats to the study's validity and reliability? If so did the researcher attempt to control these?
- Are there any obvious biases or confounding variables introduced e.g. when comparing patient's preferences for two techniques such as an endoscopy and barium meal, were the tests undertaken by different operators?
- Was the trial, if used, the stronger randomised control trial (where participants have an equal chance of being in the experimental or control group) or the weaker case controlled trial (where patients with a particular condition are "matched" with controls)?[12]
- Was the power of the study calculated?[6] This refers to the ability of the research design to detect existing relationships among variables.[13] It will determine how likely it is that a relationship may be missed and is particularly important in interpreting null results. The number of participants needed in a study to ensure that relationships are not missed may not have been realistic, due to other constraints such as time or funding, leading in effect to a pilot or feasibility study being undertaken. Common sense has a bearing here. If a condition is uncommon e.g. aspergillosis, a rare pulmonary fungal infection, it may be judged reasonable to image 20 patients with the condition but not so reasonable to image only 20 patients with lung cancer, a much more prevalent condition.

Results

The data presented should not be raw but should be scientifically analysed to present representative and relevant values, that the "average" reader of the journal in which the paper is published can easily assimilate.[14] If an unfamiliar test is used the values it generates should be presented along with a normal range of values. The results should be sequenced appropriately and a decision should be presented by the author as to whether the aims and hypotheses of the study were met by the results.

Graphs and tables of the data, if provided, should promote clarity. They should have a title or legend, a key and labelled axes. It should be possible to understand them without referring to the text.[6] Clearly, the way the results were analysed will depend on whether the research was qualitative or quantitative. Points to consider include:

- Are there any major omissions? E.g. not all of the sample is represented in the results.
- Are percentages used to disguise small sample sizes?
- Are the data generated consistent with the data collected?

Statistical tests, if used, should be named but not described. Consider whether the appropriate statistics were used depending on whether statistically differences or correlations were sought.

- Were the data gathered interval/ratio data (the strongest data achieved by the use of a calibrated scale e.g. density readings from a densitometer)?
- Ordinal (where the data have a clear order but not from a calibrated scale e.g. strongly agree, agree etc. from a Likert scale).
- Nominal (the least robust data which categorise but do not rank data e.g. a list of radiographers, radiologists and nurses working in a particular work area).

Most statistics used by researchers are parametric, a term which classifies a group of tests including the one way analysis of variance (ANOVA) and the paired and unpaired *t*-tests. If parametric tests are used you need to check that the data are:

- Approximately normally distributed,
- Derived from interval or ratio scales,
- The variances of the data are similar.[15]

Non-parametric tests are used for ordinal or nominal data e.g. the Wilcoxon matched pairs test and the chi-squared test. This group of tests requires few assumptions to be met, regarding the underlying population distributions.[11]

Findings which are negative are just as relevant to the body of knowledge but are harder to get published, which is an example of publication bias.[8]

Discussion

The discussion is a commentary on the research findings and should show an insight into their meaning and significance. It should not repeat the results or introduce new ones.[6] It should demonstrate that the aims and objectives of the research have been met. The discussion should present all the relationships demonstrated by the results and state the extent to which these findings can be generalised. If there are any exceptional results or correlation failures these should be explained. The discussion should embed the current findings in the context of previous research work and theoretical concepts.[14] Any limitations of the work and problems with the design of the research and methods should be acknowledged, as should the effect of any biases on the results. The reader should consider whether the author's interpretation of the results follows from the results presented and whether it is the only possible interpretation. If not, does the author present a balanced discussion?[6]

Conclusions

The conclusions should be clearly stated and can only be valid if the study was reliable, valid and the sample size representative. Reliability is the degree of consistency or dependability with which the instrument measures the attribute it is designed to measure and validity is the degree to which the instrument measures what it is intended to measure.[13,16] The extent to which the sample size represents the population is a factor in assessing the validity of a study i.e. the extent to which the results can be generalised to other samples or situations.[11,13] The conclusions often give rise to recommendations for future practice and, or further research. The conclusions should not over-claim and they should be based on the results. These should be feasible and the reader should make a judgement as to whether it is reasonable to make these on the basis of one study.[6]

References

Different journals have different requirements for presentation of references.[17] The "Guide for Authors" of a specific journal will state their requirements. In general the references should follow a consistent format and correlate with the citations in the text, be up to date, comprehensive and relevant. There should not be the excessive use of secondary sources.[6,14] A secondary source is when the author refers to an account of a study prepared by someone other than by the original researcher.[13]

Abstract

This is presented first but is written last by the author/s. It is often structured e.g. purpose, method, results, conclusion. It is always concise, around 300 words and should not contain so much information that reading the article is redundant.[14] It is in essence the "nub" of the work and it does not usually contain references. It allows readers to judge its appropriateness to their research needs.[17]

Impact factors

When critiquing an article it is worth considering the impact factor of the journal in which it is published. The Institute for Scientific Information produces the *Journal Citation Reports*® (JCR®). This provides a qualitative tool to rank, evaluate, categorise and compare journals. The impact factor is one of these tools; it is a measure of the frequency with which the "average article" in a journal has been cited in a particular year or period. Impact factors are the ratio between citations and recent citable articles published. They are dynamic factors which alter year on year and are published annually. Impact factors are thus valuable in academic evaluation. They provide a gross approximation of the prestige of the journal in which the article is published and can be studied by accessing <http://jcrweb.com/jcr_summary>, which will generate a list of these factors for various journals. If your institution does not subscribe to this web resource an internet search for "impact factors" will take you to a variety of sites where similar information can be accessed free of charge. The higher the value of the impact factor the more prestigious the journal. Factors for Radiology journals currently range between 0.3 and 6.2.[18] This measure must be used with some caution as the amount of review or other types of articles published in a journal, variations between disciplines and item by item impact make it a less than absolute measure of the academic prestige of a journal. It is nevertheless a useful factor to consider in critiquing peer reviewed articles.[19]

Summary

The above information has demonstrated the need to read literature, even that published in peer reviewed journals, with a critical mind. It has provided a systematic framework with which to do this, allowing the reader to appreciate both the strengths and weaknesses of the work. This should empower the reader to assess the value of the work and thus judge how much credence be given to it, in influencing future practice or research activities.

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Critiquing Research for Use in Practice

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INTRODUCTION

Pediatric nurse practitioners (PNPs) are encouraged to base their practice on research findings or have an evidenced-based practice. One way to incorporate research findings into clinical practice is to read about research that others have done. Several authors suggest guidelines for critiquing quantitative research (Bassett & Bassett, 2003; Fosbinder & Loveridge 1996; Girard, 1999; & Schmelzer, 2000) and qualitative research (Byrne, 2001; Fosbinder & Loveridge 1996; Girard, 1999). Evans and Shreve (2000) and McCaughan (1999) provide frameworks for evaluating research for use in practice. This article will discuss the various components of a research article and provide suggestions for determining the usefulness of study findings for application to one's practice setting.

SYSTEMATIC EVALUATION OF RESEARCH

Some aspects of evaluating a research article are the same whether the study is quantitative or qualitative. Specific terminology for evaluating a qualitative study will be discussed later in this article. First the reader should consider the authors' job titles and qualifications. Is the article written by an individual, single-location group, or multi-center group? Do the researchers have knowledge of the practice area in which the study took place? Does the population and sample size allow the reader to generalize the findings to other populations and settings? For example, a small sample size in one location, utilizing a Hispanic population, may not be sufficient to apply the study conclusions to other populations.

Next, the reader should evaluate the title of the article. The title should be clear, accurate, and reflect the study's purpose. What does the title tell the reader about the subjects and what the study involves? If the study subjects are similar to the reader's patient population, the reader may wish to continue to evaluate the article for relevance to his/her practice setting. Research articles usually contain similar sections depending on the journal's editorial requirements. A variety of headings may be used to describe each of the sections. Below are examples of headings and sections included in the article. The Box provides additional guidelines for evaluating a research report.

Abstract

The abstract provides a brief summary of the study and should address the following items, based on journal requirements: purpose, methods, sample, results, and conclusions (with implications for practice). The abstract content helps the reader decide whether the study is of interest, relevant to practice, and

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BOX. Guidelines for critiquing a research report

Abstract
- Does the abstract discuss the purpose, methods, sample, results, and conclusions with implications for practice?

Statement of Problem and Purpose
- Are the problem and purpose clearly stated?
- Are the variables identified, if applicable? Is the problem significant to improved outcomes for children, their families, and/or the staff who care for them?
- Are the definitions of terms clear?
- Is (are) the hypothesis(es) and/or research question(s) clearly stated?

Background
- Is the purpose justified by the literature? Are only premier, primary, and up to date sources included? Does the review address all the concepts proposed in the study?

Methodology
- Is the design appropriate for the study's purpose?
- Is sampling method appropriate and sample size adequate?
- Is the study approved by an Institutional Review Board (IRB)?
- Is the mechanism for obtaining assent from any child over 7 years of age described?
- Is the setting clearly described?
- Is there a rationale for selection of the instrument(s)?
- Has validity and reliability for the instrument(s) been established? If not, are the methods for doing so described?
- Are the limitations of the instrument(s) given?
- Is the process for administration of the instrument(s) given?
- Has (have) the instruments been piloted?
- Are the data collection methods appropriate to the study?
- Are data analysis methods described and appropriate?

Results
- Are the data presented objectively and factually?

Discussion/Conclusion
- Are the findings explained with regard to their significance?
- Is the relationship between the findings and the theoretical framework discussed?
- Is the relationship between the findings and previous relevant research explained?
- Are the conclusions linked to the study objectives?
- Do the conclusions flow from the data and the analysis?
- Are the limitations of the study presented?

Implications for Practice and Future Research
- Are the implications for practice and future research presented?
- Do the findings advance the knowledge base for nursing?
- What other questions need to be answered on the topic?

whether to continue reading the entire article.

Introduction and Statement of the Problem/Purpose

The researcher should clearly state the problem and purpose of the study. The purpose statement defines the project and provides a global view of the study's focus (Fosbander & Loveridge, 1996). The variables of interest should be stated, if applicable. Terms should be defined and the hypothesis(es) or research questions clearly stated. This section helps the reader determine if the problem is significant to improved outcomes for children, their families, and/or the staff who care for them.

Theoretical Framework

If the research is linked to a theoretical framework or conceptual model, the relationship of the variables should be examined as presented in the theoretical framework and addressed in the research design.

Background or Review of the Literature

The review of literature should be comprehensive but concise. Some publications allow only 15 references due to space limitations. Only premier, primary, and up-to-date sources (less than 5 years old) should be used in the article. Older articles that are considered "classics" may be included. Sources should be drawn from a wide range of scientific literature. The background or review of literature section should justify the purpose of the study and provide a sound theoretical framework for the research.

Methodology

When reading a report in a refereed journal, the reader can have some confidence that the methods described should produce reliable findings (Fosbander & Loveridge, 1996). The reader should examine other sources such as the Internet in more detail. The Internet provides a wealth of resources from a variety of reliable sites such as National Association of Pediatric Nurse Practitioners (*http://www.napnap.org*), National Institutes of Health (*http://ninr.nih.gov*), National Institutes of Nursing Research (*http://ninr.nih.gov/ninr*), and Sigma Theta Tau (*http://www.nursingsociety.org)*. If the reader wishes to enhance his/her critical thinking skills in order to review the methodology section in more detail, several nursing research textbooks such as *Essentials of Nursing Research: Methods, Appraisal, and Utilization* (5th ed.) by Polit, Beck, & Hungler (2001) and *The Practice of Nursing Research: Conduct, Critique, and Utilization* (5th ed.) by Burns & Grove (2005) provide additional information pertaining to the various aspects of the research process.

Research Design

The research design spells out the strategies that the researcher used to answer the research questions or test the hypothesis(es). In this section, the researcher should specify which of the various research approaches were adopted in the study and how the researcher implemented controls to enhance the interpretability of the results. (Polit, Beck, & Hungler, 2001).

Sample and Setting

The sample and setting should be described in enough detail for the reader to determine if the subjects and setting are similar to his/her own patients and practice setting. Many publications require that consideration of the rights of human subjects be discussed.

Instruments or Research Tools

The instruments used should be fully described, including reliability and validity, whether the tool was developed by the researcher and/or previously tested. The instruments should match the variables being studied. The reader can determine whether the instruments accomplished what the researcher intended (Bassett & Bassett, 2003). This section plays an important role in helping the reader determine the validity of the study findings.

Data Analysis

This may be the most difficult section for the reader to evaluate. The main question is whether the statistical method fit the study design (Girard, 1999). If the study was a survey, were descriptive statistics used? If the relationship between two variables was evaluated, were correlational statistics used? If a comparison was made, were inferential statistics such as *t*-test or analysis of variance (ANOVA) used? For studies attempting to predict the effect of two or more variables on a dependent variable, was multivariate method such as multiple regression or multiple correlation method used? Was the level of significance identified?

Results

Figures and tables may be used to illustrate and reinforce the results. The results should lead the reader toward the researcher's conclusions (Fosbander & Loveridge, 1996). In the results section, the data should be presented objectively. The results section is reserved for factual information, and interpretation of the data should be reserved for the discussion section.

Discussion/Conclusions

The meaning of the findings should be explained with regard to their significance. The researcher should describe the relationship of the findings to the theoretical framework, if applicable, and to previous relevant study findings in the literature. The conclusions should be linked to the objectives of the study and flow from the data and analysis (McCaughan, 1999). Limitations of the study are included in this section.

Implications for Practice and Future Research

Implications for practice and future research should be presented. At this point the reader can ask questions regarding whether the findings advance knowledge in the discipline and identify additional questions to answer related to the topic. This section also describes what else needs to be done before the findings can be generalized to other situations (Fosbander & Loveridge, 1996).

SPECIFIC CONSIDERATIONS FOR QUALITATIVE STUDIES

In considering qualitative research, the terms credibility, trustworthiness, rigor, and truth-value have similar definitions to indicate the plausibility of the methods and findings. Qualitative researchers should demonstrate their credibility by documenting their qualifications, experience, perspective, and assumptions. If the researcher has personal connections with the topic or participants, they should be identified (Byrne, 2001).

Numerous strategies can be used to establish the credibility of a research method and subsequent findings. Observation, interview, and document analysis are common techniques for data collection. Prolonged engagement, such as interviewing or observing the same person more than once or on repeated occasions, enhances credibility. Multiple readings during document analysis are suggested for prolonged engagement. Triangulation or use of multiple methods or data sources in the study phenomenon is another strategy for establishing credibility. The qualitative researcher may also use other individuals to analyze and confirm the data (Byrne, 2001).

In qualitative research, transferability is a criterion used to judge the extent to which findings can be applied to a different context. Thick descriptions and purposive sampling are techniques used to achieve transferability. The researcher should provide the reader with enough information to judge the themes, labels, categories, and constructs of the study (Byrne, 2001).

Finally, confirmability or dependability is another criterion that can be used to judge qualitative research. This is accomplished through the researcher's audit trail using specific documentation including a researcher journal, original data, early data interpretation and analysis, research reports, and communication with peer debriefers and research participants (Byrne, 2001).

SUMMARY

Promoting evidence-based practice is an important role for PNPs. In order to make practice changes, PNPs have a responsibility to review current research and apply the findings to their practice. Through reading research, dialogue with colleagues, and changing practice based on evidence, interdisciplinary relationships and patient outcomes will both benefit.

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Original article

Critiquing a paper: a guide

L. Sbaih

Introduction

Critiquing:

- Can be done by an individual or in a group. Working in a group can be very motivating, as group members are able to discuss various aspects of the paper and put forward why they think it is valuable or not valuable. Also discussions about the paper's potential contribution to practice can be developed within a group.
- Should not be thought of as a means of deciding what is wrong with the paper – it is not an invitation to attack the author and the paper. Instead it is a means by which the strengths and weaknesses of the paper are identified and drawn out. Once this is done you can confidently consider how the paper may assist you in the development of your own work either in practice or in your own academic advancement.
- Is time consuming, and for many of us is achieved in a number of stages. Often involving putting the paper down and returning to it after thinking about its contents for a couple of days. You will be expected to read the paper a number of times as well as make notes about its various parts. However, as with all other skills, practice does speed the process up over a period of time.

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Choose the article

When making your choice, think about why you want to read the article. Many of us choose papers that we fundamentally agree with. Therefore it can be a useful exercise to critique a paper that is outside your area of expertise and interest. This approach should help you develop a more objective approach to evaluating published work.

One of the first stages when evaluating a paper is to decide what kind of paper it is. Papers can be categorized as follows:

- original research
- literature review
- case study
- personal view
- report
- discussion paper.

One way of determining what kind of paper you are dealing with is to read the abstract at the beginning, or the conclusion at the end. I know of a number of people, including myself, who collect photocopies of the first and last pages of articles so that they can be read thoroughly and the type of paper determined correctly. If it is considered that the whole paper needs to be read then I return to obtain a copy of the rest of the pages of the article. This saves time and money in photocopying articles that are then not used/critiqued. One additional hint – if you are photocopying the front and back sheet make sure you have the full reference of the article and details of whence you obtained it (library, floor, section) so that you can return and retrieve the rest of the article easily. It is surprising just how deceptive memories become in libraries, particularly if you use more than one library.

Read the article

You need to become familiar with what the paper is about. In addition you need to establish:

- who wrote it
- why they wrote it
- what they did
- why, when, where and how they did it
- what was found
- was it morally sound?

Divide the article into sections

Research articles are usually divided into sections as detailed below:

- abstract
- introduction
- method
- sampling approach
- ethical discussion
- analytical approach
- presentation of data
- discussion
- recommendations.

Having the article divided up into sections, by the author, provides you with manageable parts to consider in depth. You need to be able to understand each section. If you do not understand then try to determine why, is it because you lack research knowledge and skills? Or critical reading skills? Or because the author has omitted something or not fully explored the issue? Do not immediately assume it is a failure on your part. Those of you who are involved in writing articles or assignments know how easy it is to make assumptions and not clarify your ideas fully on paper. If there are things you do not understand then you may need to go away and find out. For example, if the author has used grounded theory and you are unclear about this you will have to do some further investigating before you can make any informed judgements about the paper.

Consider each section in detail

1. Consider the strengths and weaknesses of each section.
2. Make notes on your impressions of each section.

When considering each section be aware of your own personal feelings about research. For example, you may not like questionnaires, believe that interviewing is a waste of time or may favour qualitative research. You need to be aware of your personal biases and the various ways they may influence your evaluation. Do not fall into the trap of feeling angry or irritated with the paper/author because they have used a technique that you believe lacks credibility. Make sure that your judgements are based on an objective review of strengths and weaknesses rather than personal opinion and bias.

Consider each section in relation to the whole study

Now you need to decide how each section contributes to the paper as a whole. Are there sections that seem out of place? Are some sections particularly strong or weak? Does the author pay more attention to some sections than others, e.g. more attention to the data collection method than to ethical considerations?

Consider the value, significance, strengths and weaknesses of the whole study

You can now consider the value of the whole study and its potential application to your practice

The following should act as a guide to your critique

Overall the title of the article should represent the contents of the paper. The article should be clearly written and well organized. The author of the paper should be qualified to write about the study. The abstract should provide an overall picture of the paper and include: the research question and/or hypotheses, sample size, research design and method and an overview of the findings.

1. The research problem and aims of the study should be outlined.
2. Definitions of terms should be provided.
3. The literature review should provide a summary of what is currently known about

the subject. There should be evidence of an organized, critical review of a wide range of relevant literature, made up of primary sources, associated with the subject.

4. The research method/s should be explained. The method should be linked to the research question and aims. Hypotheses should be testable.
5. There should be some discussion of the potential strengths and weaknesses of the chosen method.
6. The sample should be appropriate to the type of question, aims and method.
7. Methods for analysing data should be discussed.
8. Data should be clearly presented and be related to the research question and aims.
9. Ethical issues such as confidentiality, anonymity, consent and the protection of information should be discussed. Also, the ways in which subjects are recruited to the study and any access issues experienced. If patients are involved, then the support of the Local Research Ethics Committee should be evident.
10. There should be some discussion of the findings with recommendations. The overall strengths and weaknesses of the study should be explored.

Further Reading

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