

Negative terms in biology research reports

Dulce María Gilbón Acevedo
CELE-UNAM

La naturaleza y el procesamiento de los términos negativos han sido estudiados desde diferentes ángulos, generalmente a partir de enunciados aislados. En este artículo se presentan los resultados de tres estudios sucesivos de los términos negativos en el discurso académico de la Biología. En un análisis preliminar, seiscientos veinte términos negativos fueron localizados en veinte reportes de investigación. Se abordó el análisis de uno de los reportes para determinar la función retórica de esos términos en las diferentes secciones del reporte, conforme a las categorías propuestas por Crombie (1985), Castaños (1986) y Van Dijk (1983). Los resultados dan evidencia de la importancia de la negación para crear o modificar conocimientos en el contexto de un reporte de investigación.

Studies on the nature and processing of negative terms and statements have been carried out from different angles. They have focused mainly on isolated statements. The purpose of the work reported in this paper was to study negative terms in the discourse of academic articles. The distribution of these terms (620) in Biology research reports was obtained and the functions of negatives in the rhetorical sections of one of the articles were analyzed according to the categories proposed by Crombie (1985), Castaños (1986) and Van Dijk (1983). The results are taken as evidence of the importance of negation to create or modify knowledge in the context of a research report.

The complexity of negation may be observed through the different etymological, logical, ontological and psychological approaches intended to define it. Due to that complexity, the nature and processing of negative terms and statements have been studied in the areas of Psychology, Logic, Philosophy, Literature and Linguistics. In 1964, E. S. Klima performed a detailed analysis of the syntactic characteristics of the main negative terms in English, according to generative grammar. Presently, transformational grammar theorists are still considering the special rules negatives need.

Traditionally, grammatical descriptions have focused on the following lexemes: not, no, never, neither, nor. Often they have also included the so called “negatives in meaning but not in form”: *little, few, seldom, rarely, hardly, barely* (Quirk et al, 1972, 1985). Prefixes like *in_, un_, non_*, etc. have received considerable attention (Celce-Murcia and Larsen-Freeman, 1983). It has been pointed out that implicit or inherent negatives should be included in the study of negation (Clark & Clark 1977: 452). These are terms such as: *absent, different, conflict, forget or dissuade*. Only some of them, like *doubt, forbid, too*, were “tentatively” described by Klima in 1964 (p. 294), not much progress has been made since then. The most noticeable recent developments are the account of inherent negatives in terms of a cancel X component in their underlying propositional structure (Bartlett, 1987:43), and the discussions about the presuppositions of negation in natural language (Burton-Roberts, 1989).

For many years psychologists studied mainly the latency of responses to negative statements in verification and reasoning tasks, and found that it took longer to process negative than affirmative statements. It was concluded that negatives were more difficult to process due to the double transformation the reader had to perform (Just & Carpenter, 1971; Sherman, 73; Hoosain, 1973; R. Revlis *et al.*, 1974).

In Mexico, Alcazar *et al* (1985) and Valenzuela *et al* (1985) found differences in the processing of negative statements between English and Spanish speakers when comparing their results with Clark and Chase’s (1972).

A more recent finding is Valle Arroyo’s (1982) empirical support for Wason’s claim about plausible denials (1965); and Wright and Hull’s conclusions (1986) about the factors influencing strategy selection for the processing of IF NOT. B. Bartlett (1987) described some author’s use of negatives in literary texts.

J. Mestre *et al* (1988) have dealt with negatives as an attempt to identify and develop specific strategies for the comprehension of negatives from a pedagogical point of view.

My interest in negation is related to the kinds of issues mentioned above and to the teaching of reading to university students. It seems to me that negation is a very important element of academic texts and that the processing of negation is decisive to understanding such texts. In order to find out to what extent this is true I have undertaken three different studies of negation, including this one.

In order to get insights on the reading process and to design adequate and useful

reading comprehension materials for college students, a deeper understanding of academic discourse is needed (Meyer, 1984; Kamil, 1984, Royer *et al.*, 1984), specifically of the research paper (Crookes, 1985; Régent, 1985; Trimble, 1985). In a previous contrastive analysis of two biology articles in English (17 450 words) and two in Spanish (16500 words) on the same topic (Gilbón, 1988), I found that negative lexemes appeared twice as many times in English as in Spanish (93-46). In that study it was also shown that: 1) In both languages negative terms occurred more frequently in complex sentences (85%- 83%) than in simple ones; 2) In Spanish the most frequent negative term was NO (93%); 3) In English the terms were: NOT (75%) and NO (23 %). Other negatives were not considered for the study.

In a subsequent error analysis (Gilbón, 1989) the objective was to determine if college students attending reading comprehension courses in English (30) could identify negative terms in 15 isolated sentences taken from academic texts. Terms underlined by students were: NOT = 83%, NO = 80%, NEITHER= 15%, NOR=20%. Only one non-cognate negative marker, “few”, was identified, but its frequency was very low (5%). Other such markers, namely “scarcely”, “hardly”, “barely”, and “seldom” were not identified at all, as apparently they are not identified either by upper elementary and junior high school English native speakers (Mathewson, 1984).

For the above reasons it was thought useful to analyze negative terms in the different rhetorical sections biology research reports, as these are the kinds of texts my students need to read. An overall frequency analysis of negative terms in 20 Biology research reports was performed. The reports were selected from the latest issues of 7 specialized journals, found in the libraries at ENEP Zaragoza and UAM-Iztapalapa, in the areas suggested by the coordinator: Hydrobiology and Fish culture.

The results showed that from the total of negative terms (630), the highest frequency occurred in the Discussion section (265=42%) and the second highest in the Results section (179=28%). Two hundred and fifteen prefixes were found (34%). The most frequent prefixed terms were formed from: un_ = 114 (53%), non_ = 44 (20%), in_ = 36 (16%). The other prefixes were: dis_, ir_, im_). The negative lexemes were 415 (65%). The most frequent were: *not* (244 =38%), and *no* (96=15%). The other lexemes were: *none, neither, nor, few, little, rarely, seldom, never*. The so called “inherent negatives” were not considered for this first analysis.

According to Castaños (1984), utterances may be studied as sentences, propositions, illocutionary acts or as dissertation acts. Summarizing, we could say these categories correspond to morpho-syntactic, semantic or pragmatic properties of utterances. The frequency analysis involved a morpho-syntactical account only. This provided criteria to select one text for deeper analyses on the basis of pedagogical considerations.

The research questions for the present study were:

How do negative terms and statements function within the discourse of Biology research reports?

What are the dissertation acts where negatives occur?

What is the importance of negative terms in a Biology research report?

The alternative analyses of one of the reports intended to give information about the semantic and pragmatic properties of negatives in that specific report for their better utilization in further reading comprehension tasks.

The objective was to determine the functions and kinds of discursive relationships which negative statements performed in the report. The analyses were carried out following three different subsequent approaches:

1) Analysis of the discursive values of negatives and binary relationships where they occurred according to the semantic categories established by Winifred Crombie (1985a:37-41).

2) Dissertation analysis of the utterances where negatives were found in order to determine their force, and their occurrence either in a referential expression or in the predicate (Castaños, 1986).

3) Identification of macrostatements in the report in order to determine the occurrence of negative terms and statements in those macrostatements and thus their possible relevance within the macrostructure of the report (Van Dijk, 1983).

Crombie proposes the assessment of the discourse value of utterances and the analysis of them in semantic binary relations within relational frames (Situation-Problem-Solution-Evaluation of the solution).

Although Crombie does not specifically refer to negatives, after analyzing her examples, it was hypothesized, that negatives would fit into any of the following categories: General causative (Reason-Result, Means- Result, Grounds-Conclusion); Coupling (Rhetorical and Contrastive coupling), Comparison-Contrast (Statement-Denial, Denial-Correction) and Contrastive Alternation (___ or ___).

On the other hand, for the second analysis, it was taken into consideration that for Searle: "Illocutionary acts such as stating are often directed at or done for the purpose of achieving perlocutionary effects such as convincing or persuading..." (Searle *et al.*, 1974). In this light, and broadly speaking, the illocutionary act present throughout the whole paper would be stating. So, Castaños* proposal for the study of dissertation acts was considered more suitable for this study, as he states: "Dissertation acts construct or modify knowledge (or make it present)...an identification, an observation, and a classification are examples of dissertation acts". The purpose was that through the analysis of the force of the utterances containing negatives, it would be established if they were truly negatives. Their determination either in referential expressions or in the predicate would also clarify their nature.

In the third place, an identification of macrostructures was undertaken. This category in Van Dijk's model was considered adequate for the analysis of the text as the present study is intended to obtain a better understanding of the report for its further use in subsequent reading comprehension tasks.

According to this author “A text can be reduced to its essential components in successive steps, resulting in a hierarchical macrostructure, with each higher level more condensed than the previous one” (Van Dijk, 1983).

The analysis of the macrostatements, that is macropropositions explicitly stated in the report would give valuable insights about the possible importance of negatives within the report.

Method

The report selected (Matkowski, 1989) was the shortest, with approx. 1 500 words. The previous morpho-syntactic analysis revealed that from the 19 negative terms found, 8 appeared in simple sentences, 2 of them with 2 negatives, whereas 9 were found in complex sentences. The most frequent negative lexeme was NO, with 6 occurrences (31 %). Other negatives occurred once: *nor, neither, not, few, in__ , non__ , dis__* . Two lexemes with the prefix *un* were found. Inherent negatives were also considered for this analysis. They were : *absence, without, loss, negligible*. The last two occurred in the Discussion section, which also had the highest number of negatives (8 = 42%), followed by the Results section (6 = 31%).

The three subsequent analyses were also undertaken manually following the categories proposed by the authors mentioned previously. The first analysis dealt with the semantic relationships between pairs of statements when at least one pair member was a negative statement. Crombie’s binary relationships framework was used, as indicated above. Her general categories are: Comparison-Contrast, Cause-Effect, Temporal, Coupling, Supplementary Alternation, some of them with a set of subdivisions.

Sentences were grouped in two syntactic categories: simple and complex sentences in order to determine their semantic relations within the sentence or/and between clauses in a complex sentence. It was also considered necessary to establish if the negatives occurred in the first or second position in such binary relations.

For the second analysis, Castaños’ proposal for the analysis of factors such as: force, kind of reference and predication for the formal identification of utterances as specific dissertation acts (1984) was taken into consideration.

I assumed, as Castaños does, that corresponding to the Elocutionary force of Elocutionary acts there is what one might call a ‘dissertation commitment’ in dissertation acts. In fact, I extended the concept by considering a force of negation; he proposes: assertion, hypothetical assertion, mitigated assertion, and suspended assertion. This point of view implies a distinction in principle between negative utterances and negative descriptions, as was indicated previously. However, as we will see, one interesting question is when referential descriptions with a negative term convey the whole utterance a negative force. The set of references he considers for his analysis include generic and particular references. The predications were categorized as existential, equative, inclu-

sive, ascriptive and “what we do when predicate processes, events, or states”.

However, as a first step to a deeper analysis, it was decided to determine only the force of the dissertation acts where negatives occurred, and their presence either in referential expressions or in the predicate.

For the third analysis, an expert on Van Dijk’s model, psychologist and experienced reading comprehension teacher, was asked to identify the macrostatements in the different sections of the report. A further analysis was undertaken by the author of this paper to determine the presence of negatives in those macrostatements in each rhetorical section and in this way assessing the importance of those negatives in the report.

Results

The negative terms found in the report occurred in the different rhetorical sections as follows: ABSTRACT = 1 (5.7%), INTRODUCTION = 2 (12%), METHOD = 2(12%), RESULTS = 5 (29%), and DISCUSSION = 7 (41%).

The first analysis performed on the sentences with negative terms made evident that the most frequent semantic relation between clauses in a complex sentence was Condition-Consequence (4 = 23%), whereas between juxtaposed sentences the most frequent relation was Grounds-Conclusion (3 = 17%), and Conclusion-Grounds between two pairs of sentences both with negative terms. Another change in order was found for the Result-Reason relation: 3 occurrences = 17%. From the 8 simple sentences analysed 2 showed a semantic relation of contrastive alternation by means of the terms: *either...or* and *neither...nor* (Table 1). First or second position within a complex sentence or between two juxtaposed sentences was determined.

In complex sentences, negatives were more frequently found in the second position 4 = 23%, slightly higher frequency was found for negatives in second position in juxtaposed sentences 5 = 29%. A high frequency of negatives in both juxtaposed sentences was found 6 = 35%, 1 of them forming part of 2 different sets of binary relations. The latter relations occurred in the RESULTS and DISCUSSION sections where negative terms had also occurred more frequently. The relationship Grounds-Conclusion was found in both orders.

On the other hand, the dissertation analysis made evident that from the 19 negatives identified, only 8 were considered as containing the factor: force of negation. The main dissertation acts were Observations = 82%, whereas Generalizations were identified in only two cases: 12%. There was only one occurrence of what Castañón describes as a kind of relation between dissertation acts: Exemplification = 5%. Only in one of the utterances the negative occurred in the predicate (NOT); the negative terms NO, NEITHER..NOR were found in referential expressions = 7 (87%). All of the previous dissertation acts occurred in the Abstract = 1; Results = 4 and in the Discussion section = 3 (Table 2).

Table 1. General Semantic Relations*											
	In a simple sentence	Within clauses in a complex sentence				T	Between 2 juxtaposed sentences				T
		+	-	-	+		-	-	+	-	
COMPARISON CONTRAST											
Simple contrast:											
-Statement - Denial	I ₁ , R ₁ **					2					
-Denial - Correction											
-Expentancy Reversal											
-Contrastive alternation											
-Statement-Exception											
Simple Comparison:											
-Statement-exemplification							D ₆			1	
-Paraphrase											
-Amplification			A			1		M ₂		1	
CAUSE-EFFECT											
-Condition-Consequence		D ₁	I ₂	D ₃ D ₆		4					
-Means-Purpose			M ₂			1	I ₂			1	
-General Causative:											
Reason-Result	M ₁					1		D _{5,6}	D ₃ D ₄	4	
Grounds-Conclusion							I ₁	R ₅	R ₂ R ₃ R ₁ R ₂ D ₂ D ₃	8	
SUPPLEMENTARY ALTERNATION											
							A			1	
COUPLING											
-Rhetorical coupling	D ₂	D ₃				2					
-Contrastive coupling		R ₃	R ₄			2					
TEMPORAL											
-Simultaneity											
-Chronological sequence							M ₁			1	
STATEMENT											
	R ₂ R ₅ D ₁ ** D ₄					4					
<u>Total</u>	8	4	3	2	17	5	4	8	17		

+ Affirmative A-Abstract I - Introduction M-Method

-Negative R-Results D- Discussion T = Total

* According to Crombie's categories ** Two negative terms

Table 2. Dissertation Analysis			
	FORCE	REFERENTIAL EXPRESSION	PREDICATE
GENERALIZATIONS			
R ₈ No loons nested on Perch Lake, and the nearest heron rookery was located over 10 km away.	Negation/ Assertion	*	
R ₇ During 15d of creel census and 44d of bird surveys, only two anglers were seen at Perch Lake, 4 angler-hours were fished, and no trout were captured.	Assertion/ Negation	*	
OBSERVATIONS			
A No poststocking mortality was observed, the primary cause of mortality appeared to be birds.	Negation/ Assertion	*	
R ₅ Neither stress related mortality nor angling appeared to be important in Perch Lake..	Negation	*	
R ₆ I found no dead trout during 28 surveys of the lake shoreline and bottom.	Negation		*
D ₁₂ NO evidence of mortality from stocking stress or disease was found.	Negation	*	
D ₁₁ Angling pressure was low, and no harvest was observed or reported.	Assertion/ Negation	*	
(E x e m p l i f i c a t i o n)			
D ₁₅ For example, if a lake has a large littoral area and is frequented by great blue herons, it would not be wise to stock brook trout which frequent inshore waters.	Suspended assertion	*	

A - Abstract

R - Results

D - Discussion

Table 3. **Macropropositions**

Section	Total	With negatives
Abstract	3	1
Introduction	4	2
Methods	7	2
Results	3	1
Discussion	11	3
Total	28	9

Through the third analysis 24 macrostatements were identified in the different sections of the report: Abstract = 3, Introduction = 4, Methods = 7, Results = 3, Discussion = 7; within them 8 negatives were found (33 %), 3 of them occurring in the Discussion section (Table 3).

DISCUSSION

The high frequency of negatives in the Discussion (41%) and the Results section (29%) in the report was highly consistent with the analysis performed on the other 19 reports studied previously (42% and 28%). However, there was not found the same correlation for the negative lexemes NOT and NO: 60% and 23% in the reports against 13% and 87% in the report.

Results were also different in the contrastive analysis performed in 2 expository texts related to the frequency of negatives in complex sentences: (85%); in the present study the frequency was: 47%.

The whole set of negatives were analysed in the report: prefixes, lexemes and implicit or inherent negatives although their force as negation was not made evident. This approach is considered adequate and consistent with Valle Arroyo's point of view as "most of the existing information processing models of negation do not take the issue of plausibility into account" (1982).

From the semantic relations considered for the first analysis, most of them were found, but some others were reconsidered only through a careful study of Crombie's categories. Although apparently quite evident, some of the relations were not found in the report: Statement-Denial, Denial-Correction, Statement-Exception. Another interesting result was the inversion made present in relations such as Result-Reason and

Conclusion-Grounds in the Results and Discussion sections, where negatives were present in both juxtaposed sentences. This fact could be related with Castañós claim that “dissertation acts modify our knowledge”, although further deeper analyses are required.

Of further interest was the higher frequency of negatives in the second place while analyzing them in binary semantic relations. This fact could be compared with Givón’s claim: “the negative serves to reverse figure-ground relationships, bringing the background to the foreground” (Bartlett, 1987).

Valle Arroyo (1982) suggested that “apparently natural languages use negative statements to distinguish and contrast the exception from the norm”, but at least in this report the relation Statement-exception was not found.

Although all negative terms were at first considered for the analysis, their force could be assessed through the categories established by Castañós. For further analyses not only the force of negation will be important to consider, but, establishing a parallelism with Castañós’ categories, will perhaps also be necessary to use hypothetical negation, suspended negation and mitigated negation for the analysis. For subsequent studies it will also be necessary to distinguish the kinds of reference and predication in the dissertation acts where negatives occur.

The importance of negatives in the research report analyzed was established as their occurrence in the macrostatements was relatively high (33%), this frequency was also consistent within the rhetorical sections of the report (A = 33%, I = 50%, M = 28%, R = 33%, D = 27%). The easiness or difficulty for the comprehension of those terms and statements will have to be assessed in the next stage of this study.

The results of the present study are preliminar as the analyses performed have not been validated through the agreement with other analysts. Crookes (1985) describes an interesting approach for a validation of this kind. It will be useful to attempt it before the preparation of the reading comprehension test using the report analyzed. It is also necessary to perform a statistic analysis so the significance of the results may be claimed. Although only some of the hypotheses could be confirmed, the main objective, to obtain a better understanding of the functions and importance of negatives in the dissertation acts present in a research report was achieved.

Bibliografía

- ALCÁZAR, R; VÉLEZ, M.; MORALES, M. & FIGUEROA, J. (1985). "Resolución de una tarea lógica en niños". IV Congreso Mexicano de Psicología.
- BARTLETT, B. (1987). "Negatives, narrative and the reader". **Language and Style**. 1987, 20, 1, Winter 41-62.
- BURTON-ROBERTS, N. (1989). "On Horn's dilemma: presupposition and negation". En: **Journal of Linguistics**. 25, 95-125.
- CASTAÑOS, F. (1977). Consideraciones sobre el estudio del lenguaje de la ciencia. Tesis de Licenciatura. Fac. de Ciencias UNAM
- _____(1982). "Consideraciones sobre el discurso científico y la definición". **Estudios de Lingüística Aplicada**. Año 1, Núm. 2, Enero, 1982. UNAM, 6-30.
- _____(1984). "Las categorías básicas del discurso y la disertación". **Discurso: Cuadernos de Teoría y Análisis**, 5, 11-27.
- _____(1986). "Acts and relations". **Estudios de Lingüística Aplicada**. Año 4, Núm. 6, Octubre 1986, 6-41.
- CELCE-MURCIA; LARSEN-FREEMAN. (1983). **The Grammar Book**. An ESL/EFL Teacher's Course. Newbury House Publishers, Inc. Rowley, Massachusetts 1969.
- CLARK, H.H. & CHASE, W.G. (1972). "On the Process of Comparing sentences against pictures". **Cognitive Psychology**. 3, 472-517.
- CLARK, H. Y CLARK, E. (1977). **Psychology and Language**. Harcourt Brace Jovanovich, Inc.
- CROMBEE, W. (1985). **Discourse and Language Learning: A Relational Approach to Syllabus Design**. Oxford University Press
- CROOKES, G. (1985). "Towards a Validated Analysis of Scientific Text Structure". En: Riley, P.(Ed.). **Discourse and Learning**. General Ed. C.N.Candlin, Longman, 57-70.
- GILBÓN, D.M. (1988). "Análisis contrastivo de la presencia de términos negativos en textos expositivos de Biología". Proyecto para la materia de Estudios Contrastivos de la Maestría en Lingüística Aplicada, CELE- UNAM.
- GILBÓN, D.M..1989. "Análisis de errores en la identificación de enunciados negativos en inglés". Proyecto para la materia de Análisis de Errores, Maestría en Lingüística Aplicada, CELE-UNAM.
- HOOSAIN, R. (1973). "The Processing of Negation". **Journal of Verbal Learning and Verbal Behavior**, 12, 618-626.
- JUST M. Y CARPENTER. P. (1971) "Comprehension of Negation with Quantification. **Journal of Verbal Learning and Verbal Behavior** 10, 244-253.
- KAMIL, M.L. (1984). "Current Traditions of Reading Research". En: Pearson P. D. **Handbook of Reading Research**. Longman, N.Y., London.
- KLIMA, E. S. (1964). "Negation in English". En Fodor, J.A. y Katz J.: **Readings in the Philosophy of Language**. Prentice Hall, Inc. Englewood Cliffs, New Jersey.
- MESTRE, J.; THIBODEAU H. P., GERACE, W. y WELL A. (1988). **NABE Journal** 12, 3, 243-279.
- MATHEWSON, G. (1984). "Teaching Forms of Negation in Reading and Reasoning", **UM The Reading Teacher** 37,4, Jan., 354-358.
- MEYER, B. y RICE G. (1984). "The Structure of Text". En: Pearson, D. (Ed.) **Handbook of Reading Research**. Longman, 319-351.
- QUIRK, R. et al. (1972). **A Grammar of Contemporary English**, Longman, Ltd.
- QUIRK, R.; GREENBAUM, S.; LEECH, G. y SVARTVIK, J. (1985). **A Comprehensive Grammar of the English Language**. Longman, Ltd.
- RÉGENT, O. (1985). "A comparative approach to the learning of specialized written discourse". En: Riley, P. (Ed). **Discourse and Learning**. Longman.
- REVLIS, R.; LIPKIN, S. y HAVES, J. (1974). "The Importance of Universal Quantifiers in a Hypothetical Reasoning Task" **Journal of Verbal Learning and Verbal Behavior**, 110, 86.
- ROYER, J.M.; BATES, J. y KONALD, C. (1984). "Learning from Text: Methods of Affecting Reader Intent". En: Alderson J. y Urquhart, A. **Reading in a Foreign Language**. Longman, 65-85.

- SEARLE, JOHN R. (1974). **Speech Acts. An Essay in the Philosophy of Language**. Cambridge University Press.
- SHERMAN, M. A. (1973). "Bound to Be Easier? The Negative Prefix and Sentence Comprehension". **Journal of Verbal Learning and Verbal Comprehension**. 112,76-84,
- TRIMBLE, L. (1985). **English for Science and Technology. A discourse approach**. Cambridge Language Teaching Library. Cambridge University Press.
- VALENZUELA A., VARGAS, L.; RIQUELME, A. y FIGUEROA, J. (1985). "Sobre Lenguaje y Conocimiento". **Nematihuani** No. 2. ENEP-Zaragoza, UNAM, 28-35.
- VALLE ARROYO, F. (1982). "Negatives in Context". **Journal of Verbal Learning and Verbal Behavior**, 121,118-126.
- VAN DIJK, TEUN A. y WALTER KINTSCH. (1983). **Strategies of Discourse Comprehension**. Academic Press, Inc.
- WASON, PC. (1965). "The Contexts of Plausible Denial". **Journal of Verbal Learning and Verbal Behavior**, 4,7-11.
- WRIGHT, P. y HULL, A. J. (1986). "Answering Questions about Negative Conditionals". **Journal of Memory and Language** 25, 691-709.

BIOLOGY JOURNALS USED TO INTEGRATE THE CORPORA

- American Fisheries Society Symposium, 1988,5:80-88; 96-103,104-109.
- Hydrobiologia, 1988, 169:265-277; 319-325; 327-338.
- Journal of Experimental Marine Biology & Ecology 1989, Vol. 130:147-165; 167-187.
- Journal of Fish Biology, 1989, 35: 59-71; 237-247.
- Limnology and Oceanography, 1989, Vol.34 No.5:831-839; 868-881;913-930.
- Marine Biology, 1989,103:445-451; 503-511; 563-569.
- North American Journal of Fisheries Management, 1989, 9:154-162;171-176; 177-183.