Rec'd 10/10/90

RPWG
R

Literature Review: Natural Recovery

Objective: Synthesize literature regarding long-term population and ecosystem- and community-level responses to perturbations and stresses, both anthropogenic and natural.

Focus: The historical record with respect to natural recovery times from catastrophes and stress, both anthropogenic and natural.

Options:

1) we secure literature to be reviewed;
2) contractor secures literature to be reviewed

1) perturbations, environmental (natural) and man-induced
2) man-induced only, but of all types
3) oil only

Product: Synthesis and annotated bibliography. Synthesis is essentially a review paper of publishable quality.

Possible contractors:

a) private consultants
b) academic institutions
c) agency (in-house)
d) non-profit research organizations

Subject areas:

a) fish & shellfish
b) birds, marine/coastal
c) intertidal and subtidal ecosystems
d) marine mammals

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EBASCO ENVIRONMENTAL
A Division of EBASCO SERVICES INCORPORATED

EBASCO

10900 NE 8th Street, Bellevue, WA 98004-4405, (206) 451-4600, Fax (206) 451-4691

October 1, 1990
EBEL-ESD-90-026

Dr. Dave Gibbons
USDA Forest Service
Federal Building, Room 225
709 West 9th
Juneau, Alaska 99802

Subject: Restoration Project - Intertidal and Subtidal Ecosystems Literature Review Cost Proposal

Dear Dave:

I appreciated the opportunity to visit with you and discuss the Forest Service's activities concerning natural recovery of the Prince William Sound ecosystem. Following the oil cleanup efforts, recovery of the ecosystem in the affected area will be very important and interesting.

We have developed the attached cost proposal outlining the tasks, options, and estimated costs for performing a comprehensive literature review for the intertidal and subtidal components of your project. As we discussed, Option A2/B2 (see attachment), which includes a literature review for man-induced perturbations only, but of all types, is the most viable option at this time. As proposed, Ebasco Environmental would gather the literature for this option. We have included all of the options (six combinations) so that you can compare the relative cost estimates.

We have separated the activities into two phases:

(1) literature collection, annotation, and evaluation, and

(2) synthesis and publication.

Phasing would provide a midpoint in the project for all members of the study team to meet and compare results of the collection activities. Our experience has shown that this interaction is extremely valuable. Phasing would also provide additional opportunity to evaluate the positive points and the limitations of the literature. Furthermore, it would provide the opportunity (with most phase one options) to initiate the first step for under $25,000. As a suggestion, this would allow the Forest Service to directly contract this phase and initiate activities sooner than if you needed to advertise the entire package.

In addition to the cost estimates, the attachment provides the assumptions for each option. Throughout the program, we would anticipate close interaction with the Forest Service so that we can support its overall program efforts.

As we discussed, Ebasco Environmental would also be available to assist the Forest Service in coordinating the literature reviews and syntheses amongst the project participants. We have participated on similar major project efforts such as:

U.S. Corps of Engineers Endicott (North Slope Alaska) Environmental Monitoring Program

Ebasco Environmental managed a seven-year, multidiscipline effort of numerous subcontractors who gathered data, conducted field studies, and synthesized results regarding impacts of causeway development in Prudhoe Bay, Alaska.

Pacific Northwest River Basin Commission's Columbia River Estuary Data Development Program

Ebasco Environmental managed this multidiscipline approach to gathering field and literature information on the Columbia River Estuary. The information was systematically collected and synthesized into a comprehensive analysis of the physical, chemical, and biological interactions of the estuary.

U.S. Forest Service Quartz Hill Mine EIS

Ebasco Environmental prepared the EIS for this large scale molybdenum mine development proposed by the U.S. Borax Company near Ketchikan. Our activities included gathering and evaluating information from multidisciplines, and synthesizing the information into a comprehensive impact analysis.

We are currently working on multidiscipline programs for other government agencies. Examples include:

- U.S. Federal Energy Regulatory Commission's nationwide environmental analysis of hydropower and natural gas pipeline projects;

- National Aeronautics and Space Administration's rocket motor facility siting EIS;

- U.S. Department of Energy's low level nuclear waste program; and

- Washington Department of Transportation and the U.S. Army Corps of Engineers (Walla Walla District) for which we provide on-call environmental services.

The reason for our success in all of these programs is that we have on-staff technical experts in most environmental disciplines including fish and shellfish; marine and coastal birds; intertidal and subtidal ecosystems; and marine mammals. This provides our clients with full services within one organization. We would be more than happy to provide you with a detailed statement of qualifications and capabilities concerning any of our ongoing or past studies, and project references.

The coordination task could include a range of activities such as:

- o coordination of study approaches and analyses;
- o information gathering;
- o progress reporting;
- o overall synthesis of multidiscipline results;
- o formatting of reports and document preparation; and,
- o coordination of schedules and meetings

We have not developed a detailed cost estimate for the coordination task. However, based on similar efforts for comparable projects, the activities have ranged in cost from $75,000 to $150,000.

The major benefit to the coordination task is that Ebasco Environmental would be able to assist you in tracking the progress of the program and in coordinating the overall synthesis amongst the various project components. If the coordination task becomes a possibility, we would be more than happy to discuss the details of the task and any level of support you might require.

Thank you for your interest in Ebasco Environmental and this opportunity to provide the cost proposal. If you have any questions about the cost estimates or if we can be of assistance to the Forest Service, please call me at work (206-451-4612) or home (206-481-9482).

Sincerely,

EBASCO ENVIRONMENTAL

Don

Donald L. Beyer
Principal Scientist

Cost Proposal to the
Forest Service

for

Literature Review: Natural Recovery
(Intertidal/Subtidal Task)

Introduction

Ebasco Environmental proposes this cost estimate to the Forest Service for conducting a literature review regarding long-term population and ecosystem- and community-level responses to perturbations and stresses. This estimate focuses on a review of the intertidal and subtidal ecosystems component of the overall literature review program related to the Exxon oil spill in Prince William Sound.

Options and Cost Estimate Structure

We have prepared cost estimates for six options that the Forest Service has identified in regard to this component. These are identified as follows:

Forest Service Secures Literature

- Option A1/B1 - Literature encompasses perturbations, environmental (natural) and man-induced
- Option A1/B1 - Literature encompasses man-induced perturbations only, but of all types
- Option A1/B3 - Literature encompasses oil only

Ebasco Environmental Secures Literature

- Option A2/B1 - Literature encompasses perturbations, environmental (natural) and man-induced
- Option A2/B1 - Literature encompasses man-induced perturbations only, but of all types
- Option A2/B3 - Literature encompasses oil only

Technical Approach

Each option has been separated into two phases:

(1) literature collection (except options A1/B1 through A1/B3), annotation, and evaluation; and

(2) synthesis and publication.

The following describes the key activities for each phase:

Phase 1 - Literature Review, Annotation, and Evaluation

Phase 1 will include gathering information from sources such as the University of Washington library, Ebasco Environmental's library, nearby government libraries (e.g., excellent libraries exist at the National Marine Fisheries Service's Sand Point facility and the National Oceanic and Atmospheric Administration's Montlake Laboratory, both in Seattle). We will supplement literature from these sources with computerized searches of the major literature bases. In addition, we will utilize materials that the Forest Service and other study sponsors may already have collected on the subject.

We anticipate that this information gathering will be a comprehensive review of literature from around the world. We have assumed that the major portion of the literature will be in English or have been translated into English.

During Phase 1, we will annotate pertinent references and highlight the most promising sources that can be used for the synthesis. At the end of this phase, we will attend a meeting with other members of the review team and present results of the literature search. We will also participate in planning activities for a coordinated effort for synthesizing the information.

The key product of Phase 1 will be the annotated bibliography and a proposed outline for the synthesis report.

Phase 2 - Synthesis and Publication

In Phase 2, we will utilize the information from the literature as a basis for describing the mechanisms of natural recovery by intertidal and subtidal populations following major perturbations. This synthesis will include approaches taken in other studies, results obtained, and their applicability to conditions such as those found in Prince William Sound, the primary location and focus for utilization of the results of the literature review. The synthesis will include recommendations and an evaluation of the natural recovery approach to major perturbations.

The synthesis will be developed in close coordination with the Forest Service and other members of the literature review study team. A draft publication will be prepared for review by the Forest Service. Following review and comment, the publication will be finalized and published. We anticipate that 50 copies of the report will be prepared. Options for publishing the report in a scientific journal will be considered.

Cost Estimates

Table 1 provides the detailed cost estimates (by phase) for the six options. Labor rates incorporate a mix of job classifications that optimize the work effort. These classifications include the Ebasco Environmental task manager,

Table 1. Ebasco Environmental Cost Estimate – Natural Recovery/Literature Review (Intertidal/Subtidal Task)

PHASE 1 – LITERATURE COLLECTION, ANNOTATION, AND EVALUATION														
OPTIONS		A1/B1		A1/B2		A1/B3			A2/B1		A2/B2		A2/B3	
	RATES	HRS	BILLING	HRS	BILLING	HRS	BILLING		HRS	BILLING	HRS	BILLING	HRS	BILLING
PRINCIPAL SCIENTIST	$81.77	40	$3,270.80	40	$3,270.80	40	$3,270.80		45	$3,679.65	40	$3,270.80	40	$3,270.80
SCIENTIST 1	$64.89	16	$1,038.24	16	$1,038.24	16	$1,038.24		16	$1,038.24	16	$1,038.24	16	$1,038.24
SCIENTIST 2	$57.42	180	$10,335.60	150	$8,613.00	130	$7,464.60		295	$16,938.90	248	$14,240.16	210	$12,058.20
TECHNICAL AIDE	$33.38	30	$1,001.40	25	$834.50	25	$834.50		40	$1,335.20	40	$1,335.20	35	$1,168.30
LIBRARIAN	$32.53	0	$0.00	0	$0.00	0	$0.00		55	$1,789.15	40	$1,301.20	35	$1,138.55
Subtotal Labor		266	$15,646.04	231	$13,756.54	211	$12,608.14		451	$24,781.14	384	$21,185.60	336	$18,674.09
Out of Pockets								Out of Pockets						
Air Fare Juneau/Seattle RT			$1,360		$1,360		$1,360	Computerized Literature Search		$500		$500		$500
Lodging/Meals			$345		$345		$345	Air Fare Juneau/Seattle RT		$1,360		$1,360		$1,360
Mileage/Parking/Telephone			$350		$350		$350	Lodging/Meals		$345		$345		$345
Reproduction/Copying/Report Prep			$205		$205		$205	Mileage/Parking/Telephone		$350		$350		$350
Word Processing			$500		$500		$500	Reproduction/Copying/Report Prep		$500		$500		$500
Computer			$240		$240		$240	Word Processing		$500		$500		$500
								Computer		$240		$240		$240
Subtotal Outpockets			$3,000		$3,000		$3,000	Total		$3,795		$3,795		$3,795
TOTAL – PHASE 1			$18,646.04		$16,756.54		$15,608.14			$28,576.14		$24,980.60		$22,469.09
PHASE 2 – SYNTHESIS AND PUBLICATION														
		A1/B1		A1/B2		A1/B3			A2/B1		A2/B2		A2/B3	
PRINCIPAL SCIENTIST	$81.77	120	$9,812.40	90	$7,359.30	80	$6,541.60		120	$9,812.40	90	$7,359.30	80	$6,541.60
SCIENTIST 1	$64.89	75	$4,866.75	70	$4,542.30	45	$2,920.05		85	$5,515.65	70	$4,542.30	45	$2,920.05
SCIENTIST 2	$57.42	704	$40,423.68	680	$39,045.60	590	$33,877.80		704	$40,423.68	680	$39,045.60	590	$33,877.80
TECHNICAL AIDE	$33.38	115	$3,838.70	90	$3,004.20	70	$2,336.60		115	$3,838.70	90	$3,004.20	70	$2,336.60
LIBRARIAN	$32.53	40	$1,301.20	50	$1,626.50	30	$975.90		60	$1,951.80	50	$1,626.50	30	$975.90
Subtotal Labor		1054	$60,242.73	980	$55,577.90	815	$46,651.95		1084	$61,542.23	980	$55,577.90	815	$46,651.95
Out of Pockets														
Air Fare Juneau/Seattle RT			$2,720		$2,720		$2,720			$2,720		$2,720		$2,720
Lodging/Meals			$480		$480		$480			$480		$480		$480
Mileage/Parking/Telephone/Postage			$700		$700		$700			$700		$700		$700
Reproduction/Copying/Report														
Publication/Graphics			$1,600		$1,600		$1,600			$1,600		$1,600		$1,600
Word Processing			$750		$750		$750			$750		$750		$750
Computer			$350		$350		$350			$350		$350		$350
Subtotal Outpockets			$6,600		$6,600		$6,600			$6,600		$6,600		$6,600
TOTAL – PHASE 2			$66,842.73		$62,177.90		$53,251.95			$68,142.23		$62,177.90		$53,251.95
Total Labor – Phases 1 & 2		1320	$75,888.77	1211	$69,334.44	1026	$59,260.09		1535	$86,323.37	1364	$76,763.50	1151	$65,326.04
Total Out of Pockets – 1 & 2			$9,600		$9,600		$9,600			$10,395		$10,395		$10,395
GRAND TOTAL – PHASES 1 & 2			$85,488.77		$78,934.44		$68,860.09			$96,718.37		$87,158.50		$75,721.04

technical support staff, and Ebasco Environmental's librarian. Table 2 summarizes the total estimated costs for each option by phase.

Out-of-pocket expenses for Phase 1 are based on the assumption that:

Ebasco Environmental staff will attend one meeting (one day) with the Forest Service and other literature review personnel. This meeting could occur either in Juneau or in Anchorage, near the end of Phase 1 activities.

Deliverable products at the end of Phase 1 will be the annotated bibliography (in draft form) and the proposed outline for the synthesis report.

Out-of-pocket expenses for Phase 2 assume that:

Ebasco Environmental staff will attend two meetings (one day each) with the Forest Service (either Juneau or Anchorage). The purposes of these meetings will be to finalize the draft synthesis report and to participate in meetings with other study participants.

Ebasco Environmental will provide the Forest Service with 50 copies of the final published report.

It should be noted that the Forest Service would gather all literature in the options A1/B1 through A1/B3. Therefore, the labor and out-of-pocket estimates reflect this lower requirement for Ebasco Environmental activities.

Table 2

EBASCO ENVIRONMENTAL
SUMMARY OF COST ESTIMATES BY OPTION AND PHASE

	Phase 1	Phase 2	Option Total
Option A1/B1*	$18,646	$66,843	$85,489
Option A1/B2	16,757	62,177	78,934
Option A1/B3	15,608	53,252	68,860
Option A2/B1	28,576	68,142	96,718
Option A2/B2	24,981	62,178	87,159
Option A2/B3	22,469	53,252	75,721

*Options:

Forest Service Secures Literature

- Option A1/B1 - Literature encompasses perturbations, environmental (natural) and man-induced
- Option A1/B2 - Literature encompasses man-induced perturbations only, but of all types
- Option A1/B3 - Literature encompasses oil only

Ebasco Environmental Secures Literature

- Option A2/B1 - Literature encompasses perturbations, environmental (natural) and man-induced
- Option A2/B2 - Literature encompasses man-induced perturbations only, but of all types
- Option A2/B3 - Literature encompasses oil only

Pentec
ENVIRONMENTAL

October 1, 1990

U. S. Forest Service
Alaska Region
P.O. Box 1682
Juneau, Alaska 99802

Attention: Dr. Dave R. Gibbons

Dear Dave:

Per your request of September 14, this letter briefly describes an approach and level of effort to address your interest in a review and synthesis of literature on the natural recovery of marine ecosystems from disturbance. As you are aware, this topic has been reviewed previously in several forums, most notably and perhaps, most directly in the 1977 Conference on Recovery and Restoration of Damaged Ecosystems. More recently, the 1985 review by the National Research Council touches on some aspects of recovery from spills. The biannual issues of the Oil Spill Conference Proceedings also contain occasional reference to recovery from spills (e.g., Blaylock and Houghton 1989).

There are also several studies which have been done in Alaska and California of recovery patterns in rocky intertidal areas that have been manually stripped. Most recently, an MMS sponsored study in northern California has documented recovery patterns and times of plots stripped in several different ecological zones and at two times of the year. Their observation of slower recovery of plots stripped in the fall than those stripped in the spring may have implications for our observation of slower recovery in areas in Prince William Sound that were "cleaned" in the summer and fall of 1989, than at those where no cleaning occurred. Also, there is some interesting recent literature on long-term recovery of areas and resources affected by the *Amoco Cadiz* spill (e.g., Dauvin and Gentil 1990). *

As you have obviously noted, however, there are no recent comprehensive reviews of information on the long-term recovery of marine resources from catastrophic disturbances, such as oil spills. Review of this literature is something we at Pentec have begun during the last year, with particular emphasis on the areas of intertidal ecology and the effects of shoreline oil treatment attempts on recovery of nearshore resources. We would welcome the opportunity to continue and complete this effort!

Pentec Environmental, Inc. - 120 West Dayton, Suite A7 • Edmonds, WA 98020 • Phone: (206) 775-4682 • Fax: (206) 778-9417

The additional effort we would apply, should we gain funding from the USFS, would include the following steps:

1. Formal literature searches by our staff Information Specialists of published information available through local libraries and the Dialog electronic information service. On-line data bases that would be searched include Government Reports Announcements and Index (NTIS), Aquatic Science and Fisheries Abstracts, Global Marine Pollution Bibliography, Pollution Abstracts, Selected Water Resources Abstracts, and Biosis.

2. Expansion of searches we have conducted to date to include birds and marine mammals.

3. Preparation of a computerized annotated bibliography and a narrative synthesis of the information reviewed.

We see only a minor difference in cost between covering effects of all perturbations (natural and man-caused; oil-related and non oil-related). Furthermore, we believe that the inclusion of relevant information from non oil-related studies, e.g., monitoring of experimental denudation of beaches, is essential to maximum understanding of the processes involved. We would focus on information relevant to temperate and sub-arctic environments (for example, we would not cover the abundant literature on the recovery of mangrove swamps from oiling).

We envision two primary end products:

1. An annotated bibliography, in both electronic and hard copy,

2. A narrative synthesis of information reviewed in a publishable format.

We estimate that the cost of completion of the above described tasks in a thorough manner would be in the range of $25,000 to $35,000. A reasonably complete job could be provided for around $20,000. Approximately $5,000 (each) would be added to include marine birds and mammals.

I hope this provides the type of information you were looking for at this stage. If needed, I would be happy to provide additional information on our qualifications for this work, a more formal scope of work, and/or a more detailed cost estimate. Please call me to discuss whatever additional needs you may have.

Sincerely,

Jon Houghton

Jonathan P. Houghton, Ph.D.
Vice President

DRAFT

Important literature for Aquisition,
As of 5/3/90
listed by page number as in
March 1990 Preliminary Draft of
<u>Ecological Restoratrion</u>
<u>of Prince William Sound and the Gulf of Alaska,</u>
<u>an Annotated Bibliography of Relevant Literature</u>

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DRAFT

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FROM: ... bibliography

Literature for Possible Acquisition
Taken From 1990 Preliminary Draft of Ecological Restoration of Prince William Sound and the Gulf of Alaska, an Annotated Bibliography of Relevant Literature

Southern Hemisphere:
24ar, **26, 27, 29ar,** 30ar, **31,** 32ar, **86,** 151, 158, 166, 185, 213ar, 202, **205,** 376, **407,** 416ar

Northern Hemisphere:
1, 7, 11, 33, 39, 40, 75, 82, 87, **137, 176, 197, 203,241,** 251, 311, **338,** 365, 348ar, 349ar, **383, 386, 422**

Seagrass, Estuary, Vegetation:
60, 85, 92, 155, 155, 173, 178, 264, 298, 328, 346, 380, 398, 410, 411, 414, 448

Soil Organisms\Structure, Habitat:
34, 78, 94, 100, 147, 153, **162, 195, 206, 207, 218,** 228, **239, 254, 265, 293, 294, 301,** 302, **327, 353, 329, 334, 342, 352, 358, 395, 397, 421, 424, 425, 442, 447,**

Oil Spill General:
17, 18, **50, 89,** 90, **102, 105, 109, 112, 114, 123, 1227, 135, 141,** 149, 160, 169, 179, 182, 183, 191, **192, 215, 216,** 225, 242, **249,** 290, 295, **314, 331, 339, 343, 357,** , 404, 406, **418, 419,** 420,

Foreign:
337, 46, 63, **64,** 66, 71ar, 73ar, 76ar, 77, 99,**143,** 163, **164,** 170, 201ar, 209, 219, 237, **246, 286,** 350, 363, **371, 382, 396,** 388, **432, 368, 412,** 437,

Bivalves, Fish, Other organisms:
35, 53, **98, 110, 124,** 133, **172, 204, 221, 220, 247, 260, 293, 321, 341, 345,** 355, **364, 435**

ar= artificial reefs
bold= priority
not bold= valuable but not priority

Some, not many, additions, deletions from Kirsten list.

Frankie
5/30

DRAFT

Important literature for Aquisition,
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FROM: A.D.N.R. review of bibliography

Literature for Possible Acquisition
Taken From 1990 Preliminary Draft of Ecological Restoration of Prince William Sound and the Gulf of Alaska, an Annotated Bibliography of Relevant Literature

Southern Hemisphere:
24ar, **26**, **27**, **29ar**, 30ar, **31**, 32ar, **86**, 151, 158, 166, 185, 213ar, 202, **205**, 376, **407**, 416ar

Northern Hemisphere:
1, **7**, **11**, **33**, **39**, **40**, **75**, **82**, 87, **137**, **176**, **197**, **203**, **241**, 251, 311, **338**, 365, 348ar, 349ar, **383**, **386**, **422**

Seagrass, Estuary, Vegetation:
60, 85, 92, 155, 155, 173, 178, 264, 298, 328, 346, 380, 398, 410, 411, 414, 448

Soil Organisms\Structure, Habitat:
34, **78**, **94**, **100**, **147**, 153, **162**, **195**, **206**, **207**, **218**, 228, **239**, **254**, **265**, **293**, **294**, **301**, 302, **327**, **353**, **329**, **334**, **342**, **352**, **358**, **395**, **397**, **421**, **424**, **425**, **442**, **447**,

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17, 18, **50**, **89**, 90, **102**, **105**, **109**, **112**, **114**, **123**, **1227**, **135**, **141**, 149, 160, 169, 179, 182, 183, 191, **192**, **215**, **216**, 225, 242, **249**, 290, 295, **314**, **331**, **339**, **343**, **357**, , 404, 406, **418**, **419**, 420,

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Bivalves, Fish, Other organisms:
35, 53, **98**, **110**, **124**, 133, **172**, **204**, **221**, **220**, **247**, **260**, **293**, **321**, **341**, **345**, 355, **364**, **435**

ar= artificial reefs
bold= priority
not bold= valuable but not priority

Some, not many, additions, deletions from Kirsten's list.

Frankie
5/30

DRAFT

Important literature for Aquisition,
As of 5/3/90
listed by page number as in
March 1990 Preliminary Draft of
Ecological Restoratrion
of Prince William Sound and the Gulf of Alaska,
an Annotated Bibliography of Relevant Literature

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RPWG
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Comprehensive Review and Critical Synthesis of the Literature on Recovery of Marine Bird Populations from Environmental Perturbations

Final Report
To Restoration & Planning Work Group
(Contract COOP-91-039)

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Literature Review, Marine Birds

Executive Summary

The scientific literature pertaining to the ability of marine bird populations to recover from oil spills and other environmental perturbations was reviewed with the aim of considering: (1) the rate, duration and extent of recovery and what response might be expected from various populations, (2) biotic and abiotic influences on the rate, duration and degree of recovery, (3) the influence of management practices on the rate, duration and degree of recovery and (4) how best to monitor the recovery of marine bird populations. The review of the literature, both peer-reviewed and "gray" literature, included seabirds and seaducks, as well as oystercatchers and eagles (if relevant to marine populations). To establish the demographic capabilities of marine bird populations to respond to perturbations, we reviewed observations on growth and recovery as well as critical demographic parameters.

Some seabirds were characterized by population growth rates of 10 - 13% per year (penguins, albatrosses, petrels, gannets and boobies, skuas, auks) whereas others were characterized by substantially higher growth rates (pelicans, cormorants, gulls); seaducks appeared intermediate between these two groups. The scarcity of population studies of oystercatchers makes it difficult to generalize about their characteristic growth rates. In contrast, published models of seabird population growth indicate that most species are not capable of growing at much more than 12% per year.

The rate of recovery is influenced by the availability of immigrants, the presence of a pool of non-breeders, the abundance of pre-breeders (subadults), and prey availability. Re-establishment of entire breeding colonies that have been extirpated is difficult because recruiting individuals favor high-density colonies and/or their own natal colony. Protection from exploitation and disturbance and insuring high prey (fish) availability are management practices that can influence rate of recovery; active restoration has not

often been attempted. We suggest that, if possible, both total population size and number of breeding pairs be monitored. Otherwise misleading conclusions may be drawn regarding recovery. We advocate that primary demographic parameters be monitored, in order of priority: fledgling production, adult survival and recruitment of offspring. It is very difficult to make quantitative predictions regarding duration (or rate) of recovery without population-specific information on critical demographic parameters; hence we encourage the systematic collection of such data. Two criteria of recovery have often been invoked: (1) return of the population to its historic size, or (2) return of the population to what it would have been in the absence of perturbation. The latter criterion is, in theory, preferrable, but we recognize that it will always be very difficult to establish what might have been. The former criterion is more practical but we must recognize that due to temporal changes in ecosystems and their components, it may be impossible for a population to recover to its historic level.

INTRODUCTION

Background and Objectives

A variety of marine birds, waterfowl and other birds were killed or injured as a result of the *Exxon Valdez* Oil Spill. In order to plan wisely for the restoration of bird populations injured by the spill, it is necessary to consider and estimate the rate, degree, and extent of recovery from oil spill losses. In this review and synthesis we examine studies published in the scientific and "gray" literature pertaining to the recovery of seabird and seaduck species from other oil spills and from other environmental perturbations, both anthropogenic and natural.

Specific goals of the review and synthesis were:
1) To consider the rate, duration and degree of recovery of bird populations following disturbance, so as to determine what might be expected, quantitatively and qualitatively, from various populations;
2) To consider biotic and abiotic influences on the rate, duration and degree of recovery;
3) To consider the influence of management practices on the rate, duration and degree of recovery, including protection of species, protection of habitat, and restoration practices; and
4) To consider how best to monitor recovery, if any, of affected species, and how to determine when a population has recovered. The last point also includes consideration of the best indicators to be monitored.

Rationale

Our review of the literature was wide-ranging. In addition to studies reporting recovery from known perturbation, we have also included studies pertaining to the growth of marine bird populations, regardless of whether a negative factor had reduced numbers previously. Information on population growth came from two sources: 1) studies on the basic demographic parameters of a population (production of offspring, survival of offspring to breeding age, survival of adults, age of first breeding, immigration and emigration), and 2) studies reporting observed changes in total population size or breeding population size.

We had two reasons for adopting this broad, demographic approach. First, the literature on recovery of marine bird populations from perturbations, such as oil spills and other examples of large-scale mortality, is not great, especially in regard to species differences and other influences on rate of recovery. The demography of gulls, cormorants, murres, albatrosses and seaducks are all quite different, making it impractical to consider the recovery of a generalized seabird. Secondly, we consider information on the demographic capabilities of seabirds, derived from studies of their growth, to be relevant to the question of how they would respond to a perturbation such as additional mortality or disruption of reproduction. To put it another way, our thesis (and one that has a long tradition in the scientific literature) is that the long-term impact of a perturbation can be predicted knowing the short-term impact coupled with the demographic parameters of the population.

The literature reviewed and presented in the annotated bibliography can be classified into four groups:

1) Studies providing key demographic information enabling one to estimate the intrinsic rate of increase. Either the study provided all necessary information, or the study did so in combination with other studies (which were also included in the literature review).

2) Studies reporting recovery (or in some cases, lack of recovery) from a perturbation.

3) Studies reporting growth of marine bird populations, for whatever reason. We did not include in the review studies reporting stasis or decline of populations (except for those falling into category 2, above).

4) Studies providing other information relevant to the question of recovery, e.g. regarding the role of density dependence.

Scope of the Review

Taxa included: The literature was searched with regard to all seabirds: penguins, loons (divers), grebes, the Procellariiformes (albatrosses, and the three families of petrels, including shearwaters), the Pelecaniformes (gannets and boobies; pelicans; cormorants and shags; frigatebirds; and tropicbirds), and six families from the Charadriiformes (skuas and jaegers; gulls; terns; skimmers; phalaropes; and alcids [auks]). In addition, we included seaducks (eiders, scaup spp., scoters, mergansers and other sawbilled ducks, Oldsquaw, Harlequin Duck, goldeneyes, Bufflehead, steamer ducks and Kelp Goose) and Osprey, as well as oystercatchers (most are not marine, but the Black Oystercatcher is) and eagles (if the reference pertained to marine populations). Some taxa were well represented in the literature reviewed, others not at all.

Time period: The period searched emphasized studies published from 1960 on, but quite a few studies published 1940 to 1960 were also included. We reviewed papers obtained by 1 November 1991, with a small number that were received in November and December 1991, principally papers on oystercatchers.

Languages: We emphasized papers published in English, but some studies written in other languages were also included.

Geographical regions: No regions were excluded. However, there were few papers from the tropics, and papers from the north temperate regions were the most numerous.

Subject matter: This is discussed in the section, "Rationale," above.

METHODS

The literature was systematically searched using computerized bibliographic databases, specifically BIOSIS, Zoological Record, and Wildlife Review, as well as the on-line version of Current Contents. We searched for suitable key words in titles as well as in abstracts.

This approach was supplemented by our own knowledge of relevant papers, studies, etc. and by referring to literature cited by papers already available to us. The systematic, computerized approach was poor at identifying papers in the "gray" literature; for this we relied on our own knowledge or by referring to citations of literature we already had obtained. We emphasized papers that were "readily available", though we did attempt to obtain a number of papers that were not "readily available" (the latter included, e.g. Ph.D. dissertations); some of these were obtained with the assistance of the Alaska Department Fish and Game, others through Inter-Library Loans. In addition colleagues, especially Dr. Joseph Jehl, Jr., and Dr. Eric Woehler, were generous in providing references, publications, and reports.

In this way we identified, initially, 313 references, which we then attempted to obtain as detailed above. One of the two co-Principal Investigators (Nur or Ainley) read each article and prepared an abstract. Papers (from among the original 313) that were deemed not relevant to the literature review and synthesis were not included in the bibliography; however, papers for which it was not possible to compose an abstract (if no copy of the paper could be obtained in a timely fashion), have been included in the bibliography if they appear to be relevant to the goals of the literature review. At some future date, it would be desireable, we feel, to consult these unannotated references. We deleted older papers from the bibliography if more recent papers superceded them.

The annotations (abstracts) have been written expressly with respect to this project, i.e. they abstract information relevant to the question of recovery of marine bird populations from perturbation. They do not aim to provide a general summary of each article (though that, sometimes, has been accomplished). Instead, the annotated bibliography provides a ready source of information concerning recovery and growth of marine bird populations. It is our hope that the annotated bibliography will provide a useful research tool in and of itself.

RESULTS

General Comments

We consider that **rate of recovery** is the key parameter of the three mentioned. We defined this rate as the annual percent growth rate. The **duration** of the recovery will be determined by the **initial impact** of a perturbation (e.g., known or estimated mortality resulting from an oil spill) and the **rate** at which the population can recover. As for **extent of recovery**, we expect that populations will be able to fully recover, eventually, unless the rate of recovery is zero or negative (the latter case, meaning that the situation of a population is worsening rather than ameliorating, subsequent to a perturbation). However, if the time to recovery is fixed (e.g., recovery is measured after 50 years), then the extent of recovery achieved after the fixed period of time will depend on impact and rate of recovery.

We collated information on rate of recovery from reports of observed population growth, whether or not that growth was in response to an identified perturbation. In some cases, seabird populations grew because areas were newly colonized or because additional food sources became available (e.g., fishery refuse for gulls). Some papers did not report the reason for population growth, e.g. whether or not the growth represented recovery from a perturbation, and in some cases this was probably not known. Other papers included speculation on reasons for population growth without firmly establishing the antecedent factors and influences.

Rate, duration and extent of recovery

Observed rates of population growth are presented in Table 1, grouped by taxonomic family. We have calculated exponential growth rates, for time periods during which the population was observed to grow. This is equivalent to assuming that the growth rate of a population was constant during the period considered and in many cases this assumption was supported. Where population growth could be divided into two or more periods, one period in which growth was rapid and others in which it was slow, we have separated the phases. At the same time, we have tried to avoid including data on growth of very small, incipient populations, for two reasons: 1) there is greater sampling error associated with the dynamics of very small populations, and 2) there is greater likelihood that changes in the size of small colonies represents immigration and emigration, as compared to either very large colonies or populations of entire regions, in which immigration and emigration play a smaller role. We included reference to immigration if a researcher thought it was an important factor. We also excluded cases in which the population showed no growth, very slow growth (less than 1% per year) or even decline.

We stress that our objective in this exercise was not to characterize all possible population trajectories, but to characterize recovery or **the potential for recovery** of marine bird populations. The rationale was that if, for instance, a species is often observed to grow at a rate of 13% per year but is rarely observed to grow at a faster rate, then this indicates that a perturbed population (e.g. subject to large-scale mortality) **can** grow at this rate, but not that a perturbed population **will** grow (recover) at that rate.

The data presented in Table 1 display a great diversity of results. Nevertheless, some generalizations are possible. The first is that different taxonic groups display characteristically different growth rates. In other words, though there is no rate of growth that characterizes all marine birds, species or groups of species (genera or families) do exhibit characteristic rates of growth. *Larus* gulls are clearly capable of sustaining growth rates of 12-13% per year. In fact, Herring Gulls on the Isle of May did so for sixty-five years (Duncan 1978), until a program of gull control was instituted. However, the Emperor Penguin does not appear to be able to sustain such growth rates: no population has been observed to grow at more than 10% per year. Other species groups growing at 12% or less per year include the petrels and skuas. Table 2 summarizes life-history characteristics of seabirds (by family) in relation to "typically observed" growth rates. To provide an objective criterion for comparing "typical" rates of growing populations, we present in Table 2 the median observed growth rate (i.e., the rate corresponding to the 50th percentile) and the upper quartile growth rate (i.e., the rate corresponding to the 75th percentile). These statistics were derived from Table 1, excluding populations growing at less than 1% per year. As a preliminary estimate of what a recovering population is capable of achieving we put forward the upper quartile statistic.

Rates of recovery and life history traits: In general, species groups can be divided into one of two classifications: upper quartile growth rate 19% or more (pelicans, cormorants, and gulls) or upper quartile growth rate 13% or less (penguins, albatrosses, shearwaters, boobies, skuas, terns, and auks), with seaducks intermediate (15% upper quartile). The "fast" growing species are characterized by laying a clutch of more than one egg. The "slowly" growing species are characterized either by a clutch of one or a clutch of two eggs in which only one chick is successfully reared (penguins and skuas). Terns are exceptional in that their clutch size is three yet the upper quartile growth rate is only 10%.

It would be overly simplistic to expect that much of the variation in observed maximal growth rates could be attributed to a single life-history (or demographic) trait. However, the other two life-history traits, age of first breeding and adult survival rate, do not demonstrate a strong correlation with observed population growth rates. Albatrosses, for example, have the oldest age of first breeding, but do not show the lowest rate of population growth. Nevertheless there does seem to be a trend for early age of first breeding to be associated with faster population growth, as might be expected. Adult survival tends to correlate negatively with population growth, contrary to any simplistic views of population dynamics. This is probably because adult survival tends to be negatively correlated with fecundity (Ricklefs 1973); a partial correlation analysis assessing the relationship of adult survival and growth rate, after adjusting for the effect of fecundity, would be valuable. A key demographic parameter which has not been included in this analysis, owing to a lack of published data, concerns survivorship of young after fledging.

Rates of recovery in relation to perturbation: It was also apparent in our review that growth rates often vary with time, depending on the phase of growth or recovery. Soon after the perturbation, growth is often high (approaching or even exceeding the maximum intrinsic rate of growth), but later growth slows. This pattern is characteristic of colonization (or recolonization). For example Northern Fulmars grew at 16.0% per year soon after colonizing Great Britain (1879-1901), at 10.0% between 1909 and 1939 and at 6.5% between 1939 and 1969 (Evans 1984).

The temporal and spatial scale of the perturbation influences recovery. Where short-term, localized mortality has occurred, populations often recover in a few years, owing to a pool of immigrants and subadults who were elsewhere when the mortality occured. A classic example is provided by European Shags breeding in northeast Britain. Shags breeding on Farne Island were subjected to a red tide in 1968 and the breeding population crashed, from 350 pairs to 75 pairs (Potts et al. 1980). However, within 6 years, the population had recovered its original number, as a result of both immigration from nearby populations (not affected by the red tide) and of recruitment of additional individuals into the breeding population (who otherwise were non-breeding owing to lack of adequate breeding sites). Another classic example is offered by the Peruvian "guano birds" (pelicans, boobies and cormorants). In former years there was such a large "floating" population, precluded from breeding by lack of a breeding site, that in spite of large-scale mortality due to lack of food (brought about by El Niño events), once the food web was re-established **breeding** populations returned to pre-El Niño levels within a few years (Murphy 1936, Tovar et al. 1987). As is often the case, it was impossible to quantify the **total** population (breeders and non-breeders) and track its trends.

Conversely, where there is long-term, pervasive mortality recovery starts slowly and requires decades to complete. For example, King Penguins on Macquarie Island had been hunted to the point of near-extinction and recovery took about 80 years (Rounsevell & Copson 1982). However, in the first 20 years following the cessation of hunting the population showed no growth. The Macquarie Island is very isolated and, thus, little if any immigration was possible and all growth was intrinsic.

Rates of recovery in relation to immigration and emigration: A strong influence on observed population growth rate is immigration and emigration, the former being especially important among growing populations, and the latter important among shrinking populations (see below). The results in Table 1 provide inferences about immigration, in that unusually rapid growth implicates immigration. More specifically, observed growth exceeding the demographic capabilities of a population implies that immigrants are contributing to this growth. In Table 3 we list studies in which predicted population growth rates based on demographic models were compared with observed growth. Cases where observed growth exceeds the projected growth rate (for that species or that population) suggest immigration as a factor. Another example (not cited in Table 3) is provided by Ainley et al. (1990), who estimated a negative growth rate for a population of skuas, but data on banded birds indicated that immigration resulted in a stable breeding population. Note, however, that growth rates less than the predicted maximal growth rate do not imply the **absence** of immigration.

Table 3 gives us reason to believe that immigration is implicated in the growth of certain populations (e.g., Atlantic Puffins on the Isle of May; Harris 1983). What is most striking about the results in Table 3, however, is that no population model predicted a growth rate of more than 12%, except for a model of Harris (1983) in which he allowed adult survival to be 100%, an exercise of theoretical value only, and a model by Kosinski & Podolsky (1979) in which fecundity and mortality of a kittiwake colony was assumed to reflect observed values for "center" individuals only (no "edge" individuals, whose fecundity and mortality rates are lower, were included). Even in these two instances, projected growth rate was only 14 to 14.9%. Yet Table 1 provides numerous examples of observed growth rates exceeding 14.9%, not to mention 12%. Two possibilities should be considered: (1) The populations represented in Table 3 are a biased sample of those in Table 1, i.e. biologists have not studied rapidly growing populations in sufficient detail to construct models of their growth, or (2) A large number of populations listed in Table 1 are rapidly growing because of immigration rather than intrinsic growth. We have no reason to favor conclusion (1) and so are led to conclude that growth rates much in the excess of 12 to 15% reflect, to a great extent, immigration.

Recovery duration: To provide a yardstick to assess recovery durations, we note that if a population has been knocked down to one-half its previous size, it will require 7 to 8 years to recover to its former level at a growth rate of 10% per year, 5 to 6 years to recover if the population growth rate is 13% per year, and about 4 years to recover if its growth rate is 19% per year. However, the rate of recovery is not entirely independent of the impact of the perturbation, being higher where the perturbation is less extensive (in time and space) and vice versa, the recovery rate being slow where the perturbation is extensive. The result is that recovery duration will tend to increase in a more-than-proportional manner with an increase in the severity of the perturbation.

Limitations of the data: We stress that there are strong limitations on what we may conclude from the data in Table 1. Results indicate what growth rates are possible and plausible; they provide an envelope of possibilities. However, they do not allow predictions of what growth rate will actually occur, because the rate is strongly affected by local factors. The key demographic parameters determining population growth rate are not easy to obtain and, in particular, are not species-constant nor are they even population-constant. For example, during a period in which the Common Murre population on Skomer Island was static (in the mid 1970's), adult survival and fledging success (and possibly, survival of immatures) were lower than they were during a period of growth (in the mid-late 1980's; Hatchwell & Birkhead 1991). Thus, knowledge of the demographic parameters of the Skomer population in the 1970's would not have allowed adequate prediction of population behavior in the mid 1980's. Similarly, adult survival of Atlantic Puffins on the Isle of May was high (96%) while the population was expanding (1973-1981), but was considerably lower during the period of stasis and decline in the 1980's (Harris 1991).

Influences on recovery rates, biotic and abiotic

In this section, we review influences on recovery rates, drawing on some examples already presented, as well as additional examples. We emphasize biotic influences, rather than abiotic ones, reflecting the consensus of seabird biologists that the former will influence population recovery the most. For example, El Niño events may be ultimately a function of abiotic forces (especially upwelling), but their influence on bird populations is felt through alteration of the food web.

Immigration and emigration: Immigration, or its absence, plays an important role in the recovery process. Where there are unaffected populations nearby, this allows the possibility that immigrants will help restore population number (see example of European Shags, discussed above). Species vary in their tendency to immigrate/emigrate in regard to both dispersal of young and dispersal of adults. Terns and cormorants, for example, show a great deal of dispersal, even among breeding adults, or to put it another way, site tenacity is low. Such a tendency, in fact, has made designation of critical breeding habitat to be a tenuous proposition in managing the recovery of various tern species.

In general, seabird species show a considerable amount of dispersal at the juvenile stage, post-fledging. Dispersal during the juvenile stage may or may not lead to effective emigration among breeding individuals. Harris (1991) found that pre-breeding Atlantic Puffins from the Isle of May visited colonies at other islands, and appeared to return to the natal colony only if there were few breeding vacancies at the visited colony. The fact, then, that many puffins returned to their natal colony to breed should not be taken to imply that puffins are **constrained** to do so. Another example is offered by Ainley et al. (1990) who found that skuas visited a number of colonies as young pre-breeders, but most eventually returned to within meters of their natal sites and those that emigrated were attracted by unusual opportunities of ample food availability. In sum, the potential for immigration depends on both the species and its propensity to disperse, and on the population substructure, i.e. the availability of nearby colonies to serve as a source of additional breeders. This potential has, in fact, been tested "experimentally" by culling Herring Gulls (Coulson 1991).

Many seabirds are specifically attracted to extant colonies. Coulson (1983) found that small colonies were the most attractive to Black-legged Kittiwakes seeking to breed, whereas Birkhead (1977) found that Common Murres were most attracted to high-density subcolonies, but were most likely to settle in medium-density subcolonies (since high-density subcolonies had few vacancies). Heubeck et al. (1986) observed that small kittiwake colonies declined at faster rates than did large colonies, suggesting that kittiwakes were more likely to emigrate from small colonies. As a consequence, the recovery prospects for a small colony that has been severely depleted are poor. Futhermore, extinction or near-extinction of a breeding colony, as a result of a perturbation, may make it hard to reestablish that colony.

Variation in rate: role of density dependence. There is little consensus regarding the evidence for density-dependent population regulation in seabirds (Birkhead & Furness 1985). In some cases, nest sites appear limiting. Population regulation by way of food limitation, however, is not well supported. Instead, food has a direct effect (not necessarily dependent on density) on reproductive success and perhaps survival, too, (Croxall & Rothery 1991). This contrasts with the commonly-held view, among the lay public, that events reducing population number, e.g. oil spills, are "good" for the population. Evidence from murres indicates, if anything, the opposite relationship: reduction in density decreases reproductive success, by making colonies more susceptible to predation (Hudson 1985). It is not a simple matter, however, too large a colony can act to lower reproductive success (Hunt et al. 1986).

The importance of food availability: In general, population dynamics of seabirds tracks food availability more than any other ecological factor (Furness & Monaghan 1987). For example, when predatory fish were heavily fished in the North Sea, sand lance (*Ammodytes*; their prey) bloomed, and numbers of many seabird species increased, but when numbers of sand lance crashed (a result of a switch in target species of the fisheries), so too did the reproductive success of seabirds and with that population numbers. Decline in North Sea herring stocks was associated with decline in kittiwake reproductive success (chicks fledged per pair) and a decline in population growth rate (Coulson & Thomas 1985). The Peruvian seabirds represent another example: overfishing of anchoveta caused a dramatic decline in baseline numbers of boobies and cormorants and in the ability of these seabirds to recover from El Niño events (Tovar et al 1987).

Pool of non- or pre-breeders: Mortality of breeders can lead to the recruitment into the breeding population of individuals who otherwise would not breed (e.g. if they were previously excluded from obtaining nest sites). An example is provided by European Shags, not just at Farne Island (Potts et al. 1980), discussed above, but also on the Isle of May (Aebischer 1986). The recruitment of individuals who had not yet begun breeding at the time of the perturbation (i.e. pre-breeders) can also hasten recovery. However, we should consider that individuals recruiting early in the recovery process (i.e. at an earlier age than they might otherwise do) are not available to recruit later in the recovery process. Furthermore, recruitment of individuals who had previosuly been pre-breeders can lead to a spurious recovery, a good example of which is provided by Cory's Shearwaters breeding on Selvagem Grande Island (Mougin & Roux 1987). The population had been decimated by poaching up through 1976. Between 1977 and 1986 the number of breeders increased dramatically, fivefold, to 25000. At the same time, the number of sub-adults dropped correspondingly (as those who had been pre-breeders entered the breeding population). The result was that the total population of Cory's Shearwaters did not increase at all during this time. If only breeders had been monitored (common practice for seabirds), a dramatic recovery would have been implicated. An alternative example is that of the Peruvian guano birds mentioned above.

Influence of management practices

The most common, effective management practice promoting recovery of seabirds is protection: protection from egging, hunting, and from disturbance. Scores of species have benefited from protection, including Common Murres on the Farallones (Ainley & Boekelheide 1990), King Penguins on MacQuarie Island (Rousevell & Copson 1982) and Laysan Albatrosses on Midway Island (Rice & Kenyon 1962).

A second means of promoting recovery concerns effective management of prey availability, specifically fish. As pointed out above, availability and abundance of fish is a prime determinant of seabird population growth. Recovery of Peruvian guano birds (especially Peruvian Booby and Guanay Cormorant) was strongly affected by the anchoveta fishing industry. For example, since 1963 the population number of guano birds has been inversely correlated with the anchoveta catch. Fishery activity in the Gulf of Alaska area has great potential to impact recovery of seabirds.

A third means of promoting recovery is through active restoration. One such success story is that of the Atlantic Puffin, reintroduced to Maine by obtaining chicks from Newfoundland, artificially rearing chicks in burrows in Maine, and releasing them there (Kress and Nettleship 1988). The investigators provided puffin decoys in an effort to encourage puffins to breed at the release site. Restoration efforts have not been commonly pursued. They are affected by all the processes reviewed above and certainly require large, local source populations and a propensity to emigrate.

OVERVIEW, DISCUSSION AND CONCLUSIONS

We first consider the question, How to monitor seabird recovery? After discussing a definition of recovery, we consider which parameters should be monitored, and how this should be carried out. We then discuss the specific case of monitoring Common Murre colonies that were impacted by the *Exxon Valdez* oil spill. The results of our literature review are in marked contrast to the viewpoints espoused in a recent review paper by Baker et al. (1990) and we discuss these differences in an Appendix to this report.

Defining recovery

Monitoring recovery of seabirds from perturbation requires adopting a definition of recovery, in particular defining a suitable endpoint. This endpoint could be: (1) return of the population to what it was before the perturbation or (2) return of the population to what it would have been had the population not been perturbed. The second definition is of greater value but it is always difficult to establish what might have been. Use of the first definition is thus more practical, but the problem is that the environment may be deteriorating (making it impossible for a species to return to its previous state) or improving. Ford et al. (1982) use a third criterion of recovery, return of the population to a stable age structure, but a drawback of this criterion is that, in practice, due to a fluctuating marine environment (Ainley & Boekelheide 1990) many populations never achieve or maintain a stable age structure. We recommend that both of the first two definitions be kept in mind in defining recovery, and that one try not to focus entirely on one or the other.

What to Monitor: Population Size

There is no disagreement among biologists that monitoring population size is of great importance, but there are different ways to enumerate a population. The first question is whether to enumerate the entire population or just the breeding portion. If the latter, then one can count nest-sites, defended territories, breeding pairs, nest-sites with eggs, etc., as appropriate. In murre studies it is common practice to count all adult individuals at a colony and then translate that number into the number of breeding pairs by using a correction factor, based on study plots which establish the ratio of adults to breeding sites (e.g. Takekawa et al. 1991). In any case, in most seabirds, it is the breeding population that is enumerated. This approach has some drawbacks: (1) The proportion of individuals attempting to breed often varies among years (Ainley & Boekelheide 1990, Ainley et al. 1990), and (2) the demographic health of a population depends on the number of juveniles, subadults, and non-breeding adults, too, and not just the number of breeding adults (see Peruvian guano bird example, above). We have also already mentioned the example of Cory's Shearwaters on Selvagem Grande Island, in which the breeding population appeared to recover dramatically, whereas the total population did not increase at all. However, counting the entire population (irrespective of breeding status) has its drawbacks: (1) non-breeders are often not present at a seabird colony, and only return to the colony for breeding or prior to obtaining a breeding territory, and (2) the reproductive capacity of a population depends on the number of breeding pairs not the total population size. It would be of greatest value to monitor both breeding numbers and total population size; doing so allows one to estimate the number of pre- and non-breeders by subtracting the number of breeding individuals from the total number of individuals. Such an estimate is not possible if one counts only total or breeding numbers.

The importance of monitoring additional demographic parameters

We stress that effective monitoring of seabird species requires more than merely enumerating population size. Knowledge of the primary demographic parameters (fledgling production, adult survival, juvenile survival, proportion of breeders among adults) is of critical value in effective monitoring and management. One cannot project recovery rate or duration without obtaining at least some of these data. Population size can give some insight into the status of a species, but does not provide insight into causes of population decline or growth. In addition, population size shows considerable time-lag in revealing problems affecting a species. For example if the only effect of a perturbation is to reduce fledging success to nil, the size of the breeding population will not demonstrate adverse effects for several years to come (i.e., until that fledgling class would have recruited).

Of the primary demographic parameters that could be monitored we list the following, in order of their value and/or practicality:

(1) *Fledgling production* (i.e. the number of young produced which leave the nest and/or are able to fly). With this parameter we also include the parameter 'fledging success' (i.e. proportion of eggs which successfully fledge). We place this parameter first because it is relatively easy to monitor and much evidence indicates that it is an important determinant of population change (Croxall & Rothery 1991). An additional advantage is that it can be used to predict the health of a population several years in advance, as pointed out above. Finally, fledgling production may provide a good index of food availability for that species, and thus serve as a more general monitoring tool, i.e, a means of monitoring a species' prey base (Ainley & Boekelheide 1990).

(2) *Adult survival.* There is increasing evidence that change in population growth rate among seabirds is associated with changes in adult survival (Coulson & Thomas 1985, Harris 1991, Hatchwell & Birkhead 1991). However, monitoring adult survival is more difficult than monitoring fledgling production. For one, monitoring adult survival requires banding individuals, which itself can be disturbing to the colony. Secondly, small differences in adult survival can have important implications for population dynamics, but can require very large sample sizes to determine the magnitude (or even the existence) of such differences. For example, a change in adult survival rate, from 0.96 to 0.92, which implies a doubling of adult mortality will have a substantial impact on population growth or decline yet would require a total sample size of over 1000 individuals to establish statistical significance (at the 0.05 level) with a probability (i.e. power) of 80%.

(3) *Survival to breeding age and/or probability of recruitment into the population.* This

parameter is undoubtedly of importance in the growth and decline of seabird populations but is more difficult to study than fledgling production or adult survival. In fact, only a handful of seabird studies have obtained good information on this parameter. One problem is that investigators must wait three, five, or even ten years for a single cohort to recruit. A second problem is that juveniles often disperse, and may or may not return to their natal (study) colony to breed. Nevertheless, we think it essential for a good, long-term seabird monitoring program to attempt to collect information on this parameter.

(4) *Proportion of the adult population that breeds.* Fluctuations in this parameter are responsible, in some cases, for short-term changes in breeding number (e.g., changes in numbers of several species breeding on the Farallon Islands Common Murres during the El Niño of 1983 [Ainley & Boekelheide 1990]), but it is not likely of importance with regard to long-term changes in population size. Reasons for monitoring this parameter are that (1) information on proportion of adults that are breeding can help explain year-to-year fluctuations in number and thus "smooth out" long-term trends and (2) the proportion of adults that breed will influence fledgling production and ultimately, recruitment. New statistical techniques make it easier to estimate this parameter than has been the case before (Lebreton et al. 1992).

The four parameters discussed are generally applicable to all seabird species, including sea ducks and oystercatchers.

Remarks on Monitoring Alaskan Common Murres following the *Exxon Valdez* Oil Spill

Common and Thick-billed Murres appeared to have been strongly impacted by the *Exxon Valdez* spill, not just with regard to mortality of adults and subadults (which was on a catastrophic scale) but also with regard to reproductive success, which was near zero for affected colonies in 1989 and 1990, and not much greater in 1991 (Nysewander & Dippel 1991). Other alcids also suffered substantial mortality, but many species live in burrows and, thus, much less is known about population sizes and natural history owing to difficulty of study. The murre, thus offers the best "surrogate" species for understanding impacts and recovery potential.

We wish to point out that the dramatic reduction in reproductive success (fledgling production) observed at these colonies was unprecedented: we know of no other case where murre reproductive success (or that of any alcid species) was affected over such a large scale, in space and time. Nysewander & Dippel (1991) attributed the reproductive failure, proximally, to a lack of reproductive synchrony. We wish to correct the impression that the Farallon Common Murre population experienced a similar reproductive failure associated with a population crash between 1982 and 1986 (cf. Nysewander & Dippel 1991). In the first place, reproductive failure on the Farallones was short-lived, in 1983 alone, and this failure could be directly attributed to the El Niño of 1982/83, itself an unprecedented environmental perturbation affecting food availability for breeding birds, rather than being attributed to the effects of gill-net mortality (Ainley & Boekelheide 1990). In 1984, reproductive success was reduced, but not dramatically so; by 1985, fledgling production was normal. Secondly, there was no obvious lack of reproductive synchrony in 1983 or 1984. Instead, in those two years, there was a low proportion of breeders among individuals at the colony (Ainley & Boekelheide 1990, Sydeman, MS). This leads us to suggest that a similar phenomenon has occurred at oil-impacted colonies in Alaska. That is, it may be that adults, rather than breeding asynchronously in affected colonies, have been less likely to breed at all.

If investigators suspect reproductive asynchrony, we suggest that it be quantified. It would also be helpful to study chick diet throughout the breeding season in these colonies and compare that to chick diet at unaffected colonies. Such a study would be instructive because it may provide insight into the mechanism by which the murres have become reproductively asynchronous. For example, the oil spill may have altered the temporal pattern of prey abundance and availability such that peak availability for some species, but not others, has been delayed. If different murres are tracking different prey species, the result may be reproductive asynchrony, with this asynchrony not involving any intrinsic, social mechanism. We further suggest that late-breeding birds be monitored at unaffected colonies to facilitate comparisons with birds breeding at affected colonies (at which colonies birds in general have been observed breeding late). Our final recommendation is that oil-impacted colonies be studied as thoroughly as possible, not just fledgling production and chick diet (see above), but also adult survival, age of first breeding, and recruitment of offspring.

Recovery and non-recovery

It is easier to find studies documenting a recovery, to whatever degree and at whatever that rate might be, than it is to find reports discussing the lack of recovery. A more rigorous approach to finding information that may instruct us in the recovery process might be to consider major incidents (as reported in the literature, such as *Marine Pollution Bulletin*) and then follow each one up, regardless of recovery. Unfortunately, this would be very hit or miss (many incidents have not been followed up and it would be hard to track those that have), and we feel this approach would not yield a large number of studies. By keying in on recoveries, in our search, we bias our selection to cases where recovery has occurred. This bias was partly compensated by our inclusion of studies that described growth of populations regardless of whether a perturbation occurred. An additional bias may exist if investigators are less likely to report a non-recovery than they are to report a recovery. Finally, we remark that short-term impact of oil spills are commonly reported in the literature, but the long-term impact is rarely reported, often due to a short-fall in funding. We wish to encourage investigators to redress the balance.

One conclusion of our review is that one cannot, with much confidence, predict the rate, duration, or even extent of recovery of a marine bird population, simply on the basis of knowing the short-term impact of a perturbation. Statements such as "Populations should fully recover in 20-70 yr" (Piatt et al. 1990:395) are suspect unless based on studies of affected populations. Moreover, making an accurate prediction requires the availability of current estimates of critical demographic parameters of that population. Such parameter estimates are difficult to obtain for avian populations in general, and for many seabirds may be impossible to obtain, for example, due to limited accesss to breeding colonies for observation and banding. Study of murres presents fewer problems, and that is why this review has emphasized that species.

The problem is that demographic parameters vary among populations and, even within a population, they vary with time. For example, intensive study of the Skomer (Wales) Common Murrre population indicated that during a period of growth (in the mid-1980's, which represented recovery from a population crash in 1969/70), fledging success and adult survival increased compared to values during a period of stasis, about a decade earlier (Hatchwell & Birkhead 1991). Survival and recruitment probability of offspring during the mid-1980's, however, were not at that time known. Using parameter estimates for survival to breeding age, collected during the 1970's, produced a projected rate that did not match the observed population growth rate. Hatchwell and Birkhead inferred that survival to breeding age was about 50% greater during the 1980's than during the 1970's. If so, projected population growth rates matched observed rates. In other words, even in a relatively well-studied population, growth (i.e. recovery) rates, instead of being **predicted** by our knowledge of demographic parameters, are being used, retrospectively, to fill in our knowledge of these parameters.

There is also substantial differences among populations in their demographic parameters, e.g. Common Murre populations on Skomer Island (Wales), Isle of Canna (Scotland) and Semidi Islands (Alaska) all differ in one or more primary demographic parameters (Birkhead & Hudson 1977, Swann & Ramsey 1983, Nysewander & Dippel 1991). One must be cautious, therefore, in using a population model that "borrows" parameter estimates from one population to apply to a divergent population, as was done by Murphy et al. (1985).

The difficulty biologists and managers face is not just of quantitatively predicting a recovery trajectory, but even of qualitatively predicting it. Why a population recovers or does not recover is a question, in practice, not easily answered. For example, Common

Murres on the Farallon Islands were recovering well during the 1970's and early 1980's from the effects of disturbance and chronic oil pollution (Ainley & Boekelheide 1990). Between 1982 and 1986, however, they were subjected to heavy mortality from gill-nets, a severe El Niño, and two oil spills (Takekawa et al. 1991). Though these perturbations did not extend beyond 1986, the murre population has yet to show any signs of recovery, even by 1991 in spite of high breeding success (PRBO, unpublished). A second example of the elusiveness of predicting population recovery also concerns Common Murres, those of Skomer Island. After heavy winter mortality in 1969/70, the murre population dropped substantially. Between 1970 and 1972 the population recovered only 50% of its losses; between 1972 and 1979 there was no further population recovery. However, between 1979 and 1988 the murre breeding population increased by 85-90%. Hatchwell & Birkhead (1991) could offer no explanation for the pattern of recovery and non-recovery.

The case of the Peruvian guano birds and the collapse of the anchoveta fishery provides an example in which the degree of recovery **can** be attributed to a biological factor: fish availability (Tovar et al. 1987). El Niño events in 1957, 1965, and 1972 each caused a crash of Peruvian Boobies and Guanay Cormorants, followed by recovery of population number. Over-fishing of the anchoveta, a key prey species, however, caused each subsequent recovery to be weaker than the preceding. That is, the carrying capacity of the environment had changed between the time of the population crash and the time of the recovery. This same phenomenon may explain why the Farallon murre populations in the 20th century have never come close to recovering their mid-19th century population numbers (Ainley & Lewis 1974). Thus, for some species, the answer to the question, "How long until recovery?" is "Never", at least if recovery is defined as return to pre-perturbation numbers. These examples further point out a need for ecological studies of prey in monitoring marine bird recovery.

Limited data for certain groups of marine birds

Finally, though we implemented what we felt was a thorough review of the literature, we could find little information on growth rates among certain taxa, including oystercatchers and sea ducks. There have been few studies of Black Oystercatchers altogether, and though the ecology of the European Oystercatcher has been well studied, few studies have reported on this species' population dynamics. Except for studies of Common Eiders in Europe (see Table 1), there was little information on the population trends or, even, the impacts of heavy mortality on sea ducks. The problem may be that sea ducks do not attract the attention of seabird biologists (e.g., because they do not breed on the marine coast), nor have they attracted the attention of duck biologists, who are more likely to study hunted species instead. Some studies reported fluctuations in numbers of wintering sea ducks from year to year, but it would be particularly unreliable to use these data to infer population growth rates since winter populations are very fluid and thus annual changes in number are likely to reflect dispersal and migration. We encourage further study of sea ducks, if possible on their breeding grounds.

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Appendix: Critique of the Review by Baker et al.

We discuss in this appendix the arguments by Baker, et al. (1990) in their paper, "Natural recovery of cold water marine environments after an oil spill", with regard to birds. We emphasize the paper of Baker et al. for two reasons: (1) It purports to be a review of studies concerning the recovery of marine populations, including seabirds, from oil spills, and thus its subject matter is similar to our own literature review. (2) Baker et al.'s review was intended to draw inferences about the expected consequences of the *Exxon Valdez* oil spill on marine populations, an objective which is coincident with that of the Restoration & Planning Work Group in requesting this study.

Baker et al. make several points that we wish to take issue with; in this appendix we restrict ourselves to those points that are directly relevant to the results and conclusions of our literature review. First, they state that "there is no reason to suppose that, from a biological point of view, this mortality [as a result of oil slicks] is damaging to seabird populations" (p. 23). On the contrary, there is certainly good reason, from a biological point of view, to think that such mortality is damaging, unless the mortality from oiling is compensated by a reduction in mortality from other sources. There is no good basis for supposing that oiling mortality is of that nature. What evidence there is from marine birds suggests the opposite. For example, Hudson (1985) argues that, for auks, mortality from an oil spill will endanger a population, because reproductive success often **declines** as colony size declines (as might happen after a spill). The field reports from the 1989 - 1991 breeding seasons (Nysewander & Dippel 1991) indicate that the deleterious effects of the *Exxon Valdez* oil spill on murre reproductive success may have been much more severe than even Hudson anticipated. Whether compensatory mortality is a real phenomenon is a subject of discussion in the duck literature where there has been argument concerning the role of hunting in population regulation. Many studies have provided evidence that hunting mortality is compensatory, while a comparable number have produced evidence that hunting mortality is additive, non-compensatory (Nichols 1991). Therefore no facile argument regarding compensatory mortality can be made. Baker et al. (1990) present no evidence that oil spill mortality is compensated.

A second point, and this is probably the key argument of Baker et al., is that even "auks, which because of their very low reproductive rate might be expected not to be able to make good these losses, have sustained their population." This argument is fallacious on two grounds. First, what holds for the auks of Great Britain and the North Sea may not hold for Alaskan auks. Baker et al. admit that auk colonies are much larger in the Arctic than they are further south, and yet there is good evidence that the ability of auks to rear young is diminished at the uppermost levels of colony size (Hunt et al. 1986). Therefore even if auks in Great Britain are able to sustain their number, in the face of oiling, this tells us nothing about the ability of Alaskan auks to maintain theirs. Baker et al.'s argument also collapses because British and North Sea auks have been declining in recent years, not increasing or maintaining their numbers. In the 1970's, in spite of well-publicized oil-related mortalities, auk numbers in Britain were indeed increasing but by the 1980's were not, and in fact were declining; in Norway they were declining during both decades (Harris 1991, Lloyd et al. 1991). This widespread decline of auk numbers is not likely a result of oiling, but rather of changes in food availability, but this does not absolve the oil industry. The impact of an oil spill on an increasing population is indeed transient, but the impact of an oil spill on a declining or otherwise static population is essentially permanent.

The third point of Baker et al. is that a reservoir of non-breeding individuals exists which can be tapped to make good mortality of breeders. This may be the case in some species (e.g. European Shag, Armstrong et al. 1978) but is not widespread. What is more likely is that an individual which loses a mate, can replace it, but often at the price of reduced reproductive success in the first year or two (Manuwal 1972, Emslie and Sydeman, MS). In contrast, a crash in the population size of Common Murres on the Farallon Islands between 1982 and 1986, has not resulted in a shift toward earlier age of first-breeding (PRBO unpublished).

Finally, we note that between 1969 (when efforts were first made to monitor the effects of oil spills on seabirds) and the present, the British Isles have not suffered an oil spill killing large numbers of seabirds, comparable to the number affected by the *Exxon Valdez* oil spill. Therefore the conclusion that British seabird populations have been able to tolerate oil spills, with only transient effects, even if correct, is of little value in assessing the impact of a catastrophic oil spill, such as that of the *Exxon Valdez*.

TABLE 1. Summary of exponential growth rates (percent increase per annum) in various seabird populations.

Species	Area (No.Sites)	Rate	Period	Chronology	Cause	Source
PENGUINS						
Aptenodytes forsteri	Amanda Bay	7.1	1961-87	G		Woehler ms
	C.Washington	9.5	1968-86	G		
	Franklin I	5.8	1964-83	G		
	Haswell I	2.3	1962-70	G		
	Kloa Pt.	5.0	1977-85	G		
	Taylor Glacier	6.7	1980-88	G		
A. patagonicus	Crozet I (2)	10.2	1962-86	Rec,Late	E	Jouventin & Weimirskirch 1990
	Heard I	24.0	1963-71	Rec,In	E	Budd 1974
		18.1	1969-88	Rec	E	Woehler 1991
	N Spit Bay	23.4	1969-80	Rec	E	Gales & Pemberton 1988
	S Spit Bay	10.6	1969-88	Rec	E	Gales & Pemberton 1988
	Kerguelan I (2)	6.7	1963-86		E	Jouventin & Weimirskirch 1990
	MacQuarie I	9.1	1930-80	Rec,All	E	Rousevell & Copson 1982
	South Georgia I	5.6	1925-80	G,All	E	Croxall et al. 1984
		17.3	1978-85	Rec,Late	E	Woehler ms
Eudyptes chrysolophus	Kerguelan I	0.7	1963-80	G	F	Jouventin & Weimirskirch 1990
Megadyptes antipodes	Otago Peninsula	12.2	1942-52	G	E,Im	Richdale 1957
Pygoscelis adeliae	Ardley I	8.5	1980-84	G		Woehler ms
	Aviation I	7.4	1961-85	G		
	Buckle I (3)	3.8	1973-84	G		
	C.Denison	11.8	1974-82	G		
	Joubin Is (4)	4.6	1984-90	G		
	Haswell I	2.3	1912-62	G,All		Pryor 1968
	Hope Bay	2.2	1945-63	G,Late	F	Conroy 1974
	Peterman I	18.0	1982-88	Col,In		Woehler ms
	Pt.Geologie	1.7	1958-84	G	C	Thomas 1986
	Pr.Olav Coast (3)	3.4	1972-81	G		Woehler ms
	Ross Sea (20)	8.5		G	C	Taylor et al. 1990
	C.Bird	4.6	1967-87	G	C	K.Wilson 1990
		8.7	1981-87	G		Woehler ms
	C.Hallett	1.3	1967-88	Rec,All	D	
		9.8	1981-87	G	C	Taylor et al. 1990
	Beaufort I	9.2	1963-87	G		Woehler ms
		5.7	1981-87	G	C	Taylor et al. 1990
	C.Royds	5.2	1966-87	G	C	Taylor & Wilson 1990
		10.0	1980-87	G		Woehler ms
	C.Crozier	7.7	1970-87	G		
	Unger I	27.1	1980-85	Col;In		
	Sentry Rk	42.8	1980-85	Col,In		
	Duke of York I	16.8	1982-88	G		
	Downshire Cliffs	3.5	1982-88	G		
	C.Wheatstone	2.7	1964-87	G		
	Coulman I (4)	2.4	1964-88	G		
	Wood Bay	4.1	1981-89	G		
	Inexpressible I	3.0	1963-87	G		
	Franklin I (2)	2.1	1981-86	G		
	Sabrina I	5.6	1978-84	G		
	Signy I	2.8	1957-82	G	F	Croxall et al. 1984
	Syowa Coast (10)	9.9	1975-82	G		Woehler ms
	Windmill Is. (14)	4.6	1961-89	G	C	Woehler et al. 1991
P. antarctica	Cuverville I	24.9	1971-88	Col,In		Woehler ms
	Deception I (5)	20.0	1953-66	G,In	F	Conroy 1974
	(7)	3.5	1967-87	G,Late		Woehler ms
	Georges Pt	18.9	1984-88	Col,In		
	Heywood I	6.7	1966-87	G		
	Harmony Pt	4.5	1972-87	G		
	Joubin I	6.2	1984-90	Col,In		
	Livingston I (3)	14.0	1957-65	G,In	F	Conroy 1974

Abbreviations
I = Islands or Islands C = Cape
Rec = recovery from population decline; duration: In = initial period, Mid = middle period, Late = late period; G = growth of established population, All = entire period
Factors involved: E = relaxation from exploitation, F = enhanced food supply, D = relaxation from disturbance, H = habitat improvement, Im = immigration, P = lessening of pollution

Table 1 Continued

	(4)	1.0	1965-87	G,Late		Woehler ms
	Nameless I	11.4	1984-90	Col,In		
	Seal I	11.3	1970-88	G		
	Signy I	6.6	1957-82	G	F	Croxall et al. 1984
	Tupinier I	5.4	1969-90	G		Woehler ms
P. papua	Livingston I (3)	17.9	1957-65	G	F	Conroy 1974
	Harmony Pt	6.4	1957-65	G	F	
	Heard I	1.9	1954-87	Rec	E	Woehler 1991
	Peterman I	11.2	1982-88	G		Woehler ms
	Port Lockroy (2)	12.5	1984-88	G		
	Pr.Edward I (14)	12.6	1974-84	G		
	Thule I	20.2	1966-79	G		
	Yankee Harbour	19.9	1957-65	G	F	Conroy 1974
Spheniscus magellanicus	Pen. Valdes	3.0	1978-87	G,Late		Boersma et al. 1990
GREBES						
Podiceps cristatus	Netherlands	4.4	1966-83	Rec?	E?	Camphuysen 1989
ALBATROSSES						
Diomedea albatrus	Torishima I	6.6	1956-82	Rec,In	E,	Hasegawa & DeGange 1982
D. immutabilis	Laysan	5.3	1911-57	Rec	E,H	Rice & Kenyon 1962
	Lisianski I	10.4	1923-57	Rec	E,H	
	Midway I	27	1900-45	Rec,In	E,H	
		4.0	1945-58	Late		
		4.7	1958-73	Rec,Late	E,H	Fisher 1975
D. melanophrys	Heard I	4.3	1954-87	Rec,Late	E,D	Woehler 1991
D. nigripes	Laysan	8.7	1911-57	Rec	E,H	Rice & Kenyon 1962
	Lisianski I	3.0	1923-57	Rec	E,H	
	Midway I	27	1900-45	Rec,In	E,H	
	Torishima I	13.2	1964-82	Rec,In	E,Im	Hasegawa 1984
PETRELS						
Fulmarus antarcticus	Pt.Geologie	6.0	1955-84	G		Thomas 1986
F. glacialis	Funk I	11.0	1959-80	G,All	F	Kirkham & Montevecchi 1982
	NE Atlantic	7.0	1952-80	G,Late	F	Ollason & Dunnet 1983
	Great Britain	16.0	1879-'01	G/Col,In		Evans 1984b
		10.0	1909-39	G,Mid		
		6.5	1939-69	G,Late		
	Eynhallow I	6.0	1953-70	G		Dunnet et al 1979
	Shetland Is	10.3	1878-'59	Col,All	F	Fisher 1966
	Orkney Is	4.6				
	Isle of Man	8.6	1969-86	G		Lloyd et al 1991
	Norway	10.0	1920-47	Col	Im	Brun 1979
	Runde	5.3	1947-81	G,Late		Barrett & Vader 1984
	SW Norway	10.2	1950-79	Col,All	F	Toft 1983
	Ydre Kitsigsut	12.1	1971-83	G,Late		Evans 1984a
Puffinus diomedea	Selvagen Grde I	1.2	1980s	Rec,In	E	Mougin et al. 1987
P. tenuirostris	Fisher I	6.0	1972-80	Rec,In	E	Serventy & Currey 1984
PELECANIFORMS						
Pelecanus occidentalis	Anacapa I	37.0	1973-80	Rec	P,F,Im	Anderson & Gress 1983
	Coronado I	8.6	1920-35	Rec,All	E	Jehl 1973
		24.0	1971-80	Rec	P,F,Im	Anderson & Gress 1983
	No. Carolina	46.8	1977-83	Rec,In		Clapp & Buckley 1984
	So. Carolina	18.7	1978-82	Rec,In		

Abbreviations
I = Islands or Islands C = Cape
Rec = recovery from population decline; duration: In = initial period, Mid = middle period, Late = late period; G = growth of established population, All = entire period
Factors involved: E = relaxation from exploitation, F = enhanced food supply, D = relaxation from disturbance, H = habitat improvement, Im = immigration, P = lessening of pollution

Table 1 Continued

Phalacrocorax aristotelis	Farne Is	9.0	1910-65	Rec,All	E	Potts 1969
		11.0	1930-65	G,In	E	Armstrong et al. 1978
		40.0	1968-74	Rec,In	Im	
	Isle of May	7.7	1900-53	Rec,All	E	Potts 1969
		15.6	1962-83	G	E	Aebischer 1986
	N E England	11.1	1969-86	Rec,All	Red Tide	Lloyd et al 1991
	SW Norway	6.8	1950-79	G		Toft 1983
Ph. atriceps	Arthur Harbor	17.6	1973-87	G		Ainley & Sanders 1988
	Heard I	3.5	1951-85	Rec	D	Woehler 1991
	South Orkney Is	2.0	1960-87	G		Cobley 1989
Ph. auritus	Anacapa I	25.0	1973-80	Rec	P,F,Im	Anderson & Gress 1983
	Br. Columbia	8.6	1959-83	G	E	Vermeer & Sealy 1984
	Mandarte I	10.8	1927-83	G	E	
	Farallon I	20.7	1972-82	Rec,All	E	Ainley & Boekelheide 1990
		70.0	1983-86	Rec,All	E	
	Great Lakes	21.5	1970-80	Rec,In	P	Bloekpol & Scharf 1990
		38.4	1980-87	Rec,Late		
	Maine	24.2	1934-45	G,In	E	Buckley & Buckley 1984
		1.6	1972-77	G,Late		Milton & Austin-Smith 1983
	New England	21.0	1930-45	G Im		Drury 1973/4
	Nova Scotia	9.4	1927-71	G,In	E	
		10.2	1971-82	G,Late	E,Im	
	St.Lawrence R	3.0	1963-80	G,Late	E	
	Texas	24.4	1949-75	G,All	E,Im	Morrison et al. 1983
Ph. bougainvillii	Peru	50.0	1953-57	Rec	F	Tovar et al. 1987
		10.0	1959-64	Rec	F	
		1.2	1966-72	Rec	F	
		8.2	1974-82	Rec	F	
Ph. carbo	France	4.0	1968-83	G	E	Evans 1984b
	NW Overijessel	17.0	1930-40	Rec,In	E	Veldkamp 1986
		12.0	1970-86		P	
	Nova Scotia	10.3	1940-72	Col,All		Erskine 1972
	Nova Scotia	3.8	1971-82	G,Late	E	Milton & Austin-Smith 1983
	Scotland	4.0	1905-83	G	E	Evans 1984b
	Dublin Co.	7.8	1969-86	G		Lloyd et al 1991
Ph. olivaceous	Texas	32.0	1967-75	Rec,In	E,Im	Morrison et al. 1983
Ph. pelagicus	Bare Pt	8.8	1959-83	G	E	Vermeer & Sealy 1984
	Farallon I	16.3	1976-81	Rec,All		Ainley & Boekelheide 1990
	Mandarte I	4.7	1915-83	G	E	Vermeer & Sealy 1984
Sula bassanna	Bird Rks	1.0	1967-73	G,Late	E,F	Nettleship 1976
	Bonaventure I	3.6	1919-76	G	E	Brown & Nettleship 1984
		2.2	1961-73	G	E,F	Nettleship 1976
		9.9	1961-66	G		
	Funk I	19.3	1936-72	G,All	E,F,Im	Kirkham & Montevecchi 1982
		3.0	1959-72	G,Late	E,F	Nettleship 1976
	Great Britain	3.0	1900-83	G		Evans 1984b
	Grassholm I	20.3	1914-24	Rec,In	E	Fisher & Vevers 1944
	Grassholm I	7.8	1924-1939	Rec,Mid	E	Fisher & Vevers 1944
	Bass Rock	6.3	1969-86	G		Lloyd et al 1991
	Runde	8.4	1969-74	G,Late		Brun 1979
		7.5	1969-82	G,Late		Barrett & Vader 1984
	Skarvklakken	38.4	1969-82	Col,In	Im	Barrett & Vader 1984
	Syltefjord	14.5	1969-74	Col,In		Brun 1979
		18.3	1969-82	Col,In		Barrett & Vader 1984
S. capensis	Algoa Bay	3.6	1956-74	G,Late	E,D	Randall & Ross 1979
S. serrator	Colville	4.9	1928-47	G		
	Hawkes Bay	2.5	1931-46	G		
	Hawkes Bay	2.5	1879-'03	Col,In		Fleming & Wodzicki 1952

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Table 1 Continued

S. variegata	Peru	10.0	1953-57	Rec	F	Tovar et al. 1987
		8.0	1959-64	Rec	F	
		7.8	1966-72	Rec	F	
		1.0	1974-82	Rec	F	
SKUAS						
Catharacta skua	Foula	3.3	1880-1963	Rec	E	Parslow 1967
	Orkney	9.3	1915-63	Rec	E	
	Orkney	9.4	1974-84	Rec,Late		Lloyd et al 1991
	Shetland	7.0	1900-70	G	E	Evans 1984b
C. maccormicki	Arthur Harbor	7.6	1974-87	G		Ainley & Sanders 1988
	McMurdo Snd (9)	1-15	1957-83	G,All	F,Im	Ainley et al. 1986
	Pt.Geologie	2.7	1966-81	G,All	F	Jouventin et al. 1984
Stercorarius parasiticus	Fair Isle	11.6		Rec	E	Parslow 1967
		3.7	1962-73	G	E	O'Donald & Davis 1975
	Orkney Is	9.4	1969-86	G,In		Lloyd et al 1991
GULLS						
Larus argentatus	Berlengas I	3.2	1939-81	G,Late	F	Barcena et al. 1984
	E Canada	13.1	1925-35	G,All	F,H	Lewis 1927
	Funk I	5.9	1956-80	G,All	F	Kirkham & Montevecchi 1982
	E U.S.	4.5	1900-70	G	F	Nisbet 1978
	Lk Huron/Mich.	12.3	1960-65	G,All	F,H	Ludwig 1966
	Muskeget I	9.2	1925-40	G,In	F	Kadlec & Drury 1968
	Thatcher I	92.0	1959-66	G,All	F,Im	
	New England	9.8	1938-42	G		Drury & Kadlec 1974
	New England	4.2	1900-40	G		Drury 1963
	Great Britain	12.8	1930-70	G,All	F	Chabrzyk & Coulson 1976
	Skokholm I	10.2	1959-69	G		Harris 1970
	Skomer I	10.8	1962-69	G		Harris 1970
	Isle of May	12.0	1907-70	G,All	F	
	Walney I	17.0	1904-64	Col,All	E,F,Im	Parslow 1967
	Suffolk Co.	7.0	1973-86	G		Lloyd et al 1991
	German Wadden Sea	5.7	1966-82	Rec,All	P	Becker 1991
	Holland	12.1	1930-38	G	F	Morzer Bryuns 1958
		5.3	1947-54	G	C	
	Scania, Sweden	4.7	1947-76	G	E	Mathiasson 1980
	Sisargas I	5.1	1948-81	G,Late	F	Barcena et al. 1984
	SW Finland	8.7	1943-80	G	F	Berman 1982
	SW Norway	3.6	1950-79	G	F	Toft 1983
L. a. heuglini	Meda I	4.4	1961-82	G	F,E	De Juana 1984
L. atricilla	Jamaica Bay	84.6	1979-84	Col,In	Im	Buckley & Buckley 1984
L. auduonii	Cabrera Is	14.1	1974-82	G,In	F,E	De Juana 1984
	Chafarinas I	8.5	1966-83	G/Col,In	F,E,Im	De Juana et al. 1984
	Columbretes I	20.2	1974-82	Col,In	F,E	De Juana 1984
L. californicus	Western U.S.	2.0	1920-80	G,All	F,H	Conover 1983
	Lahontan Lk	7.0	1941-83	G,All	F	Jehl et al. 1991
	Mono Lk	4.6	1916-76	Rec,All	E	Winkler & Shuford 1988
		15.1	1950-76	G,Late	H	Jehl et al. 1984
	Pyramid Lk	19.5	1927-60	Rec,All	E,F	Jehl et al. 1991
	San Fran. Bay	80.0	1980-89	Col,In	F,Im	Ainley & Hunt 1990
	Stillwater	17.6	1950-77	Col,All	F,H	Jehl et al. 1991
L. delawarensis	E Canada	2.4	1925-35	G,All	H	Lewis 1937
	Maritime Prov	20.9	1972-86	G,Late	F,Im	Lock 1988
	New Foundland	11.2	1940-80	G,All	F,Im	
	St.Lawrence R	7.6	1945-67	G,All	F,H	Ludwig 1974
	Lk Erie	23.6	1945-67	G,All	F,H	
		19.1	1976-84	G,Late	F,H	Bloekpol & Scharf 1990
	Lk Huron	22.1	1930-45	G,In	F,H	Ludwig 1974

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Table 1 Continued

		8.4	1945-67	G,Mid	F,H	
		10.1	1976-84	G,Late	F,H	Bloekpol & Scharf 1990
	Lk Michigan	17.3	1945-67	G,All	F,H	Ludwig 1974
		11.3	1976-84	G,Late	F,H	Bloekpol & Scharf 1990
	Lk Ontario	14.4	1930-45	G,In	F,H	Ludwig 1974
		22.2	1945-67	G,Mid	F,H	
		9.5	1976-84	G,Late	F,H	Bloekpol & Scharf 1990
	Lk Superior	11.3	1976-84	G,Late	F,H	
	Western U.S.	6.0	1920-80	G,All	F,H	Conover 1983
L. dominicanus	Lk Wainono	33.0	1969-77	G,All	F,H,Im	Pierce 1980
L. fuscus	New England	14.8	1941-65	G		Drury 1973/74
	Spain (2)	77.8	1973-81	Col,In	F,Im	Barcena et al. 1984
	SW Norway	3.7	1950-79	G	F	Toft 1983
	Skokholm	20.6	1960-69	G Im?		Harris 1970
	Walney I	29.0	1930-66	Rec,All	E,F,Im	Parslow 1967
L. glaucescens	NW Washington(7)	2.0	1963-70	G,Late	F	Reid 1988
	Colville I	3.0	1963-75	G	F	Amlaner et al. 1977
	Protection I	5.9	1976-84	G,Late	F	Reid 1988
	SW Br.Columbia(4)	4.0	1900-60	G	F	Reid 1988
	Mandarte I	4.7	1915-60	G	F	Vermeer & Sealy 1984
	Mitlenatch I	3.6	1922-75	G		
L. marina	E Canada	6.2	1925-35	G,All	F,H	Lewis 1937
	E U.S.	17.0	1926-65	Col,All	F,Im	Nisbet 1978
	New England	18.7	1930-65	G,In	F	Buckley & Buckley 1984
		2.0	1965-77	G,Late	F	
	England/Wales	15.0	1880-1930	G,In	E,F	Parslow 1967
		1.4	1930-56	G,Late	E,F	
	Funk I	17.1	1956-80	G,All	E,F	Kirkham & Montevecchi 1982
	Isles of Scilly	1.5	1930-66	G,Late	E,F	
	SW Norway	1.7	1950-79	G	F	Toft 1983
L. occidentalis	Alcatraz I	7.7	1982-88	G,Late	F	Boarman 1989
	Santa Barbara I	19.0	1980-84	G	F,Im	Ainley & Hunt 1990
L. ridibundus	Lk Tasserssuaq	52.0	1971-80	Col,In		Evans 1984a
	England/Wales	11.2	1938-58	G	E,F	Parslow 1967
	Lancashire	8.3	1969-86	G		Lloyd et al 1991
Rissa tridactyla	Berlengas I	20.1	1975-81	Col,In		Barcena et al. 1984
	E Canada	15.7	1970-83	Col,All	F	Lock 1987
	Germany	30.0	1952-62	G,In	F	Evans 1984b
		19.5	1972-82	G,Late		
	Great Britain	3.5	1900-69	G,All	E,F	Coulson 1983
		1.0	1969-79	G,Late	E,F	
	Shetland Island	7.2	1977-83	G		Heubeck et al 1986
	Humberside	6.4	1969-86	G		Lloyd et al 1991
	SW Norway	7.4	1950-79	G		Toft 1983
		8.6	1956-79	G,All		Munkejord & Folkedal 1981
	Kjor	38.9	1956-63	G,In		
	Urter	28.7	1973-80	Col,In		
	W Greenland	9.0	1965-74	G	F	Evans 1984a
TERNS						
Sterna albifrons	Long I	14	1924-72	Rec,All	E,Im	Nisbet 1973
	Loir/Allier Val	1.5	1905-80	G		Evans 1984b
	Massachusetts	10.2	1923-50	Rec,All	E,Im	Nisbet 1973
St. arctica		5.5	1890-1946	Rec,All	E	
St. caspia	E Canada	3.4	1925-35	G,All	H	Lewis 1937
	Lk Huron/Mich	4.0	1960-65	G,All	F	Ludwig 1966
	Lk Huron	2.6	1980-87	G,Late	F	Bloekpol & Scharf 1990
	Lk Michigan	3.8	1976-87	G,Late		
	Lk Ontario	28.7	1976-87	G,Mid		

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Table 1 Continued

	Pacific US	2.6	1960-80	G		Gill & Mewaldt 1983
St. dougalli	Massachusetts	1.4	1872-1938	Rec,All	E	Nisbet 1973
St. hirundo	Massachusetts	4.0	1885-1920	Rec,All	E	Nisbet 1973
	Great Lakes	2.3	1900-60	Rec,All	E	Bloekpol & Scharf 1990
	Maine	4.3	1900-40	Rec,All	E	Nisbet 1973
	Shetland I	6.1	1969-86	G		Lloyd et al 1991
St. sandvicensis	Angholmarna	14.0	1945-76			Mathiasson 1980
	Foteviken	30.7	1939-52			
	Maklappen	20.4	1912-38	Rec,All	E,Im	
	SE Britain	3.2	1920-64	G	E	Parslow 1967
St. paradisaea	Shetland	6.1	1969-86	G		Lloyd et al 1991
	Krunnit Is	9.1	1963-73	Rec	D	Helle et al 1988
St. paradisaēa hirundo	German Wadden Sea	5.7	1968-82	Rec,In	P	Becker 1991
ALCIDS						
Alca torda	Hornoy	9.0	1967-80	G		Barrett & Vader 1984
	Orkney Is	7.6	1976-85	G		Benn et al 1987
Cepphus grylle	E Canada	10.1	1925-35	Rec,All	H	Lewis 1937
	New England	6.8	1931-45	G		Drury 1973/4
	SW Norway	0.9	1950-79	G		Toft 1983
Cerorhinca monocerata	Cleland I	19.2	1967-88	Col,All		Rodway 1990
	Farallon I	56.4	1972-82	Rec,All	P,E,Im	Ainley & Boekelheide 1990
Fratercula arctica	E Canada	2.6	1925-35	Rec,All	H	Lewis 1937
	Mantinicus Rk	4.7	1937-77	Rec,All		Buckley & Buckley 1984
	Hornoy	30.3	1967-80	G		Barrett & Vader 1984
	SW Norway	1.8	1950-79	G		Toft 1983
	Farne I	12.2	1969-75	G		Harris 1983
	NE Britain	9.1	1969-1979	G		Harris 1983
	Isle of May	19.0	1973-81	G Im		Harris 1991
F. cirrhata	Farallon I	6.4	1971-82	Rec,All	P	Ainley & Boekelheide 1990
Ptychoramphus aleuticus	Farallon I	5.0	1870-1920	Rec,All	F	Ainley & Lewis 1972
Uria aalge	E Canada	5.4	1925-35	Rec,All	H	Lewis 1937
	Funk I	10.8	1936-1972	Rec,All	E	Kirkham & Montevecchi 1982
	Farallon I	7.9	1972-82	Rec,All	E	Ainley & Boekelheide 1990
	Hornoy	36.4	1974-82	G		Barrett & Vader 1984
	Humberside	7.0	1972-76	G		Stowe 1982
	Isle of Canna	c.13	1973-82	G		Swann & Ramsey 1983
	Skomer I	6.6	1977-88	Rec,All		Hatchwell & Birkhead 1991
	Farne I	13.0	1970-85	G		Harris 1991
DUCKS						
Somateria mollisima	Baltic	10.3	1969-81	G	E,F	Stjernberg 1982
	New England	15.2	1949-72	G		Drury 1973/4
	E. Canada	5.7	1925-35	G	E,H	Lewis 1937
	Great Britain	3.9	1958-82	Rec	E	Coulson 1984
	Scania	5.1	1947-76	Rec	E,H	Mathiasson 1980
	Netherlands	14.8	1968-76	Rec	P	Camphuysen 1989
Histrionicus histrionicus	E U.S.	23.7		G,All	H,Im	Vickery 1988

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Table 1 Continued

OSPREY/EAGLES						
Pandion haliaetus	New England	c. 9	1976-81	Rec	P	Spitzer et al. 1985
OYSTERCATCHERS						
Haematopus stralegus	Rottumeroog, NL	7.5	1960-88	Rec,All	P	Nolet, 1988
	Germany	5	14 yrs	G		Schnakenwinkel, 1970

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Table 2. Comparison of Life History Traits and Population Growth Rates

	Life History Traits			Growth Rates (%)		
	Fecundity (Annual)	Age of First Breeding	Adult Survival (%)	Median	Upper Quartile	N=Number Studies
Penguins						
Aptenodytes spp.	1	3-4	82-95	9	11	15
Other penguins	1.7-2	2.5	c.85	7	12	56
Adelie				5	9	33
non-Adelie				11	16	23
Grebes				(4)		1
Albatrosses	1	7-9	92-96	7	12	11
Petrels & Shearwaters	1	4-6	90-96	7	12	11
Pelicans	3	2	c.80	19	24	5
Gannets & Boobies	1	4	c.94	8	10	23
Cormorants & Shags	3	2	c.83	10	21	39
Skuas	2	3-4	78-94	8	9	9
Gulls						
Larus argentatus	2.4-3	3-4	91-93	9	12	23
Other Larus	2.5-2.9	2-4	80-87	11	19	53
non-Larus spp.	2	3	87	9	20	13
Terns	3	2	c.91	4	10	22
Auks	1-1.8	3	83-96	9	13	23
Seaducks	8-10	1-2	54-72	10	15	5
Eagles/Osprey	2.9	3	85	(9)	-	1
Oystercatchers	4	4	87-91	6	-	2

Table 3. Literature Review: Marine Birds

Species	Population Growth Rate (%) Projected	Observed	Reference
Northern Fulmar	7	6	Ollason & Dunner, 1978
Cory's Shearwater	1.2	0.0	Mougin et al. 1987
European Shag	11.0	11.0	Potts et al. 1980
Great Skua	8.9	7	Furness 1978
Arctic Skua	4.0	3.7	O'Donald & Davis, 1975
Herring Gull	11-12	10-11	Harris 1970
Herring Gull	4.7-6.5	9.2	Kadlec & Drury, 1968
Herring Gull	9.5	24.4	Brown 1976
Herring Gull	5	5	Samuels & Ladino, 1983
Glaucous-winged Gull	5.1	2-6	Reid, 1988
Black-legged Kittiwake	4.7-14.9	14.6	Kosinski & Podolsky, 1979
Black-legged Kittiwake	4	4	Porter & Coulson 1982
Common Tern	3	5-6	Samuels & Ladino, 1983
Atlantic Puffin	9-14	19-22	Harris 1983
Common Murre	1-6.6	6.6	Hatchwell & Birkhead 1991
Common Murre	8	8-10	Nur & Ainley, unpublished

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Comprehensive Review and Critical Synthesis of the Literature Regarding Recovery of Marine Bird Populations from Environmental Perturbations

Annotated Bibliography

March 1992

Point Reyes Bird Observatory
4990 Shoreline Highway
Stinson Beach, CA 94970

Co-Principal Investigators: Dr. Nadav Nur and Dr. David G. Ainley

Introduction

The following is an annotated bibliography pertaining to the literature on the recovery of marine bird populations from environmental perturbations, as requested by Cooperative Agreement (Coop-91-039) between Alaska Department of Fish and Game and Point Reyes Bird Observatory. The bibliography complements the report, Comprehensive Review and Critical Synthesis of the Literature on Recovery of Marine Bird Populations from Environmental Perturbations.

The bibliography consists of citation, address of the principal author, and annotation. The annotation does not constitute simply a summary of the article or paper, but instead attempts to abstract key or relevant information from the citation. It is our hope that the annotated bibliography will provide a useful research tool in and of itself. As discussed in the accompanying report, our literature review has been broad, including not only papers that deal specifically with recovery of marine bird populations from environmental perturbation, but also papers that provide insight into the demographic abilities of marine bird populations to respond to environmental perturbation. Accordingly, papers reporting observed growth rates of marine bird populations have been included (whether or not this growth represented a recovery) as well as papers reporting key demographic parameters enabling one to calculate intrinsic growth rates of a population. As a rule, papers reporting only fecundity or reproductive success (with regard to demographic parameters) are not included since this information is usually readily available. In addition to annotated references we also include references without annotation for papers that we could not obtain in a timely fashion. We thought it would be useful to present these unannotated references for the benefit of future studies that might wish to consult these references.

We wish to acknowledge Dr. Joseph Jehl, Jr, Dr. Eric Woehler, and the Alaska Department of Fish & Game for help in obtaining references as well as Bertha Rains for help in inputting bibliographic data, Karen Hamilton for managing and supervising the bibliographic data base, and Patrice Daley for word-processing.

Aebischer, N.J. (1986). Retrospective investigation of an ecological disaster in the shag, *Phalacrocorax aristotelis:* a general method based on long-term marking. *Journal of Animal Ecology* 55:613-629.

Zoology Department, University of Durham, South Road, Durham DH1 3LE

Provides a retrospective examination of colony dynamics following a catastrophe using demographic simulations and data from banded birds. Breeding population of European shags on Isle of May crashed by 54% between 1974 and 1976 (1076 to 497 pairs). During 1962 to 1974 population had been increasing by 15.6 (SE 0.9)% per year; that rate of increase returned during 1977-83. Adult annual mortality remained unchanged, emigration and immigration were negligible. Crash due to extensive non-breeding by experienced adults. Simulation showed 0-30% among age classes non-breeding in 1974, 25-60% in 1975 and 1976. Natural or anthropogenic toxics not involved. Egg laying abnormally late in 1974-76 and breeding success dropped from 1.16 to 0.77 fledglings per pair. First year survival rate dropped from 56% to 17%. Failure of the food supply was probably the main reason for poor breeding; climate and food abundance accounted independently for 68% of annual variation in laying date. Laying date correlated significantly with abundance of 2 yr herring, the abundance of which was low in 1974-76.

Ainley, D.G. and R.J. Boekelheide (1990). *Seabirds of the Farallon Islands: Ecology, Structure, and Dynamics of an Upwelling System Community.* Stanford, California: Stanford University Press.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, California 94970.

Documents changes in population size for various species nesting on the Farallon Islands, California, 1971-1986. Brandt's Cormorant numbers fluctuated widely but showed an overall downward trend owing to increased frequency of food-poor years. Double-crested Cormorants increased steadily from about 35 nests in 1972 to 230 in 1982 (20.7% per year), they then suffered a large decrease, followed by recovery at a still higher rate over the next three years (70% per year). Pelagic Cormorant numbers fluctuated but during the period 1976 to 1981 they increased at a rate of 16.3% per year; they then decreased. In one study plot the number of breeding Common Murres, 1972-1982, increased at an annual rate of 7.9%. The Rhinoceros Auklet population increased from 2 pair in 1972 to 175 by 1982 (56.4% per year), it then decreased substantially, but in 1984 it began to recover again at a similar rate. Similar trends were shown by Tufted Puffins, which increased at a rate of 6.4% per year. Immigration is certainly involved to account for the high rates of increase exhibited by Double-crested Cormorants and Rhinoceros Auklets.

Ainley, D.G. and D.P. DeMaster (1980). Survival and mortality in a population of Adelie Penguins. *Ecology* **6(3)**:522-530.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

The authors construct a life table for Adelie Penguins at Cape Crozier, Antarctica, and for Yellow-eyed Penguins at Otago, New Zealand, providing data on sex-specific age of first breeding, proportion breeding, breeding success, and survivorship. Adelie population stable; that of Yellow-eyed Penguins was increasing (see Richdale 1957). Survivorship of Adelies affected negatively by breeding as a result of predation; much more so than for Yellow-eyed Penguins.

Ainley, D.G. and G.L. Hunt (1990). Status and conservation of seabirds in California, **In:** *Seabird Status and Conservation: a Supplement* (J.P. Croxall, ed.) pp. 103-114. ICBP Tech. Publ. No. 11. Cambridge, England: International Council for Bird Preservation.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

Documents recent changes in the populations of several seabird species. During the period 1984-1987 the number of Brown Pelicans breeding in California jumped from 3000 to 7000 pr (32.6% growth per year), then fell back to 3000 pr, as a result of emigration in turn responding to an increase in sardine populations. The Western Gull population on Santa Barbara Island fell from 1510 pair in 1972 to 500 pair in about 1980 (8.3% decline per year), then jumped to 1044 pr in 1984; the increase was due to a mass immigration responding to increased food availability during 1982-83. Immigration has resulted in an increase of California Gulls in San Francisco Bay from 12 pr in 1980 to 2381 pr in 1989 (80% per year!). Trends in the small populations of Marbled Murrelets and Least Terns are not known, though appear to be stable, and the population of the Common Murre in central California has decreased during the 1980s owing to gill net mortality.

Ainley, D.G. and T.J. Lewis (1974). The history of Farallon Island marine bird populations, 1854-1972. *Condor* **76(4)**:432-446.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

Provides information on population trends for seabird populations nesting on the Farallon Islands, California, 1854-1972. Populations decreased until about 1910-20 for all species (Brandt's, Double-crested and Pelagic Cormorants, Western Gull, Common Murre, Pigeon Guillemot and Tufted Puffin) except Cassin's Auklet. The latter increased at a rate of about 5% per year between 1870 and 1920. Beginning some time after 1920, all populations that had decreased began to increase except for the puffin and the Double-crested Cormorant; rates of change are not known, though are in the range of 4% per year if they increased over the entire span 1920-1972. The murre population increased by about 10% per year from the mid-1960s on. Reduced food supply may have negatively affected recovery rate in the puffin and cormorant. Increased food supply likely affected the population change in the auklet.

Ainley, D.G. and S.R. Sanders (1988). *The status of seabirds in the Arthur Harbor/Biscoe Bay area, 1987-88.* Final Report National Science Foundation, Washington D.C.: Division of Polar Programs.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

The authors reviewed the status of 11 seabird species nesting near Palmer Station, Antarctica. Most populations had remained stable over the previous two decades. Over a 14-year period, 1973-1987, the breeding population of Blue-eyed Shags had increased 9.7 fold (17.6% per year). Over a 13-year period, 1974-1987, the breeding population of South Polar Skuas had increased 2.6 fold (7.6% per year). The reasons for the increases were not known.

Ainley, D.G., R.E. LeResche and W.J.L. Sladen (1983). *Breeding Biology of the Adelie Penguin.* Berkeley: University of California Press. 240p.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

Calculates demographic parameters for a population of Adelie Penguins at Cape Crozier, Antarctica, updating the information in Ainley & DeMaster (1980). The population was declining at a rate of about 3% per year over a ten-year period, 1964-74. Decline was likely a result of changes in survivorship due to severe sea ice conditions.

Ainley, D.G., C.A. Ribic and R.C. Wood (1990). A demographic study of the South Polar Skua *Catharacta maccormicki* at Cape Crozier. *Journal of Animal Ecology* **59(1)**:1-20.

Point Reyes Bird Observatory, 4990 Shoreline Hwy., Stinson Beach, CA 94970

The study estimates demographic parameters and population growth rate for South Polar Skuas at Cape Crozier, Antarctica, 1961-1983. Nesting success low due to storms, except during a few seasons; survivorship exceedingly high. The growth rate of the Crozier banded population is slightly negative (-3%). Total population size, however, is stable and is sustained by immigrants.

Amlaner, C.J., Jr., J.L. Hayward, Jr., E.R. Schwab III, and J.F. Stout (1977). Increases in a population of nesting Glaucous-winged Gulls disturbed by humans. *Murrelet* **58(1)**:18-20.

Details growth in the size of the Glaucous-winged Gull population on Colville Island, Washington, 1963-1975. The population increased by 42%, or 3.0% per year, during the 12 years.

Anderson, D.W. and I.T. Anderson. MS. *Dispersion and Population Trend of Brown Pelicans and Heermann's Gulls off the Pacific Coast.*

U.S. Bureau of Sport Fisheries and Wildlife, P.O. Box C, Davis, California 95616

Brown Pelican numbers decreased but Hermann's Gull numbers were stable with year to year fluctuation during the period 1949-1972, on the basis of records from Audubon Field Notes.

Anderson, D.W. and I.T. Anderson (1976). Distribution and status of Brown Pelicans in the California Current. *American Birds* **30(1)**:3-12.

Tracked trends in populations of Brown Pelicans in Southern California from the turn of the century until 1974, with best data from 1949 on. Over the entire period, 1949-74, populations decreased on average about 4% per year but from 1969-74 the decrease was 11% per year. Superimposed on the long-term trend were fluctuations of increase and decrease related to fluctuations in the availability of prey fish. The variability in population trend was a function of breeding success, though the breeding population was partly sustained by immigrants from colonies farther south. Besides prey availability, organochlorine pollution reduced fecundity.

Anderson, D.W. and F. Gress (1983). Status of a northern population of California Brown Pelicans. *Condor* **85**:79-88.

Dept. of Wildlife and Fisheries Biology, Univ. of California, Davis, CA 95616.

Reviewed the status and certain demographic parameters for Brown Pelicans at Anacapa and Coronado islands and for Double-crested Cormorants at Anacapa, 1969-1980. Reproduction began to improve in 1974 following a long period of reduced success and declining populations owing to DDT contamination. A 37% and 25% annual rate of increase in pelican (247 to 2244 pr) and cormorant (16 to 78 pr) numbers, respectively, at Anacapa, from a low in 1973 to 1980, and a 24% rate for pelicans at Coronado from 1971 to 1980 (110 to 758) can not be explained entirely by improved fledging success. The authors suggest that immigration, in response to improved food supply, by both adults and young from colonies farther south is important.

Anderson, D.W., et.al. (1975). Brown Pelicans: improved reproduction off the southern California coast. *Science* **190**:806-808.

U.S. Fish & Wildlife Service, P.O. Box C, Davis, California 95616.

Between the years 1969 and 1974, reproduction by Brown Pelicans in Southern California increased from 0.004 to 0.922 young fledged per nest.

Anonymous (1980). Recovery scheduled for California Least Tern, blunt-nosed leopard lizard. *Endangered Species Technical Bulletin* **5(5)**:3-5.

Armstrong, I.H., J.C. Coulson, P. Hawkey and M.J. Hudson (1978). Further mass seabird deaths from paralytic shellfish poisoning. *British Birds* **71**:58-68.

Reviewed trends in a population of European Shags on the Farne Islands, England, 1930-1977. The island was originally colonized in about 1925. Between 1930 and 1965, the population increased an average 11% per year. Numbers decreased slightly in 1966, following a winter of increased adult mortality. Red tide in 1968 caused dramatic decrease, from about 370 to 50 birds. Aided by the young of 1969 & 1970, and immigrants from the Firth of Forth, a rapid increase followed, but stopped in 1971 and 1972 when few recruits were available. By 1974, the population reached the 1966 level. Thus, the increase between 1968 and 1974 was 40% per year, and again was due to reservoir of immatures and immigration. Red tides are likely a recent phenomenon.

Ashcroft, R.E. (1979). Survival rates and breeding biology of puffins on Skomer Island, Wales. *Ornis Scandinavica* **10**:100-110.

Population of Atlantic Puffins on Skomer Island (Wales) decreased by 3.5% per year from 1920 to 1960, and declined by a slightly lower rate thereafter to 1977. Paper presented demographic variables. Trends are due to large scale emigration or lower adult survival owing to deterioration of the amount of food available.

Bailey, E.P. and G.H. Davenport (1972). Die-off of Common Murres on the Alaska peninsula and Unimak Island. *Condor* **74**:215-219.

Aleutian Islands National Wildlife Refuge, Pouch #2, Cold Bay, Alaska 99571

Baillie, S.R. and C.J. Mead (1982). The effect of severe oil pollution during the winter of 1980-81 on British and Irish auks. *Ringing and Migration* **4**:33-44.

Large numbers of Common Murres and Razorbills were recovered oiled in winter 1980/81, some in the Skagerrak, but others due to chronic pollution. The authors compare recoveries of murres and Razorbills in 1980/81 with recoveries for the previous 12 years. First-year murres were especially hit by oiling in 1980/81, and immature murres as well; among Razorbills, it was adults who were most affected. The authors use simple population models to predict that oiling of Common Murres, as observed in winter 1980/81 would result in minor loss in number of breeding birds (for total British population) in 1981-1984, but would amount to 6% to 9% drop in breeding population in 1985 when the 1980 cohort would be recruiting. For Razorbills, a loss in breeding numbers of 3 to 6% would result, with the greatest impact in 1981. However, there are regional differences: in the Orkney and Shetland islands losses were greater and therefore we expect murre breeding numbers would be reduced more than 6 to 9%.

Baker, J.M., R.B. Clark, P.F. Kingston, and R.H. Jenkins (1990). *Natural Recovery of Cold Water Marine Environments after an Oil Spill.* Presented at the 13th Annual Arctic and Marine Oilspill Program Technical Seminar. Arctic and Marine Oilspill Program.

Consultant, Shrewsbury, England.

Reviews recovery of cold water marine ecosystems from oil spills, with emphasis on North Sea. Literature on birds is briefly reviewed. Conclude that oil spills have little long-term impact on seabird populations.

Barcena, F., A.M. Teixeira and A. Bermejo (1984). Breeding seabird populations in the Atlantic sector of the Iberian Peninsula. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 335-345. ICBP Tech. Publ. No. 2. Cambridge; England: International Council for Bird Population.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. The Herring Gull population at Sisargas Island increased from about 830 pair in 1948 to 4338 pair in 1981 (5.1% per year) and that at Berlengas Island increased from 1000 pair in 1939 to 3750 pair in 1981 (3.2% per year). The Black-legged Kittiwake population on Sisargas Island increased from 50 pair in 1975 to 150 pair by 1981 (20.1% per year). The population of Lesser

Black-backed Gulls at two colonies increased from 2 pair in 1973 to 201 pair by 1981 (77.8% per year); before 1973 the species did not nest in Iberia. Auk populations have been decreasing.

Barrat, A., H. Barre and J.L. Mougin (1976). Donnees Cologiques sur les Grands Albatros *Diomedea exulans* de l'ile de la possession (Archipel Crozet). *L'Oiseau et R.F.O.* **46**(2):43-155.

Equipe de Rech. de Biologie Animale Antarctique, Mus. Natl. d'Histoire Naturelle, Lab. de Zool. 55, rue de Buffon 75005 Paris

Presents demographic data on Wandering Albatross *Diomedea exulans*, i.e. age-specific survival and age of first breeding.

Barrett, R.T. and W. Vader (1984). The status and conservation of breeding seabirds in Norway. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 323-333. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. On Hornoy, northern Norway, numbers of Atlantic Puffins and Razorbills increased from 160 and 65 pairs, respectively, in 1967 to about 5000 and 200 pair in 1980 (30.3% and 9.0% growth per year). Common Murres increased from 500 pair in 1974 to c. 6000 pair in 1982 (36.4% per year). Among these species, populations elsewhere appear to be declining or stable. The population of Northern Fulmars on Runde, first established in the early 1900s, rose from 350 pair in 1947 to 2000 pair in 1981 (5.3% per year); small populations elsewhere in Norway have also been increasing. The Northern Gannets at five colonies, first established between 1947 and 1975, increased from 415 pair in 1969 to 1830 pair in 1982 (12.1% per year overall); the oldest colony increased by 7.5% per year whereas two new ones increased by 18.3 and 38.4% per year; one small colony disappeared between 1974 and 1979 but another appeared nearby during that time.

Becker, P.H. (1991). Population and contamination studies in coastal birds: the Common Tern *Sterna hirundo*. **In**: *Bird Population Studies*. (C.M. Perrins, et al. eds.) Oxford: Oxford University Press.

Review of effects of toxic chemicals on bird populations in the Wadden Sea (principally, Germany), with emphasis on the value of coastal breeding birds as indicators of contamination and on obstacles to the conduct of long-term monitoring. In Wadden Sea, seabirds (especially Common Eiders and Common Terns) declined in the 1950's and 1960's due to toxic chemicals, e.g. Common and

Arctic Terns (species not differentiated) on the German Wadden sea coast declined from an average of 20 - 21,000 pairs in early 1950's to 5 - 6,000 in 1967 and '68 (soon after production of telodrin ceased), but recovered to 12,000 in 1980 - '82, a growth rate of 5.7% per year. Herring Gulls showed a minor decline (from 20,000 pairs to 16,000 from 1964 to 1966), but then grew to 42,000 in 1982 - 1986, a growth rate of 6.2% per year (between 1966 and 1982). In recent years, most seabird numbers on Wadden sea coast have increased reflecting improvements in food supply (e.g. from eutrophication) and increased protection. Becker makes the case that to adequately monitor seabirds, etc., it is not enough to monitor population size because: 1) it is difficult to obtain accurate counts, 2) population size is not a sensitive indicator nor a good predictor of future problems, unlike reproductive output, 3) total population size may reflect immigration and emigration, and 4) population size shows lag in response time, unlike reproductive output.

Benn, S., M.L. Tasker and A. Reid. (1987). Changes in numbers of cliff-nesting seabirds in Orkney, 1976-1985. *Seabird* **10**:51-57.

Monitored five colonies on Orkney Islands 1976-1985. Razorbills and Common Murres both showed an increase of 7.6% per year from 1976 to 1981. Northern Fulmars had a minor increase in number and kittiwakes a decrease. All species except fulmar declined 1981-1985.

Bergman, G. (1982). Population dynamics, colony formation and competition in *Larus argentatus, fuscus* and *marinus* in the archipelago of Finland. *Annales Zoologici Fennici* **19(3)**:143-164.

Zoological Museum of the University, N Jarnvagsgatan 13, SF-00100 Helsinki 10, Finland

Provides a detailed description of population dynamics and its influences in three gull species, Herring, Lesser Black-backed and Greater Black-backed in the archipelago of S Finland from 1930 to 1982. The two larger gull species were sparse until 1930 (Herring) and 1940 (Greater Black-backed), respectively, when changes in fishing industry and urbanization promoted their spread. Historical levels of large gulls were low in the Baltic because the Baltic Sea is unproductive, also waterfowl numbers were kept low (due to hunting) and gull eggs were collected. All species especially Lesser Black-backed originally bred in single pairs or very small colonies, but now breed in large colonies. Bergman discusses the degree of sociality (single vs. colonial breeders) for each species, as well as food availability and interspecific competition. Lesser Black-backed grew from 1935-1960 but have declined since, while Herring Gulls have continuously grown (in SW Finland, growth was from 300 pairs in 1943 to 6500 in 1980, a growth rate of 8.7% per year). Growth rates of Herring and Greater Black-backed gulls are very dependent on effects of man (fishing industry, garbage dumps). For Herring gulls it is likely that population has gone from being food-limited during winter (starvation is high then) to breeding-season limited. Greater Black-backed gulls have increased from c. 50 to 400 pairs (mid '30's to 1980), an increase of 4.5% per year.

Birkhead, T.R. (1974). Movement and mortality rates of British Guillemots. *Bird Study* **21**:241-253.

Edward Grey Institute, Department of Zoology, South Parks Road, Oxford, OX1 3PS United Kingdom

Presents important demographic data on British Common Murres, derived from band recovery studies. Young disperse more than adults; no evidence of clearly defined migratory movement. Many recoveries could be attributed to shooting, but just as many were due to oiling. Concludes that adult survival is 93.7%; previous work which yielded an estimate of 87% was biased.

Birkhead, T.R. (1976). Breeding biology and survival of Guillemots (*Uria aalge).* PhD Thesis, Oxford University.

Birkhead, T.R. (1977). The effect of habitat and density on breeding success in the Common Guillemot (*Uria aalge). Journal of Animal Ecology* **46**:751-764.

Edward Grey Institute, Department of Zoology, Oxford, OX1 3PS United Kingdom

A study of the Skomer (Wales) Common Murre population. Both habitat and density influence reproductive success. At higher density, and with greater degree of synchrony among nests, reproductive success is higher, due to better deterrance of gull predation. Contrast with European Shag, where depopulation allowed young birds to acquire good breeding territories and hence high reproductive success. These results have important implications for population regulation and growth: 1) populations at low density are more likely to go extinct, 2) no evidence for population regulation by means of density-dependence. New breeding sites are added at margins of existing ones.

Birkhead, T.R. (1980). *Census Methods for Murres, Uria Species: a Unified Approach.* Occasional Papers, No.**43**. Ottawa: Canadian Wildlife Service.

Birkhead, T.R. and P.J. Hudson (1977). Population parameters for the Common Guillemot *Uria aalge. Ornis Scandinavica* 8:145-154.

Provides a synthesis of demographic data from Birkhead's study of Skomer (Wales) population of Common Murres and other sources. The most important parameter not well established is surviving to breeding age: observations of color-banded individuals indicate that 16 to 20% of chicks survive to breeding age; data from banding recoveries from a stable and an increasing population indicate 27% and 41% survival to breeding age. The Skomer population "crashed" between 1968 and 1970 (as a consequence of large "wreck" of murres in early 1969); between 1970 and 1972 there was a recovery, but only 50% of the way to a full recovery; after 1972 the population remained stable (up through 1979, as later determined), thus not regaining the former population level. The authors find little evidence for density dependent population regulation in seabirds. Skomer murres are not short of food during the breeding season; disease, predation and nest sites do not appear to be limiting factors.

Birkhead, T.R. and R.W. Furness (1985). Regulation of seabird populations. **In:** *Behavioural Ecology; Ecological Consequences of Adaptive Behaviour.* (R.M. Sibley and R.H. Smith, eds.). pp.145-167. 25th Symposium of the British Ecological Society. Oxford: Blackwell Scientific Publications.

Department of Zoology, University of Sheffield, Sheffield S10 2TN United Kingdom

Reviews evidence that seabird populations are regulated. Discusses the circumstantial evidence that colony sites are limiting. Several lines of evidence point to breeding sites being limited for some species, e.g. because some types of sites yield higher reproductive success than others and because site quality (independently assessed) declines as population density increases. Good evidence that food is a limiting resource. For example, 1) colony size varies inversely with the number of birds within 30-150 km, 2) food and reproduction are correlated for some species, and 3) fledging weight and colony size are negatively correlated for some species (work of Gaston et al., Hunt et al.). Authors demonstrate that density-dependent reproduction (as observed in the Pribiloffs) can regulate numbers. They consider demography of shags (maximum observed rate of increase 11% per annum) which could well be regulated in this way, and Northern Fulmars (maximum observed rate of increase 7% per annum), which is unlikely to be regulated in this way.

Blokpoel, H. and W.C. Scharf (1990). Status and conservation of seabirds nesting in the Great Lakes of North America. **In:** *Seabird Status and Conservation: a Supplement* (Croxall, J.P., ed.). pp. 17-41. ICBP Technical Publ. No. 11. Cambridge, Eng.: International Council for Bird Preservation.

The authors detail the present status with some information on trends for a number of species. Following reduction of pesticide pollution the population of Double-crested Cormorants increased from 200 pair in 1970 to 1400 pair in 1980 (21.5% growth rate per year) to 13,600 pair in 1987 (38.4% per year; overall, 28.2% per year). Documented the most recent census figures for Ring-billed Gulls, with annual rates of increase as follows, 1976-84: Lake Superior, 11.3%; Lake Michigan, 11.3; Lake Huron, 10.1%; Lake Erie, 19.1% and Lake Ontario, 9.5%. Increased mortality is occurring in this species, sometimes due to botulism. On Lake Ontario, the number of breeding pair of Herring Gulls increased from 519 in 1976 to 1540 in 1987 (10.4% per year). Recent rates of increase for Caspian Terns are as follows: Lake Michigan (1976-87) 3.8%, Lake Huron (1980-87) 2.6%, Lake Ontario (1976-87) 28.7%. The Common Tern population, following relaxation from persecution, increased from 4000 pair in 1900 to 16,000 by 1960 (2.3% per year), but has since declined.

Blokpoel, H. and G.D. Tessier (1986). *The Ring-billed Gull in Ontario: a review of a new problem species.* Occasional Papers, No.57. Ottawa: Canadian Wildlife Service.

Boarman, W.I. (1989). The breeding birds of Alcatraz Island: life on the rock. *Western Birds* **20**:19-24.

Documented the status and population size of birds nesting on Alcatraz in San Francisco Bay. The Western Gull population has been growing, from 224 pr in 1982 to 350 pr by 1988 (7.7% per year). Breeding by Pigeon Guillemots was first confirmed in 1981; in 1982 at least 4 burrows were occupied. The increase by gulls and the colonization by guillemots are the result of saturation of nesting localities nearby and restriction of human access to parts of Alcatraz.

Boersma, P.D., D.L. Stokes and P.M. Yorio (1990). Reproductive variability and historical change of Magellanic Penguins (Spheniscus magellanicus) at Punta Tombo, Argentina, **In:** *Penguin Biology* (L.S. Davis & J.T. Darby, eds.) San Diego: Academic Press.

School of Forestry & Environmental Studies, Yale Univ., New Haven, CT 06511.

The species has been colonizing and spreading northward along the Atlantic coast of Argentina since about the 1920s. Little quantitative data are available on population growth, which may be due to a relaxation from persecution or to a change in food supply. At Peninsula Valdes, which was colonized after 1940, the population grew from 503 nests in 1978 to 658 nests in 1987 (3.0% per year).

Bourne, W.R.P. (1972). The decline of auks in Great Britain. *Biological Conservation* **4**:144-166.

Honorary Secretary, The Seabird Group, c/o Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen, Scotland

Bourne, W.R.P. (1976). Seabirds and pollution. **In:** *Marine Pollution.* (R. Johnston, ed.) pp.403-502. London: Academic Press.

Summarizes effect of pollution (oil spills, toxic chemicals, etc.) on birds, region by region, pollutant by pollutant, species by species. Discusses at sea distribution of birds, especially auks and discusses mitigation efforts, including rehabilitation of birds. Toxic chemicals are discussed in detail. Excellent reference source. Notes that a major bird kill in the Irish Sea in 1969 (mostly Common Murres, some Razorbills) may have been mostly a result of food-failure on moulting grounds, but PCBs and organochlorine pesticides found in the birds, may have contributed to mortality.

Bourne, W.R.P. (1982). Recovery of Guillemot colonies. *Marine Pollution Bulletin* **13(12)**:435-436.

This note points out that rapid recovery of Common Murre populations on Flambourg Head, Britain resulting from 1977 spill, may have come not just from immigration but also because additional breeders recruited at younger age than usual, perhaps due to displays of birds widowed by the spill.

Boyd, H. (1962). Population dynamics and the exploitation of ducks and geese. **In:** *The Exploitation of Natural Animal Populations*, (E.D. Le Cren and M.W. Holdgate, eds). pp.85-95. Brit. Ecological Society, Symposium No.2. New York: John Wiley & Sons.

Wildfowl Trust, Slimbridge, Goucestershire, United Kingdom

Little information on population dynamics, but some demographic parameters, especially adult survival of sea ducks are presented, including information on fecundity and offspring survival of diving ducks, including Greater and Lesser Scaup (*Aythya marila* and *A. affinis*).

Bradley, J.S., R.D. Wooller, I.J. Skira, and D.L. Serventy (1989). Age-dependent survival of breeding Short-tailed Shearwaters *Puffinus tenuirostris. Journal of Animal Ecology* **58**:175-188.

Biological Sciences, Murdoch University, Western Australia 6150

Presents evidence for age-specific survival of adults in Short-tailed Shearwaters, from long-term study on Fisher islands. Survival in the first 21 years following first breeding is nearly constant with age; after that age, survival declines. This study is of great demographic value, combined with other analyses on this population (Wooller et al 1989, Wooller et al 1990).

Brown, R.G.B. (1976). Breeding success and population growth in a colony of Herring and Lesser Black-backed Gulls *Larus argentatus* and *L. fuscus*. *Ibis* **109**:502-515.

Canadian Wildlife Service, Marine Ecology Lab., Bedford Institute of Oceanography, Dartmouth, N.S.

Herring and Lesser Black-backed Gulls grew rapidly on Walney Island. Earlier workers estimated that numbers grew from 235 pairs to 700 from 1934 to 1950 (7.1 % growth per year), species not differentiated; but with 12,000 pairs in 1957 and 18 - 19,000 in 1965. Since the 1950, 1957 and 1965 involved three different estimates and at least two different methods, these estimates may be too shaky to make inferences about population growth rate. If we do so anyway, the population of the two species grew at 50.1% per year between 1950 and 1957 and at 5.5% per year between 1957 and 1965. Using ringing data Brown calculates that intrinsic rate of increase would be 9.5%; at that rate 700 pairs of gulls would have been 2700 15 years later, not 18,000. Immigration is thus implicated. Discusses importance of behavioral factors and availability of garbage in population regulation and growth.

Brown, R.G.B., D.I. Gillespie, A.R. Lock, P.A. Pearce and G.H. Watson (1973). Bird mortality from oil slicks off eastern Canada, February - April 1970. *Canadian Field-Naturalist* **87(3)**:225-234.

Canadian Wildlife Service, Marine Ecology Lab., Bedford Institute of Oceanography, Dartmouth, N.S.

Though only 1,500 known dead seabirds resulted from wrecks of two oil vessels in February 1970, a large number of Common Eider in the oiled area behaved abnormally, indicating that at least 4,000 eider were affected by the spill. Mortality of eider was also nearly entirely adult and overwhelmingly male (in 5:1 ratio of males to females), which may have resulted in unmated females that season.

Brown, R.G.B. and D.N. Nettleship (1984). The seabirds of northeastern North America: their present status and conservation requirements. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 85-100. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species. The gannet colony on St. Bonaventure increased from c. 4000 pair in 1919 to 21,215 in 1966 (3.6% per year), due to relaxation from persecution, but then fell to 16,400 by 1976, due to pollution and disturbance. Reviewed changes in other species that have been treated by Drury (1973, 1974).

Brun, E. (1979). Present status and trends in population of seabirds in Norway. **In:** *Conservation of Marine Birds of Northern North America.* (J.C. Bartonek & D.N. Nettleship, eds.) pp.289-301. Wildlife Research Report, 11. Washington, D.C.: U.S. Fish & Wildlife Service.

University of Tromso, Tromso, Norway.

Reports increase of Black-legged Kittiwakes of 1% per year in northern Norway during recent years; rate is higher at more southern colonies. The population of Northern Fulmars on Runde increased from 350 pair in 1947 to 700 pair in 1970 (3.1% per year), having colonized the island in the 1920s. The Northern Gannet population increased as follows, 1969-74: Runde 8.4% per year, Mosken 5.4%, Nordmjele 83.3%, and Syltefjord 14.5%; Nordmjele was augmented by immigration with one bird banded in Britain; the highest rates of increase occurred at the most recently founded colonies.

Buckley, P.A. and G.G. Buckley (1984). Seabirds of the north and middle Atlantic coast of the United States: their status and conservation, **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 101-134. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. Following cessation of hunting, the population of Double-crested Cormorants in Maine increased from 1200 pair in 1934 to 13,000 by 1945 (24.2% per year), but a depredation program then caused a decline. The population of Laughing Gulls increased in New England through the 1940s but then started to decrease. The species colonized Jamaica Bay, NY, in 1979 (15 pair), and then the population increased rapidly to 2802 pair in 1984 (84.6% per year). Documented the spread of Great Black-backed Gulls in the northeast; the population grew from 30 pair in 1930 to 12,000 by 1965 (Drury 1973-74; 18.7% per year) and 15,300 by 1977 (2.0% per year). Atlantic Puffins on Matinicus Rock grew from 20 pair in 1937 to 125 in 1977 (4.7% per year).

Budd, G.M. (1974). The King Penguin *Aptenodytes patagonica* at Heard Island. **In:** *The Biology of Penguins* (B., Stonehouse, ed.), pp. 337-352. London: Macmillan.

Documented changes in the numbers of penguins breeding at two colonies. One at Spit Bay increased from 37 pair in 1963 to 123 pair in 1969 (22.2% per year); and one at Vahsel Moraine, a new colony, increased from 6 pair in 1963 to 38 pair in 1971 (26.0%). Numbers at both colonies were swelled by immigrants. Provided details of a few other colonies that were formed at nearby sites during the 1963-71 period; breeding did not commence at these until adults had frequented them for several years. The increase might be caused by a relaxation from persecution.

Camphuysen, C.J. (1989). *Beached birds in the Netherlands, 1972-1988.* Stichting Werkgroep Nordzee.

Vossiusstraat 20-III, 1071 AD Amsterdam, Netherlands.

Reviews seventeen years of research and survey (especially Dutch beached bird survey), 1969 to 1985, on the occurrence of seabirds on Netherlands tideline. Emphasis is on effect of oil pollution on seabird mortality, but other causes of mortality are considered. A chronological list is presented of shipping accidents leading to seabird mortality and of seabird wrecks (large numbers of seabirds killed by oil or other factors). For each species or species group, information is summarized on breeding distribution, breeding numbers and trends, occurrence in Dutch waters, and results of beached bird surveys going back to 1915. Great Crested Grebes in the Netherlands increased from 3550 pairs to 7250 pairs, from 1966/67 to 1983, a growth rate of 4.4% per year. The reason for this increase is not known, though in the 19th century they were killed for their plumage. Common Eiders crashed after pollution from hydrocarbons in the Rhine River: the population dropped to 1,300 pairs in 1965 and 1968, but by 1976 there were 4,000 pairs (a growth rate of 14.8% per year) and in 1987 5-7,000 pairs. Between 1962 and 1988 there have been eight oiling incidents in which over a thousand scoters (Common and Velvet) have been recovered (in one case over 10,000); these are summarized in a Table. Follow-up of these incidents is recommended.

Cannell, P.F. and G.D. Maddox (1983). Population change in three species of seabirds at Kent Island, New Brunswick. *Journal of Field Ornithology* **54(1)**:29-35.

Ornithology Dept., American Museum of Natural History, 79th St. and Central Park West, New York City, NY 10024.

Carrick, R. (1972). Population ecology of the Australian Black-backed Magpie, Royal Penguin and Silver Gull. **In:** *Population Ecology of Migratory Birds: Papers from a Symposium Held at the Migratory Bird Population Station, Laurel, MD, (9-10 Oct. 1969).* pp.41-99. Wildlife Research Report 2. Washington, D.C.: U.S. Fish and Wildlife Service.

University of Adelaide, Australia

Carrick, R. and S.E. Ingham. (1970). Ecology and population dynamics of Antarctic seabirds. **In:** *Antarctic Ecology*. Vol. I., (M.W. Holdgate, ed.) pp.505-525. London: Academic Press.

Carrick, R. and M.D. Murray (1964). Social factors in population regulation of the Silver Gull, *Larus novaehollandiae* Stephens. *CSIRO Wildlife Research* **9**:189-199.

Division of Wildlife Research, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia.

Chabrzyk, G. and J.C. Coulson. (1975). Survival and recruitment in the Herring Gull *Larus argentatus*. *Journal of Animal Ecology* **45**:187-203.

Department of Zoology, University of Durham

Reviews history of Herring Gulls nesting on the Isle of May 1907 to 1970 and provides demographic parameters. Constant rate of increase of 12% per year during this period; between 1950 and 1970 it was 13%. No evidence of sudden, irregular increases. Evidence elsewhere indicates 12-13% increase throughout British Isles from 1930 on (overall 12.8%). In regard to controlling gull populations, large areas should be cleared entirely otherwise immigration, which is density dependent, will sustain numbers. Any gulls allowed to remain should be confined to dense colonies.

Clapp, R.B. and P.A. Buckley (1984). Status and conservation of seabirds in the southeastern United States. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.) pp. 135-156. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. The Brown Pelican increased 10 fold from 1977 to 1983 (46.8% per year) in North Carolina. In South Carolina they increased from 3350 pair in 1978 to 6653 pair in 1982 (18.7% per year). In the Gulf states the numbers have been declining.

Clark, R.B. (1989). Marine Pollution (2nd edition). Oxford: Clarendon Press.

University of Newcastle upon Tyne

Cobley, N. (1989). Aspects of the survival of Blue-eyed Shags *Phalacrocorax atriceps King. Antarctic Special Topic*:93-96.

Department of Biological Sciences, Science Laboratories, South Road , Durham DHI 3LE, UK.

Presents demographic variables for Blue-eyed Shags at South Orkney Islands, 1960-1987. Population at one locality increased about 2% per year during the period. The other fluctuated widely but showed no overall trend. Survival rate was much higher (0.899) than for shags in Great Britain (0.83). Emigration was on the order of 8% among prebreeding individuals; 0.1% among breeders. Immigration rates were not known.

Cohen, Y. (1986). *Optimal control of waterfowl populations in North America.* **In:** Environmental Quality and Ecosystem Stability (Z. Dubinsky & Y. Steinberger, eds.) pp.95-105.

Conover, M.R. (1983). Recent changes in Ring-billed and California Gull populations in the Western United States. *Wilson Bulletin* **95(3)**:362-383.

Dept. of Ecology & Climatology, Connecticut Agricultural Experiment Station, New Haven, CT 06504.

Reviews trends in Ring-billed and California gull populations in the western U.S. from 1920s to 1980. Numbers of Ring-billed Gulls increased from 4800 to 106,000 (2100% increase; c. 6% per year) and of Ring-billed Gull colonies from 12 to 57 (375% increase). Numbers of California Gulls increased from 102,000 to 276,000 (270% increase; c. 2% per year) and of California Gull colonies from 14 to 80 (471% increase). The average number of gulls per colony increased for Ring-billed Gulls but decreased for California Gulls. Increased food availability owing to garbage dumps, as well as formation of reservoirs (new breeding sites), was responsible for the increase.

Conroy, J.W.H. (1974). Recent increases in penguin populations in Antarctica and the Subantarctic. **In:** *The Biology of Penguins* (B. Stonehouse, ed.) pp. 321-336. London: Macmillan.

Documents changes in the populations of various penguin species at a number of sites. Those species in which increases were apparent were as follows. Chinstrap Penguin at five rookeries on Deception Island that were surveyed a number of times between 1953 and 1966 increased from 12,585 pair to 134,275 pair (20.0% per year); at three rookeries on Livingston Island, surveyed between 1957 and 1966, they increased from 4,050 to 11,550 pair (14.0%). Adelie Penguins at Hope Bay increased from 50,366 pair in 1945 to 74,264 pair in 1963 (2.2%). Gentoo Penguins at three rookeries on Livingston Island increased from 1,050 pair in 1957 to 3916 pair in 1965 (17.9%); at Yankee Harbour and Harmony Point during the same period they increased from 500 and 1000 to 2129 and 1642 pair, respectively (19.9 and 6.4%).

Conroy, M.J. and R.R. Eberhardt (1983). Variation in survival and recovery rates of Ring-necked Ducks. *Journal of Wildlife Management* **47(1):**127-137.

U.S. Fish & Wildlife Service, Migratory Bird Research, Patuxent Wildlife Res. Center, Laurel, MD 20708.

Coulson, J.C. (1966). The influence of the pair-bond and age on the breeding biology of the Kittiwake Gull *Rissa tridactyla. Journal of Animal Ecology* **35:**269-279.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Provides information on age-specific breeding success of kittiwakes 1954-1966 at North Shields colony.

Coulson, J.C. (1983). The changing status of the Kittiwake *Rissa tridactyla* in the British Isles, 1969-1979. *Bird Study* **30**:9-16.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Numbers of Black-legged Kittiwakes increased at a rate of 3-4% per year from 1900 to 1969; during the next decade the overall rate of increase fell to 1% per year (2% if one exceptional colony is included). At first the increase was confined to existing colonies but after 1920 additional sites were colonized. Small colonies increased faster than large ones (expressed as proportional increase over time); rate of growth was approximately proportional to the reciprocal of the square root of original colony size. This is because small colonies are more attractive to emigrants, a phenomenon that also resulted in some colonies increasing and neighboring ones decreasing simultaneously. From 1969 to 1979, only colonies on the east coast of England and Scotland increased (4% per year). Five regions then showed decreases from -3 to - 56%. Three other regions showed decrease in the rate of population increase compared to 1959-69; these regions are all on the southern and western coasts of England and the southern coast of Ireland. Most of the decline occurred between 1973 and 1976. It is possible that food shortage has increased mortality of adults and subadults, especially during summer (if during winter, then the decrease would have been more widely spread). The Torrey Canyon oil spill in 1967 had no noticeable effect on population growth.

Coulson, J.C. (1984). The population dynamics of the Common Eider Duck *Somateria mollissima* and evidence of extensive non-breeding by adult ducks. *Ibis* **126**:525-543.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

The population of Eider Ducks increased 2.5 times over a period of 24 years, 1958-1982 (3.9% per year). No indication that fecundity or survival changed during the period, but recruitment as a result of duckling survival may have explained the increase. Non-breeding by adult ducks was prevalent, but varied in extent annually. Eiders may forgo breeding in years when their chances for survival are diminished.

Coulson, J.C. (1991). The population dynamics of culling Herring Gulls and Lesser Black-backed Gulls. **In:** Bird Population studies: *Their Relevance to Conservation and Management* (C.M. Perrins, ed.) pp.479-497. Oxford: Oxford Univ. Press.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Provides insight into how changes in population size of one colony---in this case heavy mortality due to culling---effects the dynamics of that colony and adjacent colonies. Includes review of Duncan's studies. Culling has resulted in decreases of Herring Gull numbers on a regional basis, but not of Lesser Black-backed Gulls during past 20 years. Before the cull (1972- 1987), Herring Gulls were increasing by 13% per annum during this century. Culling in certain colonies has increased the incidence of breeding by immigrants, who produce young that have a lessened tendency to by philopatric (or so it appears). Culling also drove a greater number of individuals to emigrate. With the reduced density in the original colony, the following factors changed: age of first breeding decreased, egg size increased, production of young per pair (probably) increased.

Coulson, J.C. and C.S. Thomas (1985). Changes in the biology of the Kittiwake *Rissa tridactyla:* a 31-year study of a breeding colony. *Journal of Animal Ecology* **54**:9-26.

Department of Zoology, University of Durham, South Road, Durham City DH1 3LE

As noted elsewhere, in the British Isles, population size of kittiwakes increased at a rate of 3-4% per year between 1910 and 1969. This followed a decline in the previous century caused by human exploitation. By 1979, the growth rate was 1% per year, but colony size was decreasing and only colonies on North Sea coast showed consistent growth. During the period 1954-1982, the breeding biology of this species was studied. Colony size increased from 4 in 1949 until 1965, declined through to 1977, increased again until 1981, but declined in 1982. Various factors have fluctuated throughout this period including date of return, laying date, clutch size, and hatching, fledging and breeding success. Also changing over time were survival rates and divorce rates. These various changes did not occur in concert.

Coulson, J.C. and E. White (1959). The post-fledging mortality of the Kittiwake. *Bird Study* **6(3)**:97-102.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

The authors determine survivorship of prebreeding Black-legged Kittiwakes using recoveries of birds banded as chicks. During first year,mortality is 21%, on average.

Coulson, J.C. and R.D. Wooller. (1976). Differential survival rates among breeding Kittiwake Gulls *Rissa tridactyla* (L.). *Journal of Animal Ecology* **45(1)**:205-213.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Determined survival of breeding male and female kittiwakes at the North Shields colony, 1954-1973. Survival rates reached maximum shortly after the colony was established (1954-66; 0.854, 0.903, males vs females) and then decreased (1967-74; 0.772, 0.829) during the stable phase of population growth. Authors conclude that a density relationship is at work. Survivorship was also lowest among oldest birds (8-7 y.o), though data from these birds were from the stable phase of population growth. Rates varied among years.

Coulson, J.C., G.R. Potts, I.R. Deans, and S.M. Fraser (1968). Exceptional mortality of Shags and other seabirds caused by paralytic shellfish poison. *British Birds* **61(9)**:381-404.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Coulson, J.C., N. Duncan and C. Thomas (1982). Changes in the breeding biology of the Herring Gull *Larus argentatus* induced by reduction in the size and density of the colony. *Journal of Animal Ecology* **51**:739-756.

Department of Zoology, University of Durham, South Road, Durham City, DH1 3LE

Large numbers of gulls were culled from colonies on the Isle of May between 1972 and 1981. As a result, population size has been reduced 75% but the area of occupancy has remained unchanged, hence density has decreased. As a result recruitment age has declined, egg size and body size has increased, recruitment shows annual variability unrelated to density, and the proportion of young recruiting has increased (not due to increased survival but reduced emigration).

Crawford, R.J.M. and P.A. Skelton (1978). Pelagic fish and seabird interrelationships off the coasts of Southwest and South Africa. *Biological Conservation* **14**:85-109.

Croxall, J.P. (1979). Distribution and population changes in the Wandering Albatross *Diomedea exulans* at South Georgia. *Ardea* **67**:15-21.

British Antarctic Survey, Natural Environment Research Council, Madingley Road, Cambridge, CB3 OET U.K.

The Wandering Albatross population at South Georgia decreased from the early 1960's to 1978: 19.2% over 15 years on Bird Island and 28.7% over 21 years at Bay of Isles. Egg and chick survival may have increased during this period, but adult survival and the proportion of failed breeders that renest during the next season (this is a biennially breeding species) may have decreased. Ultimate factors causing the decrease in population size are not known.

Croxall, J.P. and P. Rothery (1991). Population regulation of seabirds: implications of their demography for conservation. **In:** *Bird population studies: Their Relevance to Conservation and Management.* (C.M. Perrins, ed.) pp.272-296. Oxford: Oxford Univ. Press.

British Antarctic Survey, Natural Environment Research Council, Madingley Road, Cambridge, CB3 OET U.K.

Reviews evidence that density-independent (catastrophe) vs density-dependent (food, breeding space) factors control seabird population size. Concludes that the former may be more important in tropical areas than previously recognized; otherwise food availability is the most important, with availability of nesting space providing an additional constraint. The authors construct a theoretical model of population demography, and "test" with data on Wandering Albatross at Bird Island.

Croxall, J.P., P.A. Prince, I. Hunter, S.J. McInnes and P.G. Copestake (1984). The seabirds of the Antarctic Peninsula, islands of the Scotia Sea, and Antarctic continent between 80°W and 20°W: their status and conservation. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 637-666. ICBP Tech. Publ. No. 2. Cambridge; Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. At Signy Island over the past 25 years the breeding population of Adelie Penguins doubled (2.8% per year) and that of Chinstrap Penguins increased 5 fold (6.6% per year). This is supposedly due to increased food supply owing to the decline of whale stocks. In a recovery from exploitation, the population of King Penguins on South Georgia increased 20 fold from 1925 to 1980 (5.6% per year). A number of species have declined, particularly albatross (due to entanglement in fishing gear).

Croxall, J.P., P. Rothery, S.P.C. Pickering and P.A. Prince. (1990). Reproductive performance, recruitment and survival of Wandering Albatrosses *Diomedea exulans* at Bird Island, South Georgia. *Journal of Animal Ecology* 59:775-796.

British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET England.

Wandering Albatross population on Bird Island has declined since 1961 at a rate of 1.0% per year, as have populations on other Subantarctic Islands. Breeding success (mean = 64%) has increased 1.2% per year, but breeding frequency has remained unchanged. Recruitment has decreased from 36% in the early 60s to 30%; average

age of first breeding has also decreased. Construct a demographic model to closely match the population decrease. It appears that increased mortality of adults, and especially subadults, due to mortality in long-lines set for tuna is responsible for the decline.

Dann, P. and J.M. Cullen (1990). Survival, patterns of reproduction, and lifetime reproductive output in Little Blue Penguins (*Eutdyptula minor)* on Phillip Is., Victoria, Australia. **In:** *Penguin Biology*. (L.S. Davis, & J.T. Darby, eds.) pp. 63-84. San Diego, CA: Academic Press.

Results of a long-term (1967 to 1987) study on Little Blue Penguins (*Eudyptula minor*) from Phillip Island, Australia, are presented, with regard to longevity, reproductive success and offspring survival. There is evidence for adult mortality increasing with age. Some data on age of first breeding and survival of chicks to age one year are presented, too. The authors estimate that 31% of chicks survive to breeding age. Using these demographic data they calculate population growth rate. The calculated value implies a steep decline in population numbers, contrary to observation; immigration accounts for some or all of the difference.

De Juana, E. 1984. The status and conservation of seabirds in the Spanish Mediterranean. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.) pp. 347-361. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. Auduoin's Gull, once on the verge of extinction, on the Cabrera Archipelago increased from 38 pair in 1974 to 110 pair in 1982 (14.2% per year). At Columbretes Islands, colonized in 1972, numbers increased from 45 pair in 1974 to 200 pair in 1982 (20.5% per year). These two populations are benefiting from the increase in availability of fish offal. The Yellow-legged Herring Gull at its largest colony (Medas Islands) increased from about 3000 pair in 1961 to 7500 in 1982 (4.4% per year); this is the only species for which egg collecting is still legal.

Drury, W.H., Jr. (1963). *Results of a study of Herring Gull populations and movements in southeastern New England.* Colloque le Probleme des Oiseaux sur les Aerodrome. Institut National de la Recherche Agronomique.

Institut National de la Recherche Agronomique, 149 rue de Grenelle, Paris 7.

Number of Herring gulls in New England increased at 4.2% per year between 1900 and 1940 (8150 to 42,600 pairs). See also Drury and Kadlec (1974) for more recent data. Much of the growth was by establishment of new colonies. Provides details on movement of gulls and attraction to refuse.

Drury, W.H. (1973; 1974). Population changes in New England seabirds. *Bird-Banding* **44(4)**:267-313; **45(1)**:1-92.

Surveys population changes among New England seabirds in the last 75 years. New England Double-crested Cormorants grew from 875 pairs in 1930 to 13,000 pairs in 1945. This is a growth of 21% per year. Common Eider in New England showed explosive growth, from 430 pairs (1941) to 1845 pairs in 1945, this is 44% growth per year. From 2100 pairs in 1949 to 15,155 pairs in 1972/3, this is 15.2% growth per year. The latter seems more likely to reflect intrinsic growth rate. Lesser Black-backed Gulls in New England grew from 450 pairs in 1941 to 12,400 pairs in 1965, this is a growth rate of 14.8% per year. Black Guillemots in New England grew by 6.8% per year, 1931 to 1945. For Herring gulls, see Drury & Kadlec 1974. Other species did not grow or were too rare. Factors which were associated with rate of growth include: 1) protection, 2) clutch size--species with large clutch sizes showed faster growth (but only to an extent), 3) immigration (particularly from Nova Scotia) and 4) site tenacity. Drury stresses that division into subpopulations is advantageous - it can buffer population change.

Drury, W.H. and J.A. Kadlec. (1974). The current status of the Herring Gull population in the Northeastern United States. *Bird-Banding* **45(4)**:297-306.

Massachusetts Audubon Society

Herring Gulls had increased at c. 5% per year from 1900 to 1965 in Northeast USA, but 1972 census indicated a levelling off. Alternatively, 1965 census may have been too high (with continuous growth from 1900 to 1972). More detailed observations confirmed that population was stable 1965-1972. Productivity, in particular fledging success was reduced, contributing to change in population growth. For all of New England, highest reported growth rate was for 1938-1942, 9.8% growth per year; and for 1945-1948, 9.1% growth per year. Within New England, immigration must be considerable.

Duffy, D.C. (1983). Environmental uncertainty and commercial fishing: effects on Peruvian guano birds. *Biological Conservation* **26**:227-238.

Duncan, N. (1978). The effects of culling Herring Gulls (*Larus argentatus*) on recruitment and populations dynamics. *Journal of Applied Ecology* **15:**697-713.

On Isle of May, Scotland, Herring Gulls increases at 13.0% per annum, from 1907 to 1972, reaching 16,700 pairs. Large numbers culled from 1972-1976. Culling also had the apparent effect of deterring gulls from breeding on the island which they otherwise would have. Nest density is important with respect to recruitment: low density areas are not attractive to prospective breeders, but at very high densities, first-time breeders are unable to secure a territory. Therefore, intermediate density is optimal for a recruiting gull in that it is both attractive and yet not too difficult for a recruit to gain a place. Many Herring Gulls do not return to the natal colony, but breed elsewhere.

Dunlop, J.N. and R.D. Wooler (1990). The breeding seabirds of southwestern Australia: trends in species, populations and colonies. *Corella* **14(4):**107-112.

Dunn, E.K. and C.J. Mead. (1982). Relationship between sardine fisheries and recovery rates of Ringed Terns in West Africa. *Seabird Report* **6:**98-104.

Edward Grey Institute Zool. Dept., S. Parks Rd., Oxford OX1 3PS England.

Dunnet, G.M. (1974). Impact of the oil industry on Scotland's coasts and birds. *Scottish Birds* **8(1):**3-16.

Discusses risks to seabirds posed by the oil industry in Scotland from the viewpoint of oil installations, transportation, etc. Mentions distribution of seabirds but otherwise nothing else about birds (demography, etc.)

Dunnet, G.M. (1980). Seabirds and oil pollution. **In:** *Energy in the Balance - Some Papers from the British Association Meeting, 1979*. pp.51-64. Guildford; Eng.: Westbury House.

Culterty Field Station, Department of Zoology, University of Aberdeen, Scotland

Discusses difficulties in studying breeding seabirds and birds at sea. States that auks are not declining in Britain, though they are heavily oiled. However 1) in the 1980's most alcid species did decline, 2) in Britain there were few incidents of large-scale mortality. Molting populations (e.g., Eiders in autumn) and juvenile murres are very sensitive to oil.

Dunnet, G.M. (1987). Seabirds and North Sea oil. *Philosophical Transactions of the Royal Society of London,* **B 316:** 513-524.

Dept. of Zoology, University of Aberdeen, Tillydrone Ave., Aberdeen AB9 2TN, U.K.

Reviews relationship between oil and seabirds in the North Sea, especially British Isles. In response to fears that North Sea oil activities would decimate seabirds, extensive and long term programs were established to monitor: 1) number of breeding birds, 2) wintering concentrations, 3) distribution and abundance of seabirds at sea, and 4) number and percentage of oiled birds on beaches. Dunnet reviews results of these programs. The few accidents to date have had little long term effect on seabirds. Reproductive success of many seabirds has been poor in the 1980's. Recent declines in seabird numbers cannot be attributed to oil activities.

Dunnet, G.M. and J.C. Ollason. (1978). The estimation of survival rate in the Fulmar, *Fulmarus glacialis. Journal of Animal Ecology* **47**:507-520.

Culterty Field Station, Department of Zoology, University of Aberdeen.

Data on survival from long-term study on Eynhallow and factors that influence probability of identifying a breeding individual. Both age and sex likely correlated with survival, though influence is small.

Dunnet, G.M. and J.C. Ollason. (1978). Survival and longevity in the Fulmar. *Ibis* **120**:124-125.

Univ. of Aberdeen, Dept of Zoology, Tillydrone Ave., Aberdeen AB9 2TN, Scotland.

Provides additional demographic data to complement Dunnet & Ollason (1978) regarding age of first breeding and discusses survivorship to breeding age (no empirical data presented). Observed growth rate was 4.0% per year, but growth rate in British Isles has been 7.0% per year.

Dunnet, G.M., J.C. Ollason and A. Anderson. (1979). A 28-year study of breeding Fulmars *Fulmarus glacialis* in Orkney. *Ibis* **121(3)**:293-300.

Univ. of Aberdeen, Dept of Zoology, Tillydrone Ave., Aberdeen AB9 2TN, Scotland.

Northern Fulmars on Eynhallow Island grew from 90 pairs to 241, from 1953 to 1970, a growth rate of 6.0% per year. Estimate that 90% of surviving fledglings leave the colony. Population size and reproductive success of small areas could differ markedly from that on a wider scale; results in a few consecutive years could go against the overall longer-term trend. This poses problems for monitoring seabirds.

Erskine, A.J. (1987). A preliminary waterfowl population budget for the Atlantic provinces, 1978-1985. Occasional Paper No.60, pp.65-72. Ottawa: Canadian Wildlife Service.

Erskine, A. J. (1972). *The Great Cormorants of Eastern Canada.* Occasional Paper no.14 Ottawa: Canadian Wildlife Service.

A historical survey of numbers of Common (=Great) Cormorant in the Maritime Provinces with mention of Double-crested Cormorants. Little detailed (e.g. demographic) information presented. The Nova Scotia population of Common Cormorant increased from 100 to 2100 (1940 to 1972), an increase of 10.3 % per year; the Double-crested Cormorant increased from 67 to 4,200 (1929 to 1971), an increase of 10.35% per year.

Erwin, R.M., J. Galli and J. Burger (1981). Colony site dynamics and habitat use in Atlantic Coast seabirds. *Auk* **98(3)**:550-561.

Evans, P.G.H. and G. Waterston. (1976). The decline of the Thick-Billed Murre in Greenland. *Polar Record* **18(114)**:283-293.

Dept. Zoology, Univ of Aberdeen, Tillydrone Ave., Aberdeen AB9 2TN

See Evans & Kampp (1991) for a more recent review of this material.

Evans, P.G.H. and K. Kampp. (1991). Recent changes in Thick-billed Murre populations in West Greenland. **In:** *Studies of High-Latitude Seabirds, Vol.2: Conservation Biology of Thick-billed Murres in the Northwest Atlantic.* (A.J. Gasaton and R.D. Elliot, eds.) pp.7-14. Occasional Paper No. 69. Ottawa: Canadian Wildlife Service.

Edward Grey Institute, Department of Zoology, South Parks Road, Oxford, OX1 3PS United Kingdom

Numbers of Thick-billed Murres have declined in W Greenland in the past several decades, due to hunting. Rehabilitation of Thick-billed Murres depends on success in prohibiting hunting, which was recently outlawed during the months of June to August, only.

Evans, P.G.H. (1984). The seabirds of Greenland: their status and conservation. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.) pp. 49-84. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species. A colony of Northern Fulmars at Ydre Kitsigsut, founded in 1945, grew from 50 pair in 1971 to 200 in 1983 (12.1% growth per year). The Black-headed Gull exhibited marked fluctuation in numbers at a few sites; e.g. at Tassiussaq Bay, a pair bred in 1969 and the next year there were 10-12 pair and at Lake Tasserssuaq one pair bred in 1971, 4 in 1973 and 70- 80 in 1980 (52% per year). Reports increases of Black-legged kittiwakes of 9% per year in west Greenland, 1965-1974.

Evans, P.G.H. (1984). Status and conservation of seabirds in northwest Europe (excluding Norway and the USSR). **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 293-321. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. In the British Isles, the population of Northern Fulmar increased from 1879-1901 at 16% per year, from 1909-1939 at 10% and 1939- 1969 at 6-7%. During this century the northern gannet has been increasing steadily at 3% per year in the British Isles. The Great Cormorant has been increasing at about 4% per year since 1905 in Scotland and since 1968 in France. Up to 1970, beginning early this century, the Great Skua population of Shetland has been increasing at 7% per year. The Little Tern, in the Loir and Allier valleys of France increased from 125 pair in 1905 to 380 pair in 1980 (1.5% per year). Reports increases of Black-legged Kittiwakes of 30% per year, 1952-1962, falling to 19.5%, 1972- 1982, in West Germany.

Fisher, H.I. (1975). The relationship between deferred breeding and mortality in the Laysan Albatross. *Auk* **92(3)**:433-441.

Fenwood Toft, Triplett, Missouri 65286

Provides valuable demographic data on Laysan Albatross population breeding on Midway Atoll, specifically, age at first breeding, age-specific survival, and survival to breeding age (the last-mentioned especially valuable). The population on Midway Atoll doubled in 15 years, an increase of 4.7% per year.

Fisher, J. (1952). *The Fulmar.* London: Collins. 496p.

Summarized in Fisher (1952, *Ibis*). See Fisher (1966) for more recent survey.

Fisher, J. (1952). A history of the Fulmar *Fulmarus* and its population problems. *Ibis* **94(2)**:334-354.

Chronicles the spectacular spread of Northern Fulmar in Great Britain, Ireland and Northern Europe, not only in terms of increases in population, but also spread in term of number of colonies, both breeding and non-breeding colonies, the latter containing prospecting individuals. This article summarizes Fisher's book on Fulmars, and for population data is superseded by his detailed paper (Fisher 1966). Interval between first prospecting fulmar and first egg (at a colony) is 4.4 years on average. Small colonies are less productive, presumably, because they contain mostly young birds.

Fisher, J. (1966). The Fulmar population of Britain and Ireland, 1959. *Bird Study* **13**:5-76.

Ashton, Northampton, England.

Describes population growth of Northern Fulmar in Britain and Ireland in great detail. In Shetland Islands, fulmars grew from 12 breeding sites in 1878 to 36,000 in 1959, a growth rate of 10.3% per year. The entire British population of fulmars grew from 12 breeding sites in 1878 to 97,000 in 1959, a growth rate of 12.0% per year. It seems, however, that, at least when colony gets large, calculated intrinsic rate of increase is not more than 5.1% per year, or at most 7.0% rate of increase, assuming demographic parameters attain very high values. Fisher provides details on fish landed, offal discharge and fulmar numbers; offal availability accounts well for fulmar population trends.

Fisher, J. and H.G. Vevers (1944). *Journal of Animal Ecology* **13(1)**:49-62.

Together with the companion paper, Fisher, J. and H.G. Vevers (1943, *Journal of Animal Ecology* 12:173-213), summarizes historical data for gannet populations throughout the world, colony by colony, region by region, from 1819 to 1939, by pentades. At Grassholm Island, Wales, Northern Gannet population grew from 300 pairs in 1914 to 1900 in 1924 (20.3% growth per year) and to 5875 in 1939 (7.8% growth per year for the latter period). At Hermaness, in the Shetland Islands, gannets grew from 600 pairs in 1934 to 2611 in 1939, a growth rate of 34.2% per year. Factors influencing rise and fall of numbers are also discussed. Much of the historical data depends on estimates rather than counts. Gannet-taking was very important activity during the 19th century.

Fleming, C.A. and K.A. Wodzicki (1952). A census of the Gannet (*Sula serrator*) in New Zealand. *Notornis* 5:39-78.

The authors present a detailed census and historical data for New Zealand (Australasian) Gannets, up through 1947. At Hawke's Bay, gannets colonized in the 19th century, before 1879. Between 1879 and 1903 the population grew at 14.3% per year (from 50 nests to 1226 nests) implicating immigration; from 1903 to 1946 it grew at 1.5% per year. At Colville, gannets increased at 7.1% between 1940 and 1946 (1,200 to 1800 pairs). Reason for increase, cannot be attributed to man, there was little persecution or exploitation in the 19th century.

Folkestad, A.D. (1978). Recent surveys and population changes of the seabird populations of More and Romsdal. *Ibis* **120:**121-122.

Abstract of a paper presented at BOU Seabird Conference. Reviews changes in numbers of seabirds of More & Romsdal County, W Norway. Northern Fulmars and Northern Gannets have been growing; Great Cormorants disappeared; European Shag was decimated, but now has recovered; all species of gulls and terns have declined; Razorbills and murres declined, but puffin numbers are stable; Black Guillemot decreased greatly, but some subcolonies actually increased. Thus surface feeders and those not inclined to fly long distances decreased in number; diving species and those flying far (fulmar, Pelicaniformes, alcids) have fared all right.

Ford, R.G., J.A. Wiens, D. Heinemann and G.L. Hunt. (1982). Modelling the sensitivity of colonially breeding marine birds to oil spills: guillemot and kittiwake populations on the Pribilof Islands, Bering Sea. *Journal of Applied Ecology* **19:**1-31.

The authors present simulation and analytic models estimating the responses of colonially breeding marine birds (specifically, Thick-billed and Common Murres, and Red-legged and Black-legged Kittiwakes) to oil spills occurring within their foraging area. Short-term impacts are predicted on the basis of a demographic submodel and a foraging sub-model, which simulates daily foraging activities of individuals coupled with energetic requirements of chicks and adults. Model projections are sensitive to assumptions and parameters regarding foraging distribution but robust to assumptions regarding demographic variables. Three specific oil spill scenarios are presented and impact on murres and kittiwakes considered. The result of a modest spill near the colony during the breeding season would be 39% mortality of adult murre population, fledgling production cut by 69%, and 20 yr for the population to recover to a stable age distribution. With a large spill during the breeding season the result is 68% mortality of murre adults, and fledgling production reduced by 96%, with 40 yr required for recovery. Impacts on kittiwakes are less severe.

Fordham, R.A. (1967). History and status of the Dominican Gull in Wellington. *Notornis* **14:**144-153.

Fordham, R.A. (1970). Mortality and population change on Dominican Gulls in Wellington, New Zealand. *Journal of Animal Ecology*. **39(1):**13-27.

1970 Zoology Department, Victoria University of Wellington, New Zealand.

Franzman, N.E. (1989). Status of the Danish breeding population of the Eider *Somateria mollissima* 1980-83, with notes on general population trends in northern Europe. (English with Danish summary.) *Dansk Ornithologisk Forenings Tidsskrift* **83(1-2):**61-67.

Furness, R.W. (1978). Movements and mortality rates of Great Skuas ringed in Scotland. *Bird Study* **25:**229-238.

Analyzed band recoveries to determine range of movement and mortality causes of Scottish Great Skuas, all banded at their natal colonies. Survival of cohorts was correlated, when one survived poorly in a given year, so too did others. Also, when a cohort survived poorly in one year, it tended to survive poorly in other years, i.e. at other ages. Adult survival estimated to be 92 to 94% (SE = 2%); derives estimates for 1st and 2nd year survival. Calculated intrinsic growth rate would then be 8.9% per year, compared with observed growth of 7% per year for all of Britain (Ph.D. thesis, Furness 1977).

Furness, R.W. (1989). Declining seabird populations. *Journal of Zoology (Lond.)* **219(1):**177-180.

Dept. of Zoology, University of Glasgow.

Describes three talks given April 1989 at the Zoological Society, London. The first was by Lloyd, summarizing the findings of Lloyd, Tasker & Partridge (1991). The Great Cormorant has increased over two-fold in Ireland where shooting is no longer encouraged. Scottish cormorants declined, probably due to persecution. The second talk was by M. Harris on British Common Murres (see Harris 1991). The third talk was by R. Furness on the relationship of seabirds and fisheries. Fish stock levels can explain seabird population fluctuations, not pollution. Increases in seabird numbers in the 1970's might be due to fishing of predator fish which feed on sand lance, but sand lance had very poor recruitment 1983-1988, hence declines in seabird numbers. Some species switched from sand lance, others did not.

Furness, R.W., H. Galbraith, I.P. Gibson & N.B. Metcalfe (1986). Recent changes in numbers of waders on the Clyde Estuary, and their significance for conservation. *Proceedings of the Royal Society of Edinburgh* **90 B**:171-184.

Dept. of Zoology, Glasgow University, Glasgow G12 800, Scotland.

Numbers of oystercatchers and other waders, dependent upon the amphipod Corophium, declined as pollution decreased prey density.

Furness, R.W. and P. Monaghan. (1987). *Seabird Ecology*. (Chapter 4, pp. 35-52) Glasgow: Blackie.

Department of Zoology, University of Glasgow.

Discusses regulation of seabird numbers. Existence of regulation has not been well demonstrated, e.g. cessation of chick harvesting (which had been 50% of chicks) of Northern Fulmars on St. Kilda did not produce a population response. Kittiwakes and gannets have steadily increased in 20th century without any indication of regulation or limitation. Some species (e.g. shags on Farne Islands) may be nest-site limited whereas others are not (Eynhallow fulmars). Summarizes evidence that seabirds are food-limited, which may influence population numbers. See Birkhead & Furness (1985) for additional points.

Gaillard, J.-M., D. Pontier, D. Allaine, et al. (1989). An analysis of demographic tactics in birds and mammals. *Oikos* **56(1)**:59-76.

Lab. Biometrie, Univ. C. Bernard Lyon 1, 43 bd. du 11 Nov. 1918, F-69622 Villeurbanne Cedex, France.

Compiles data on eggs laid per year per breeding female, female life expectancy (equivalently, survival), and earliest age of first breeding for many bird species. However, without data on egg, chick and juvenile survival (none presented), these data are of limited use.

Galbraith, H., S. Russell and R.W. Furness. (1981). Movements and mortality of Isle of May Shags as shown by ringing recoveries. *Ringing and Migration* **3**:181-189.

96 Neilston Road, Paisley, Strathclyde.

Phalacrocorax aristotelis were ringed on Isle of May. Based on ringing data 1953-1979, presents information on dispersal--spatial and temporal (annual cycle)--and mortality patterns. Both first year and older birds are found hundreds of kilometers from ringing site (breeding colony). High mortality of first years birds is in first winter, not the first few months after fledging. Age of first breeding is discussed.

Gales, R. and D. Pemberton. (1988). Recovery of the King Penguin, *Aptenodytes patagonicus,* population on Heard Island. *Australian Wildlife Research.* **15**:579-585.

Dept. Zoology, Univ. Tasmania, G.P.O. Box 252C, Hobart, Tas. 7001

Discusses recovery of King Penguin on Heard Island. Since recolonization, Spit Bay colonies have grown rapidly. The N Spit Bay colony has grown at a rate of 23.4% per year (1969-1980) and then at 28.8% per year (1983-1988); while the S Spit Bay colony grew at 10.6% per year during this time period. A growth rate of 23%-29% per year seems too high to be intrinsic; immigration is implicated, especially since some smaller colonies shrank during this period. Also, King Penguin fecundity is limited: they can only rear a maximum of 2 chicks in a 3 year interval. On Macquarie Island, growth rate was 10.2% per year, close to that observed for S Spit Bay.

Gaston, A.J. (1990). Population parameters of the Ancient Murrelet. *Condor* **92(4)**:998-1011.

Presents data on demographic parameters of the Ancient Murrelet, studied on Queen Charlotte Island, British Columbia, including brood size, adult survival and age of first breeding. No information on observed population growth rate, nor is there sufficient data presented for one to calculate it. Key parameter missing is survival from "fledging" (soon after hatching) to age 2. Age structure not presented. Adult survival is c. 77%, low for alcids, and seabirds in general.

Gill, R. and L.R. Mewaldt. (1983). Pacific Coast Caspian Terns: dynamics of an expanding population. *Auk* **100**:369-381.

Discusses life history patterns and parameters of Pacific coast Caspian Terns, based mainly on recovery of banded juveniles, 1955 to 1980. Pacific coast population has increased 70% between 1960 and 1980, a growth rate of 2.6% per year. Some colony growth was surely due to immigration; philopatry is low. Breeding adults known to change colonies. Pacific coast Caspian Terns have gone from small colonies in freshwater marshes of interior California and Oregon to large colonies on human-created habitat (bays) on the Coast. Why this range expansion? Answer is not known. Low colony fidelity of Caspian Terns and the fact that they exploit a wide variety of nesting habitat, are responsive to changes in the environment and are adaptable, helps. Habitat loss and low reproductive success (the latter associated with dispersal) cannot explain range expansion. The key is that the San Diego colony remained stable in number while "exporting" individuals.

Goss-Custard, J.D., S. Durell, S. McGrorty and C.J. Reading (1983). Use of mussell beds *Mytilus edulis* L by oystercatchers *Haematopus ostralegus* L according to age and population size. *Journal of Animal Ecology* **51**:543-554.

Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS, England.

Certain mussel beds are preferred by oystercathers in South Devon. On these beds, bird densities are high when overall numbers in the area are low and they remain high when birds begin to occupy the greater area.

Goss-Custard, J.D., S.E.A. Le V. dit Durell, S. McGrorty, C.J. Reading and R.T. Clarke (1981). Factors affecting the occupation of mussell *Mytilus edulis* beds by oystercatchers *Haematopus ostralegus* on the Exe estuary, S. Devon. **In:** Feeding and Survival Strategies of Estuarine Organisms. N.V. Jones & W.J. Wolff, eds. pp. 217-229.

Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS, England.

Investigated properties of mussel beds that attracted oystercatchers in South Devon. When population size is low and competition is minimal (an important factor), the preferred beds 1) have large mussels that have thin shells, 2) are near the roost, 3) have a hard substrate & 4) are large.

Goss-Custard, J.D., S. Durell, H. Sitters and R. Swinfen (1983). Age-structure and survival of a wintering population of oystercatchers *Haematopus ostralegus*. *Bird Study* **29**:83-98.

Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS, England.

Described age structure and demographic parameters for a stable population of European Oystercatchers in south Devon.

Goss-Custard, J.D., & S.E.A. le V. dit Durell (1987). Age-related effects in Oystercatchers, *Haematopus ostralegus*, feeding on mussels, *Mytilus edulis.* III. The effect of interference on overall intake rate. *Journal of Animal Ecology* **56(2)**:549-558.

Natural Environment Research Council, Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset, England.

The feeding efficiency of oystercatchers declined as bird density increased owing to increased interference among birds.

Grier, J.W. (1980). Modeling approaches to bald eagle population dynamics. *Wildlife Society Bulletin* **8**:316-322.

Zoology Dept., North Dakota State University, Fargo, ND 58105

Groves, S. (1984). Chick growth, sibling rivalry, and chick production in American Black Oystercatchers. *Auk* **101**:525-531.

Dept. of Zoology, University of British Columbia, Vancouver, British Columbia V6T 1W5, Canada.

Dominant chicks in two-chick broods control access to feeding by the parents. Otherwise, no chicks would likely be fledged in years of low food availability.

Harris, M.P. (1966). Age of return to the colony, age of breeding and adult survival of Manx Shearwaters. *Bird Study* **13(1)**:84-93.

Edward Grey Institute and Field Studies Council.

Presents demographic data for Manx Shearwater breeding on Skokholm, Wales, including dispersal of young, between colonies, within the colony and elsewhere and survival of pre-breeding and breeding individuals. Adult survival was estimated to be 93% to 96% or more. Survival of young Manx Shearwaters not determined.

Harris, M.P. (1983). Biology and survival of the immature puffin *Fratercula arctica. Ibis* **125**:56-73.

Discusses demography and growth of Atlantic Puffins, mainly from a colony breeding on Isle of May, Scotland. Data on age of first breeding presented, as well as attendance patterns of young Puffins at the breeding colony. Infers that 23% or more of chicks surviving to breed, breed at a different colony (not on the Island of May). Harris suggests that such emigration is widespread among alcids. Data on return rate to the colony of pre-breeders as well as breeders are presented; 30 to 39% of chicks survived to breed. Birds visited other islands, as pre-breeders, but returned to the natal island if breeding sites were hard to come by. Adult survival is 96%. Infers that the fastest possible growth rate of the population is 14% (this with 0% adult mortality), yet the Island of May population grew at 19-22%. On Farne Islands, the population grew at 12.2% per year (1969 to 1975), from 6800 to 13600 pairs. For the region of E Scotland and NE England the population grew from 10,000 pairs in 1969 to 24,000 in 1979, a rate of 9.1% per year.

Harris, M.P. (1991). Population changes in British Common Murres and Atlantic Puffins, 1969-88. **In:** *Studies of High-Latitude Seabirds*, Vol.2: *Conservation Biology of Thick-billed Murres in the Northwest Atlantic* (A.J. Gaston and R.D. Elliot, eds) pp.52-58. Occasional Paper No.69. Ottawa: Canadian Wildlife Service.

Institute of Terrestrial Ecology, Hill of Brathens, Banchory, Kincardineshire, Scotland AB3 4BY.

Describes population changes in British Common Murres and Atlantic Puffins 1969-1988. Common Murres in Britain show large increases from 1969/70 to 1985/88, but recently northern populations have begun declining with initiation of declines coming earlier the more northern (e.g. Shetlands) the population; Southern British populations were still increasing in the late 1980's. On Farne Island the murre population grew from 1800 in 1970 to 11,500 in 1985, a growth rate of 13% per annum [presumably, included immigration]. On Isle of May the population peaked and then declined in the 1980's. Adult survival and fledging output remained high 1982-1988, thus the lack of recruitment is implicated in change in population growth. Atlantic Puffins on the Isle of May grew at 19% per annum in the 1970's (1973 to 1981). Harris thinks this increase is in part due to immigration (highest possible growth rate for this population is 16%, see Harris & Wanless 1991). Population stabilized in 1980's, during which time adult survival dropped from 96.0 ±1.8 (SE) % to 91.4 ±1.8 (SE) %. Thus in contrast to Common Murre change in adult survival is implicated in change in Atlantic Puffin population growth.

Harris, M.P. (1970). Rates and causes of increases of some British gull populations. *Bird Study* **17(4)**:325-335.

Edward Grey Institute, University of Oxford

Discusses increases of three gull species (Herring, Lesser Black-backed, Great Black-backed) on Skokholm and Skomer islands, Wales. On Skokholm, Lesser Black-backed Gull population of the island increased from about 370 pairs to 20,000 pairs (1960 to 1969), a 20.6% increase per year. Harris thinks that intrinsic rate of increase of the population approaches this value, but this conclusion is based not on data but on some tenuous assumptions: that first-year mortality is only 16.5% and adult survival is 94%. For Herring Gulls, Harris calculates intrinsic increase as 11-12% similar to that observed in Isle of May (13.5%) and similar to that observed on Skokholm 1959-1969, which was 10.2% per year, and on Skomer 1962-1969, which was 10.8% However, on Walney Island growth was from 700 pairs (1950) to 18,000 pairs (1965), a growth of 24% per year, which Brown surmised included immigration. Why this increase? No good explanation; fish availability is likely to have declined, not increased.

Harris, M.P. (1970). Territory limiting the size of the breeding population of the oystercatcher *Haematopus ostralegus* - a removal experiment. *Journal of Animal Ecology* **39**:707-713.

The overall number of oystercatchers breeding on Skokholm remains stable because the availability of breeding territories limits the number of breeding birds. A floating population of non-breeding adults exists.

Harris, M.P. and S. Wanless. (1991). Population studies and conservation of Puffins *Fratercula arctica.* **In:** *Bird Population Studies; Relevance to Conservation and Management* (C.M. Perrins, J.D. Lebreton, G.J.M. Hirons, eds.) pp.230-248. Oxford: Oxford University Press.

Institute of Terrestrial Ecology, Hill of Brathens, Banchory, Kincardineshire AB31 4BY, Scotland.

Detailed presentation on population dynamics in Atlantic Puffins; data come from Isle of May, Scotland (1972-1988) principally; also Rost, Norway (1969-1988) and Egg Rock, Maine (1979-1987). Population on the Isle of May grew at 19% per annum 1973 to 1981; plateaued 1981-1985 and little change 1985-1988. Adult survival declined as population stabilized. Presents data on reproductive success, age structure and age of first breeding for all three sites. Colony fidelity is low: up to 46% of recruits emigrated; 33% of Maine recruits emigrated. Presents data on survival to recruitment for six cohorts; recruitment probability varied among cohorts. Intrinsic rate of growth of the Isle of May population, using lifetable data, is 7% to 16% per year depending on assumptions of emigration, for 1973-1981; for 1982-1988 it is -1% per year to 5% growth. High estimates reflect 46% emigration on assumption that immigration=emigration (no justification given). There was no shortage of food 1972-1988. Population stabilization reflected decrease in adult survival, perhaps immature survival; reproductive success remained high throughout the period.

Hasegawa, H. and A.R. DeGange (1982). The Short-tailed Albatross *Diomedia albatrus*, its status, distribution and natural history. *American Birds* **36**:806-814.

Due to exploitation and volcanic eruptions on their breeding grounds the population of Short-tailed Albatross decreased from millions in the last century to fewer than five during the 1930s and 1940s. After protection, the population has been growing, from 12 pair in 1956 to 63 in 1982 (6.6% per year). Another population has established itself on another island.

Hasegawa, H. (1984). Status and conservation of seabirds in Japan, with special attention to the Short-tailed Albatross. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.) pp. 487-500. ICBP Tech. Publ. No. 2, Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. Black-footed Albatross (re-?)colonized Torishima in the early 1960s; 20 nested (reared chicks) in 1964 but the population was 200 pair by 1982 (13.6% per year). One of the colonists had been banded on the Bonin Islands. A Laysan Albatross, among 14 that colonized the Bonin Islands recently, was banded in the northwest Hawaiian Islands.

Hatchwell, B.J. and T.R. Birkhead. (1991). Population dynamics of Common Guillemots *Uria aalge* on Skomer Island, Wales. *Ornis Scandinavica* **22**:55-59.

Dept of Animal and Plant Sciences, Univ of Sheffield, Western Bank, Sheffield S102TN, UK.

After a long perioid of decline/stasis, the Skomer Common Murre population has recently increased. Comparison of population parameters in 1973-75 with that of 1985-89 indicates that chick productivity increased (0.72 to 0.79 chicks/pr/year) and adult survival increased (0.915 to 0.94) but that these two parameters cannot account for observed rate of population increase--which was 6.6% growth per year (1977 to 1988) for entire island (3300 to 6700). However, assuming survival of chicks to breeding age is 41.1% (highest ever reported for common murre population), data not available for this population, produces population growth matching that observed. Authors argue that immigration is unimportant, claiming that natal philopatry is high.

Hays, C. (1986). Effects of the 1982-83 El Nino on Humboldt Penguin colonies in Peru. *Biological Conservation* **36**:169-80.

Av. Principal 560, Corpac, Lima 27, Peru

Heilbrun, L.H. (1970). Great Gull Island, its history and biology. *Proceedings of the Linnaean Society of New York* 71:54-79.

Helle, E., P. Helle and R.A. Vaisanen. (1988). Population trends among archipelago birds in the Krunnit sanctuary, northern Gulf of Bothnia, in 1939-85. *Ornis Fennica* 65:1-12.

Finnish Game & Fisheries Res. Inst., Game Div., Turunlinnantie 8, SF-00930 Helsinki, Finland.

Breeding pairs of ducks, alcids, waders, gulls and terns were censused on Krunnit Islands, Gulf of Bothnia, Finland, 1939-1985. Due to effective guarding of the sanctuary, total number of pairs, of all species, increased from 650 in the 1950's to more than 2000 in the 1980's. Despite protection black guillemots decreased from over 100 pairs to one pair in 1985. Mink, raccoon dog *Nyctereutes procyonoides*, and Arctic fox *Alopex lagopus* present danger. One Arctic fox decimated all ground-nesting birds on 2 islands; it was caught but it took 6 yrs for *Mergus serrator* to recover to normal levels. Arctic Tern increased from 150 prs in 1963 to 360 in 1973, = 9.1% growth per year.

Henry, C.J. (1972). *An Analysis of the Population Dynamics of Selected Avian Species: With Special Reference to Changes During the Modern Pesticide Era.* Brown Pelican: pp.41-46. Wildlife Research Report 1 Washington, D.C.: U.S. Fish and Wildlife Service.

Heubeck, M., M.G. Richardson and C.P. Dore (1986). Monitoring numbers of Kittiwakes *Rissa tridactyla* in Shetland. *Seabird* 9:32-42.

Colonies were monitored throughout the Shetlands between 1976 and 1985. There was much variation in population trends between colonies and even in study plots within a colony. Overall, kittiwake numbers declined but at Noss numbers of kittiwakes increased from 470 in 1977 to 715 in 1983, a rate of 7.2% per year, before declining in 1984 and 1985. The number of adults fluctuated more than the number of nests. Population decline was faster among small colonies, but note that population growth is greatest among small colonies. Monitoring results from fixed sites were not representative of the entire colony or of the entire region.

Hickey, J.J. (1952). *Survival Studies of Banded Birds.* Special Scientific Report: Wildlife No.15. Washington, DC: U.S. Fish & Wildlife Service.

Extensive discussion of avian life tables and critique on methods. Presents species by species case histories, ten in all, including Double-crested Cormorant and Caspian Tern, also Redhead. Age-specific mortality data for Double-crested Cormorant are presented; bias and error are discussed. Age-specific mortality for Caspian Tern are calculated, together with re-analysis of Herring Gull data of Marshall, Paludan and Paynter, and discussion and presentation of Austin's data on Common Tern. Note that all the studies rely on band recoveries, a method that has been severely criticized by D.R. Anderson et al. (J. Anim. Ecol. 1985).

Holmes, W.N. and J. Cronshaw. (1977). Biological effects of petroleum on marine birds. **In:** *Effects of Petroleum on Arctic & Subarctic Marine Environments and Organisms.* Vol.II: *Biological Effects* (D.C. Milne, ed.) pp.359-398. New York: Academic Press.

Department of Biological Sciences, University of California, Santa Barbara, CA 93106.

Provides a general review of effects of oil on seabirds. Compares demographic effects for alcids whose potential growth rates are low (maximum of one chick reared per pair per year; breeding does not commence until age 3 or later) with ducks, whose demographic parameters allow rapid population response. Cites evidence of oil having substantial impact on seabird populations, i.e. Atlantic Puffins on Scilly Islands, Common Murres on Ailsa Craig, Razorbills on Newfoundland coast, and Long-tailed Ducks migrating across Finland, and in particular reduction of breeding populations of alcids by 81-89% on Sept Ile, Brittany, as a result of the *Torrey Canyon* disaster.

Hudson, P.J. (1985). Population parameters for the Atlantic Alcidae. **In:** *The Atlantic Alcidae.* (D.N. Nettleship and T.R. Birkhead, eds.) pp.233-261. New York: Academic Press.

The Game Conservancy, Leyburn, North Yorkshire, England.

Provides a synthesis of data on demographic parameters of Atlantic alcids, including trends in population size (for North America and Europe), mortality factors, adult survival, incidence of non-breeding, age of first breeding, return of immature auks to the colony, and survival of immatures to breeding age. However, little information on survival of chicks, and sub-adults is presented. Auks have generally been increasing or decreasing this century, rarely showing stability of numbers. Data from observational studies and band recovery studies are collated.

Hughes, R.M., T.R. Whittier, C.M. Rohm and D.P. Larsen. (1990). A regional framework for establishing recovery criteria. *Environmental Management* **14(5)**:673-683.

NSI Technology Services Corp., US EPA Environmental Res. Lab., 200 SW 35th St., Corvallis, OR 97333

Where site-by-site assessment of endpoints and potential recovery trajectories is impractical, and since any set of national criteria would be meaningless, authors recommend a regional--specifically, ecoregional--approach. Two techniques used to consider 6 case studies: detrended correspondence analysis and index of biotic integrity (developed by Karr et al. 1986). Application is specifically aquatic (freshwater).

Hulscher, J.B. (1989). Mortality and survival of Oystercatchers *Haematopus ostralegus* during severe winter conditions. *Limosa* **62(4)**:177-181.

Zoologisch Laboratorium R.U. Groningen, Postbus 14, 9750 AA Haren, Netherlands.

Discuss strategies of European Oystercatchers when confronted with an intense cold spell during winter. Mass emigrations occur from northern to southern Europe during long cold spells. Only those birds having sufficient fat reserves survive.

Hunt, G.L., Z.A. Eppley, and D.C. Schneider (1986). Reproductive performance of seabirds: The importance of population and colony size. *Auk* 103: 306-317.

Reproductive performance of five species (Red-faced Cormorant, Black-legged Kittiwake, Red-legged Kittiwake, Common Murre and Thick-billed Murre) is presented in relation to population size on two islands. The authors compared large (250,000 seabirds) and very large (2,500,000 seabirds) colonies. Generally, reproductive performance was lower in larger colony, indicating density-dependence, which could act to regulate seabird populations. Clutch size and breeding success (the two most direct demographic components) did not vary with colony size but growth rate and fledging weight were lower and significantly so in 4 and 2 species, respectively. The total size of the colony (includes other species on island which feed on broadly similar prey) did not prove significant, indicating competition was intraspecific only, perhaps interference competition.

Jarvis, M.J.F. (1970). Interactions between man and the South African Gannet *Sula capensis*. Proceedings of the 3rd Pan African Ornithological Congress. *Ostrich Supplement* **8**:497-513.

Percy Fitzpatrick Institute, Cape Town, South Africa

Jeffery, R.G. (1987). Influence of human disturbance on the nesting success of African black oystercatchers. *South African Journal of Wildlife Research* **17(2)**:71-72.

Achtertuin, Lichfield Avenue, Claremont, 7700, Republic of South Africa.

African Black Oystercatchers declined at Cape Agulhas owing to increased disturbance from humans.

Jehl, J.R., Jr. (1973). Studies of a declining population of Brown Pelicans in Northwestern Baja California. *Condor* **75(1)**:69-70.

Natural History Museum, P.O. Box 1390, San Diego, California 92112

Documents declining populations of Brown Pelicans on islands along the northwestern coast of Baja California Mexico since the 1940s. One exception was at Los Coronados where the population grew from about 750 pair in 1920 (having been stable since the 1880s) to about 2600 pair by about 1935 (8.6% per year); numbers began to decline in the early 1950s. Declines have been the result of pesticide pollution and disturbance.

Jehl, J.R., Jr., D.E. Babb, and D.M. Power (1984). History of the California gull colony at Mono Lake, California. *Colonial Waterbirds* **7**:94-104.

Hubbs-Sea World Research Institute, 1700 South Shores Road, San Diego, California 92109

The best documented changes in the size of the California Gull population at Mono Lake are those from 1950 on. The size remained at about 4000 birds from the early 1900s to 1950, when it began to grow rapidly. It reached 50,000 in 1976 (15.1% per year) and has remained at that level since. Growth was a response to increased nesting space as a result of increased number and size of islands in the lake.

Jouventin, P. and H. Weimerskirch. (1984). The Dark-mantled Sooty Albatross *Phoebetria fusca*; a case of extreme adaptation to pelagic life. *Revue d'Ecologie la Terre et la Vie* **39(4)**:401-430.

Section Socioecologie, USTL, Place Eugene-Bataillon, F. 34060 Montpellier, France.

Jouventin, P. and H. Weimerskirch. (1988). Demographic strategies of Southern Albatrosses. pp.857-865. **In:** *Acta 19 Congressus Internationalis Ornithologici,* (H. Quellet, ed.) Vol.1:857-865. (Ottawa, Canada, 22-29 June 1986). Ottawa: University of Ottawa Press.

Provides demographic variables for 5 species of albatross: age at first breeding, fecundity, breeding success, and survival. Low fecundity renders these species very sensitive to changes in adult survival.

Jouventin, P. and H. Weimerskirch (1990). Long-term changes in seabird and seal populations in the southern ocean. **In:** *Antarctic Ecosystems.* (K.R. Kerry and G. Hempel, eds.) pp.208-213. Berlin: Springer-Verlag.

Centre d'Etudes Biologiques de Chize, Centre National de la Recherche Scientifique, 79360 Beauvoir sur Niort, France.

Provides census data for 10 seabird species on subantarctic islands and in the Antarctic at Pt. Geologie, Terre Adelie. Those species that have been increasing include the King Penguin at Crozet Is (1962-1986, in two colonies at 10.1-10.4% per year, but at another---the largest colony---the population has been stable or has decreased slightly) and Kerguelan Is (1963-1986, in two colonies the increase has been 6.3-7.2% per year); the Macaroni Penguin at Kerguelan (1963-1986, 0.7% per year); and the Adelie Penguin at Terre Adelie (1958-1984, 2.1% per year). Those species decreasing include Emperor Penguin at Terre Adelie (1952-1986, -2% per year), Black-browned Albatross at Kerguelan (1978-1987m -2.7% per year), Wandering Albatross at Crozet (1960-1985m -1.8% per year) and Kerguelan (1971-1985, - 2.3% per year), Northern Giant Fulmar at Crozet (1980-1985, -6.1% per year), and Southern Giant Fulmar at Crozet (1980-1985, 4.8% per year). The population of Gentoo Penguins at Crozet is stable. King Penguins are recovering from exploitation at the start of this century. Adelie and Macaroni Penguin populations are supposedly responding to increased food supply owing to the demise of competing whales. Decreases in albatross and Giant Fulmars is due to increased mortality in fishing gear. No reason given for decrease in Emperor Penguin numbers.

Jouventin, P. and H. Weimerskirch. (1991). Changes in the population size and demography of southern seabirds: management implications. **In:** *Bird Population Studies; Relevance to Conservation and Management* (C.M Perrins, J.-D. Lebreton & G.J.M. Hirons, eds.), pp.297-316. Oxford: Oxford University Press.

Jouventin, P., J.C. Stahl, H. Weimerskirch and J.L. Mougin (1984). The seabirds of the French subantarctic islands and Adelie Land, their status and conservation. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.). pp. 609-625. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Provides information on present status with some figures for population trends for a few species not discussed by other authors. The number of breeding South Polar Skuas at Pt. Geologie increased from 29 pair in 1966 to 43 pair in 1981 (2.7% per year). Presumably the increase resulted from the establishment of a French base and the increased availability of food (refuse). A decline in Emperor Penguins (see reference elsewhere) may be due either to the establishment of the base or to the retreat of a glacier tongue that protected the colony. The population of Antarctic Fulmars increased from 15 pair in 1964 to 35 in 1981 (5.1% per year).

Jouventin, P., J. Martinez and J.P. Roux (1989). Breeding biology and current status of the Amsterdam Island Albatross *Diomedea amsterdamensis*. *Ibis* **131(2)**:171-182.

Sea Fisheries, P.O. Box 394, Luderitz, S.W.A./Namibia.

Kadlec, J.A. and W.H. Drury. (1968). Structure of the New England Herring Gull population. *Ecology* **49(4)**:645-676.

Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, Lincoln, Massachusetts, Substation.

Calculated the age structure of the Herring Gull population using various reproductive and demographic rates as well as the growth rate of the population. In New England, overall breeding numbers grew from about 8000 pair in 1901 to 120,000 pair in 1966 (4.2% per year). Growth of some colonies was aided by immigration; for instance, numbers on Muskeget Island, Cape Cod, grew from 200 pr in 1925 to 750 pr in 1940 (9.2%) little assisted by immigration, whereas numbers at Thatcher Island grew from 25 pr in 1959 to 2400 by 1966 (92% per year).

Kharitonov, S.P. and D. Siegel-Causey (1988). Colony formation in seabirds. **In:** *Current Ornithology*, Vol.5 (R.F. Johnston, ed.) pp.223-272. New York: Plenum Press.

Center of Ringing and Marking Birds, USSR Academy of Sciences, 109240 Moscow 240, USSR.

Kirkham, I.R. and W.A. Montevecchi. (1982). The breeding birds of Funk Island, Newfoundland, Canada; an historical perspective. *American Birds* **36(2)**:111-118.

Dept. Biol., Dalhousie Univ., Halifax, NS B3H 4J1, Canada.

Provides documentation for changes in population size and status of seabirds nesting on Funk Island. Census figures available for most species are approximate. Great Auks and Arctic Terns ceased to nest, the former since the 1800s and the latter since 1952 due to exploitation and competition with gulls, respectively. Northern Fulmar established first pair in 1959 and by 1980, 9 pair nested. Atlantic Gannet numbers increased from 7 pair in 1936 to 4051 by 1972 (19.3% per year), with immigration being responsible for some of the increase. Immigration was a response to warming of Labrador Current and northward shift in mackerel population. Great Black-backed Gulls increased from 5 pair in 1956 to about 100 by 1975 (17.1% per year). Herring Gulls increased from 25 pair in 1956 to 100 by about 1980 (5.9% per year). Common Murres increased from 10,000 pair in 1936 to 400,000 by 1972 (10.8% per year), owing to a relaxation from exploitation. Numbers of kittiwakes, Razorbills, Thick-billed Murres and Atlantic Puffins remained about the same during this century.

Kosinski, R.J. and R.H. Podolsky. (1979). An analysis of breeding and mortality in a maturing Kittiwake *Rissa tridactyla* colony. *Auk* **96(3)**:537-543.

Biology Dept., College of Science, Texas A&M Univ., College Station, Texas 77843.

Used data from Coulson's North Shields colony, and elsewhere, to model growth rate in the Black-legged Kittiwake. Calculated an intrinsic rate of increase (r) of about 14.5% per year.

Kress, S.W., and D.N. Nettleship (1988). Re-establishment of Atlantic Puffins *(Fratercula arctica)* at a former breeding site in the Gulf of Maine. *Journal of Field Ornithology* **59(2)**:161-170.

National Audubon Society Research Department, 159 Sapsucker Woods Road, Ithaca, New York 14850.

Nestlings were transported from Newfoundland to Eastern Egg Rock in Maine, reared in artificial burrows and then released. 147 of 774 nestlings returned to Maine, and of these 54 eventually bred. Inter-island movements were observed for 2, 3 and 4 year olds; age of first breeding was 4 to 6 yrs on average. Young puffins learn the location of their natal island sometime after they are 2 weeks of age.

Kullapere, A. (1983). Recent changes in the population of the Common Eider *Somateria mollissima* in the eastern Baltic area. *Ornis Fennica, Supplement* **3**:75-76.

La Cock, G.D. (1986). The southern oscillation, environmental anomalies, and mortality of two southern African seabirds. *Climatic Change* **8**:173-184.

Percy FitzPatrick Inst. of African Ornithology, Univ. of Cape Town, Rondebosch 7700, South Africa.

Lack, D. (1966). *Population Studies of Birds.* Oxford: Oxford University Press. 341p.

Reviews studies of many bird species, including that of Richdale on Yellow-eye Penguin, Coulson on Black-legged Kittiwake, and studies on shearwaters (Short-tailed, Sooty and Manx). Between 1943 and 1952, Richdale's population grew from 32 to 82 pairs (11.0 % growth per year). Little relevant demographic data on Kittiwakes (see more recent papers by Coulson). Mortality data on shearwaters presented, Lack correcting some earlier data of other). Presents general discussion of demography relevant to population growth and recovery, including causes of mortality.

Laursen, K. (1989). Estimates of sea duck winter populations of the western Palaearctic. English with Danish and Russian summaries. *Danish Review of Game Biology* **13(6)**:22p.

Reviews estimates of winter populations of 5 species: Greater Scaup Aythya marila, Common Eider *Somateria mollissima,* Long-tailed Duck [Old Squaw] *Clangula hyemalis,* Common Scoter *Melanitta nigra* and Velvet Scoter *Melanitta nigra.* Most information is from aerial counts in early 1987. For much of Northern Europe Laursen compares 1985-87 estimates with that of Atkinson-Willes (1976). However, these estimates lack precision and this precludes quantitative inferences about population growth.

Leslie, P.H. (1966). The intrinsic rate of increase and the overlap of successive generations in a population of guillemots *Uria aalge. Journal of Animal Ecology* **35(2)**:291-301.

Presented derivations of equations to calculate the intrinsic rate of increase in a population using the Common Murre as an example. No empirical data included other than those for reproductive success.

Lewis, H.F. 1937. A decade of progress in the bird sanctuaries of the north shore of the Gulf of St. Lawrence. *Canadian Field-Naturalist* **51**:51-55.

As a result of the establishment of a number of sanctuaries in the 1920s the populations of a number of species have been increasing, 1925 to 1935, owing to lessened disturbance: American Eider (5.7% per year), Great Black-backed Gull (6.2%), Herring Gull (13.1%), Ring-billed Gull (2.4%), Caspian Tern (3.4%), Common Murre (5.4%), Black Guillemot (10.1%) and Atlantic Puffin (2.6%). Inexplicably, a few species have been decreasing: Arctic Tern and Razorbill.

Lloyd, C. (1974). Movement and survival of British Razorbills. *Bird Study* **21(2)**:102-116.

Lloyd, C.S. (1976). The breeding biology and survival of the Razorbill *Alca torda L.* Ph.D. Thesis, Oxford University.

Lloyd, C., M.L. Tasker and K. Partridge. (1991). *The status of seabirds in Britain and Ireland.* London: T & AD Poyser. 355p.

Reports results of follow-up to Operation Seafarer, which censused coastal seabird colonies of Britain and Ireland in 1969-70. Survey results for 1985-1987, the Seabird Colony Register project, are presented for all 24 breeding seabirds of Britain and Ireland. Results are grouped by region (14) for the British Isles, but it is hard to relate individual colonies or groups of colonies to these 14 regions. Both surveys (1969/70 and 1985/87) relied heavily on volunteers; the 1985/87 survey undoubtedly yielded better data, which makes comparisons difficult. In particular, the 1969/70 survey omitted inland colonies, which is a significant omission for some species. Alcids (4 spp.) were not adequately surveyed in 1969/70, and there was confusion over counts of individuals vs. nests, making adequate comparisons impossible. See Harris (1991) for review of Common Murres and Atlantic Puffins.
The following 11 species demonstrated increases in numbers (comparing 1969/70 with 1985/87) either in part of their range or throughout the British Isles: Northern Atlantic Fulmar; Gannet; Great Cormorant; European Shag; Arctic Skua; Great Skua; Black-headed Gull; Herring Gull; Black-legged Kittiwake; Common Tern; Arctic Tern. The remaining 9 species either did not increase in number or did not yield adequate data (e.g. relatively rare or censuses were inadequate in 1969/70 or 1985/87). Includes a general discussion of seabird population dynamics and influences, e.g. Offal and fish discards benefitted in particular skuas, gannets and Great Black-backed Gulls.

Lock, A.R. (1987). Recent increases in the breeding population of Black-legged Kittiwakes, *Rissa tridactyla,* in Nova Scotia. *Canadian Field-Naturalist* **101(3)**:331-334.

Canadian Wildlife Service, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2

Between 1970, when they began to breed in Nova Scotia, and 1983, the population of Black-legged Kittiwakes has increased at a mean 16% per year (15.7% exponential rate). Several colonies have been founded. The increase is a response to enhanced availability of prey, sand lance, owing to over-fishing of predators and competitors.

Lock, A.R. (1988). Recent increases in the breeding population of Ring-billed Gulls, *Larus delawarensis,* in Atlantic Canada. *Canadian Field-Naturalist* **102(4)**:627-633.

Canadian Wildlife Serv., Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2

Reviewed history of Ring-billed Gulls in eastern Canada. In the Maritime provinces, numbers increased at a rate overall of 20.9% per year, 1972-1986, although the rate varied between 11.7 and 32.8% depending on site. In insular Newfoundland, overall numbers increased from about 75 nests in 1940 to about 5300 by 1980 (11.2% per year). Population increases are due to higher winter survival in turn due to enhanced feeding owing to dumps and ploughed fields. Immigration from the Great Lakes has been important.

Ludwig, J.P. (1965). Biology and structure of the Caspian Tern (*Hydroprogne caspia)* population of the Great Lakes from 1896-1964. *Bird Banding* **36(4)**:217-233.

Provided data on ecology and demographic parameters of Caspian Terns nesting on islands in Lake Huron and Lake Michigan. Population structure was similar to that of gulls. Increases in population during the 1960s are due to increased reproductive success.

Ludwig, J.P. (1966). *Herring and Ring-billed Gull populations of the Great Lakes 1960-1965.* Great Lakes Research Division, Publication 15:80-89. Ann Arbor: University of Michigan.

Dept. of Zoology, University of Michigan, Ann Arbor.

During the period 1960-1965, on Lakes Huron and Michigan, Herring Gull numbers increased from 24,000 to 43,000 breeding pairs; (rate of increase = 12.3% per year);

Ring-billed Gulls increased from 27,000 to 99,000 pair (29.7% per year), and Caspian Terns increased from 1400 to 1710 pair (4.1% per year). Increase in the Ring-billed Gull but not the other species was augmented by massive emigration from Lake Ontario. The appearance of massive populations of alewives during the breeding season beginning about 1956 has lead to exceedingly high reproductive success. These fish invaded the Great Lakes in 1950. Adult and subadult mortality has remained constant. Nesting space and pesticide pollution may constrain future population growth.

Ludwig, J.P. (1974). Recent changes in the Ring-billed Gull population and biology in the Laurentian Great Lakes. *Auk* **91(3)**:575-594.

During the period 1960-1967, the Ring-billed Gull population on Lakes Huron and Michigan grew from 27,000 to 141,000 pair (26.6% per year). Largest increases occurred during years when the lake level was lower and more nesting space was available. At Gallo Island, Lake Ontario, the population increased from 1000 pair in 1945 to 82,000 pair by 1967 (22.2% per year). The acreage of the island occupied by the gulls increased in concert (i.e. the colony expanded). Overall, numbers of breeding pairs expanded as follows 1930 to 1945 to 1967, respectively: St. Lawrence River, 0, 2,000, 10,000 (7.6% per year); L. Ontario, 2,000, 15,000, 165,000 (12.7%); L. Erie, 0, 60, 6,300 (23.6%); L. Huron, 1,000, 20,000, 119,000 (13.8%); L.Michigan,0, 0, 33,300 (c. 17.3%). Growth is due to increased reproductive success and stable mortality owing to increased food supply and increased nesting space as lake levels subside.

Mathiasson, S. (1980). Sandwich Tern (*Sterna sandvicensis*) in a changing bird community and the need for alternative breeding sites. *Acta Ornithologica* **(17)8**:87-105.

Documents changes in the biology of Sandwich Terns 1947-1977, as well as changes in numbers of other species in the area of southwestern Scania, Sweden, 1947-1976. Numbers of breeding Eider Ducks (*S. mollisima*) increased 4.3 fold (5.1% per year) and Herring Gulls increased 3.2 fold (4.7% per year). Other larids decreased during the period, apparently due to the increase in Herring Gulls. The Sandwich Tern colony shifted elsewhere. Growth of some colonies is as follows: Maklappen, 1912-1938, 2 to 250 pair (20.4% per year); Foteviken, 1939-1952, 8 to 260 pair (30.7% per year). Actually, numbers in these two colonies shifted reciprocally a number of times during the period. At Angholmarna, terns appeared the year they departed Maklappen (1945), and the colony then grew from 8 to 125 pair by 1976 (14% per year). In 1977 they disappeared. Since the 1960s the terns in the study area have emigrated to Denmark and Germany, following the Black-headed Gulls to appropriate sites.

Milton, G.R. and P.J. Austin-Smith (1987). Changes in the abundance and distribution of Double-crested (*Phalacrocorax auritus)* and Great Cormorants (*P. carbo)* in Nova Scotia. *Colonial Waterbirds* **6:**130-138.

Wildlife Conservation Division, Nova Scotia Dept. of Lands and Forests, P.O. Box 516, Kentville, Nova Scotia B4N 3X3, Canada

In Nova Scotia, numbers of Double-crested Cormorants increased 2.9 fold (10.2% per year) and Great Cormorants 1.5 fold (3.8%) between 1971 and 1982. From 1925 until 1971, the Double-crested population had increased from 67 to 4150 pr (9.4% per year). In Maine, between 1972 and 1977, Double-crested Cormorant numbers grew 8% (1.6% per year) and in the St.Lawrence River estuary, between 1963 and 1980, numbers grew 1.7 fold (3.0% per year). Immigration from New England may be involved in the growth of the Nova Scotia population of Double-crested.

Monaghan, P., J.D. Uttley and J.D. Okill. (1989). Tern and Sandeels: seabirds as indicators of changes in marine fish populations. *Fish Biology* **35(Suppl.A)**:339-340.

Applied Ornithology Unit, Dept. of Zoology, University of Glasgow, Glasgow, Scotland G12 800

Morrison, M.L. and R.D. Slack (1977). Population trends and status of the Olivaceous Cormorant. *American Birds* **31(5)**:954-959.

Dept. of Forestry and Resource Manage., University of California, Berkeley, CA 94720.

The data are summarized in Morrison et al. (1983). Reasons for the observed population increase may stem largely from establishment of protected areas.

Morrison, M.L., B.S. Hale and R.D. Slack. (1983). Recent population trends of Cormorants (*Aves: Pelicaniformes*) in Texas. *Texas Journal of Science* **35(3)**:239-242.

Dept. of Forestry and Res. Manag., Univ. of California, Berkeley, CA 94720.

Examined population trends of Olivaceous and Double-crested Cormorants in Texas 1949-1981. Olivaceous Cormorant breeding population increased 9.5 fold 1967-1975 (32% per year) and then decreased 36% to 1981 (6% per year). The wintering population appeared to be stable between 1949 and 1957, but thereafter to 1981 increased 5.2 fold (7% per year) with much between year variation. Numbers of

Double-crested Cormorants wintering on the coast increased 291 fold 1949-1975 (24.4% per year), then decreased 42% to 1981 (7% per year). Numbers of Double-crested Cormorants wintering in Texas could exhibit considerable shifts between inland and coastal sites. Weather may play a role in this.

Morzer Bruyns, M.F. (1958). Gulls which are a menace to other species: the Herring Gull problem in the Netherlands. *ICBP Bulletin* **7**:103-107.

State Forestry Service, Institute for Nature-Conservation Research (R.I.V.O.N.)

Herring Gulls increased rapidly in Holland, from 10000 pair in 1930 to 26,000 by 1938 (12.1% per year). Control measures were then instituted (10,000 adults killed), but WWII complicated matters including ability to census. Eggs were taken for food. In 1947 the population was around 16,000 (likely higher) and by 1954 about 23,000 (5.3% per year increase). Additional control measures then reduced the numbers severely. Reviewed methods of control.

Mougin, J.L., C. Jouanin and F. Roux. (1987). Structure et dynamique de la population de Puffins cendres *Calonectris diomedea borealis* de l'ile Selvagem Grande. *L'Oiseau et Rev Fr Ornithol.* **57(3)**:201-225.

Reviewed exploitation of Cory's Shearwaters on Selvagen Grande Island, which began in the 19th century and ended in 1976. Using numbers of birds harvested and demographic parameters reconstructed the original population at 300 thousand breeders. Though the population of breeding birds was reduced to 5000 in 1976, the fact that the pre-breeding population is large (first breeds at 7-13 years), resulted in a large recovery among breeders (but not total population) to 26,000 during the first few years post-exploitation. The population then stabilized and the demographic model projects, on the basis of current rates of life-history parameters, that it will increase at an annual rate of 1.2% per year, thus requiring 600 years to return to pre-exploitation levels. In fact, no increase has been apparent through 1986.

Mudge, G.P. (1986). Trends of population change at colonies of cliff-nesting seabirds in the Moray Firth. *Proceedings Royal Society of Edinburgh, (Biological Science)* **91B(1-4)**:73-80.

Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, U.K.

Reviewed population changes for several species at three areas in the Moray Firth, 1980-84 and compared to trends during the preceeding two decades. During the period 1969 to the late 1970's or early 1980s, the annual rates of increase were as follows: Northern Fulmar, 2.6-4.3%; Great Cormorant, 5.7% (at one area, otherwise a decrease); European Shag, 1.2-6.8%; Black-legged Kittiwake, 1.8-6.0% (slight decline at one colony); Razorbill, 1.2-12.0% (slight decline at one colony); Common Murre, 1.2-12.1%; Black Guillemot, 9.7%; Atlantic Puffin, 2.6% (otherwise declines). Counts since have showed no further increases.

Mudge, G.P. (1988). An evaluation of current methodology for monitoring changes in the breeding populations of Guillemots *Uria aalge. Bird Study* **35**:1-9.

Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, U.K.

Murphy, E.C., A.M. Springer and D.G. Roseneau. (1985). Population status of Common Guillemots *Uria aalge* at a colony in western Alaska: results and simulations. *Ibis* **128**:348-363.

Institute of Arctic Biology and Department of Biology, Fisheries and Wildlife, University of Alaska 99775.

Constructed a population model for Common Murres breeding at Bluff, Alaska. Population was declining, 1975-83, owing to increased mortality of adults and particularly subadults during winter. The latter could be due to competition with a fishery.

Murphy, E.C., A.M. Springer and D.G. Roseneau (1989). Recent climatic anomalies and the troubled reproduction of kittiwakes at the Alaskan colonies in the Bering and Chukchi Seas. *Proceedings of the Arctic Sciences Conference*, no.40, p.27 (abstract only)

Nettleship, D.N. (1976). Gannets in North America: present numbers and recent population changes. *Wilson Bulletin* **88(2)**:300-313.

Chronicled changes in populations of Atlantic Gannets in Canada. The population at Bonaventure Island increased from 13250 pr in 1961 to 17281 pr in 1973 (2.2% per year), although the 1973 figure was a reduction from 21215 pr in 1966 (9.91 % per year increase between 1961 and 1966). Bonaventure is the largest colony and one of the best chronicled. The best known colony is the one on Funk Island, which was colonized in 1937 and reached 4051 pair by 1972 (27% per year); between 1959 and 1972, when the most detailed census data are available the annual rate of change is 3.0%. At Bird Rocks, Quebec, the rate of increase between 1967 (5000 pr) and 1973

(5331 pr) is 1.0%. Colonies in the Gulf of St.Lawrence (e.g. Bonaventure) have recently declined, whereas those in Newfoundland have remained stable. Speculated that pesticide contamination might be the cause of declines.

Nichols, J.D. (1991). Responses of North American duck populations to exploitation. In: *Bird Population Studies; Relevance to Conservation and Management* (C.M Perrins, J.-D. Lebreton & G.J.M. Hirons, eds.) pp.498-525. Oxford: Oxford Univ. Press.

Hypothesized that dabbling ducks exhibited low annual survival rates and lacked density-dependent mechanisms of population regulation, whereas diving ducks have higher survival rates and are density dependent. Density-dependent reproductive rates are a compensatory response to mortality. Therefore, the latter species would be more affected by any factor such as hunting pressure, and would not be able to withstand it to the degree that the former species could.

Nichols, J.D., M.J. Conroy, D.R. Anderson and K.P. Burnham (1984). Compensatory mortality in waterfowl populations: a review of the evidence and implications for research and management. *Transactions of the North American Wildlife Natural Resources Conference* **49**:535-554. Washington, DC: Wildlife Management Institute.

Nisbet, I.C.T. (1973). Terns in Massachusetts: present numbers and historical changes. *Bird-Banding* **44(1)**:27-55.

Massachusetts Audubon Society, Lincoln, MA 01773.

Chronicled tern populations in the eastern U.S. with the best data coming from Massachusetts. Common Terns increased from 7500 pr in 1885 to 30,000 pr in 1920 (4% per year) and then declined to 7500 pr by 1970. Arctic Terns increased from about 20 pair in 1890 to 400 in 1946 (5.5% per year) and then declined to 110 by 1972. Roseate Terns increased from about 2000 pr in 1872 to about 4750 pr in 1938 (1.4% per year) and then decreased to 2300 pr by 1972. Least Terns increased from about 100 pr in 1923 to 1500 pr by 1950 (10.2% per year) and then decreased to 950 pr by 1972. The low points in the late 1800s were reached owing to disturbance and egging, and the increase followed when egging was discontinued and some protection from disturbance was afforded. Immigration was important in several cases, especially for Least Terns, where regional shifts in populations were apparent. Some trends for other eastern states were reviewed in somewhat less detail. Rates were similar to Massachusetts. For instance, in Maine Common Terns increased at 4.3% per year between 1900 and 1940. Least Terns increased by 12-16% per year on Long Island between 1924 and 1972.

Nisbet, I.C.T. (1978). Population models for Common Terns in Massachusetts. *Bird-Banding* **49(1)**:50-58.

Massachusetts Audubon Society, Lincoln, MA 01773.

The recent increase in the rate of decline in Common Terns from 3-4% prior to 1969 to 8-10% more recently is due to an increase in adult mortality from 9 to 17%.

Nisbet, I.C.T. (1978). Recent changes in gull populations in the western North Atlantic. *Ibis* **120**:129-130.

Massachusetts Audubon Society, South Great Rd., Lincoln, MA 01773.

Reviewed trends in gull populations in the U.S. The Herring Gull increased at 4-5% per year between about 1900 and 1970, but in the 1970s the population appears to be leveling off. Leveling off was reached first in the north (maritime Canada) and progressively later moving south. Numbers in the southeastern U.S. may, in fact, still be increasing slightly. The Great Black-backed Gull colonized the U.S. in 1926 and increased until 1965. The 17% per year rate of increase was aided by immigration from Canada. The population is still increasing. Kittiwake trends are unknown. Laughing Gulls appear to be decreasing perhaps due to competition with larger species. Ring-bill Gulls increased explosively in the Great Lakes region between 1926 and 1967, though may be now decreasing due to higher water levels. Little Gulls recently colonized the Great Lakes and Black-headed Gulls are suspected of having done so in eastern Canada. The growth of refuse dumps and fisheries has aided the gull increase. In areas where fisheries have closed down, Herring Gulls have declined.

Noble, D.G., A.J. Gaston, and R.D. Elliot. (1991). Preliminary estimates of survivorship and recruitment for Thick-billed Murres at Coats Island. **In:** *Studies of High-Latitude Seabirds,* v.2: *Conservation Biology of Thick-billed Murres in the NW Atlantic.* (A.J. Gaston & R.D. Elliot, eds.), pp.45-51 Occasional Paper No.69. Ottawa: Canadian Wildlife Service.

Department of Biology, Queen's University, Kingston, Ontario, Canada K7L 3N6

Nolet, B.A. (1988). Breeding success of some coastal birds in a Herring Gull *Larus*

argentatus colony. *Limosa* **61(2)**:85-90.

Zoologisch Laboratorium, Rijksuniversiteit Gronongen, Postbus 14, 9750 AA Haren (Gr) The Netherlands.

When pesticides were no longer disposed of near Rottumeroog, Netherlands, several species began to increase, 1960-1988: oystercatchers, 7.5% per year; eiders, 17.1% and Herring Gulls, 18.2%. The rapid increase in gulls prevented a recovery in the tern populations.

O'Donald, P. and J.W.F. Davis (1975). Demography and selection in a population of Arctic Skuas. *Heredity* **35**:75-83.

Dept. of Genetics, University of Cambridge, Milton Road, Cambridge CB4 1XH, England.

Calculated intrinsic rate of increase for Arctic Skuas on Fair Isle as 3.7% for males and 4.4% for females. Between 1962 and 1973, the population increased from 71 to 106 birds (3.7% exponential rate) though by prediction it should have reached 116 birds. Emigration or immigration was not accounted for though the authors suspect it was involved in the population dynamics.

O'Donald, P. and J.W.F. Davis (1976). A demographic analysis of the components of selection in a population of Arctic Skuas. *Heredity* **36(3)**:343-350.

Dept. of Genetics, University of Cambridge, Milton Road, Cambridge CB4 1XH, England.

Calculated the intrinsic rate of increase for Arctic Skuas on Fair Isle, Shetlands as well as factors that affect the rate. The rate varies according to color morph and assortative mating. For all males, the rate is 4.6% and for all females it is 6.0%. Within sexes, dark males and pale females have the highest rates. Reproductive success and age of maturity affect intrinsic growth rate.

Olden, B., M. Peterz and B. Kollberg (1985). Seabird mortality in the gill-net fishing, Southeast Kattegat, South Sweden. *Anser* **24**:159-180.

Slatterv 27 F, 222 38 Lund.

Ollason, J.C. and G.M. Dunnet. (1983). Modelling annual changes in numbers of

breeding Fulmars, *Fulmarus glacialis,* at a colony in Orkney. Journal of Animal Ecolgy **52:**185-198.

Culterty Field Station, Univ. of Aberdeen, Newburgh, Ellon, Aberdeenshire, AB4 0AA.

On the basis of a model (in turn based on a 22 year study) of fulmar demographics, recruitment and survival were important to the growth rate of the population and particularly recruitment. The model fairly well duplicated the observed growth rate which has been 7% per year in the northeastern Atlantic and 4.6% per year over 28 years at the Orkney study colony. There is noticeable variation in the rate of increase in breeding birds between years, ranging from +60 to -40%.

Olsthoorn, J.C.M. and J.B. Nelson (1990). The availability of breeding sites for some British seabirds. *Bird Study* **37:**145-164.

Erasmus University, Erasmus Center for Environmental Studies, P.O. Box 1738, Burgemeester Oudlaan 50, 3000 Dr. Rotterdam, The Netherlands.

Studied nest-site limitation for five species (European Shag, Black-legged Kittiwake, Common Murre, Razorbill and Northern Fulmar) on a stretch of Aberdeenshire (Scotland) sea-cliff. Found many unused but adequate nesting spaces for the five species. Sites could not be divided into good and bad--reproductive success was similar for all. Thus these populations were not apparently site-limited (contrast with Potts et al 1980 study of shags). At their study site shags increased at 11.6% per year, kittiwakes at 5.1% per year, and murres at 5.1% per year (original data not presented [see Olsthoorn 1984, Thesis]), note that the sea-cliffs contained thousands of kittiwakes and murres and hundreds of shags. The other two species showed no increase.

Parslow, J.L.F. (1967). Changes in status among breeding birds in Britain and Ireland. *British Birds* **60(5):**177-202.

Reviewed the status of birds breeding in Britain as of 1966. All Atlantic Puffins have declined noticeably during this century, but populations of Razorbill, Common Murre and Black Guillemot appear to be stable (local extinctions and colonizations). All terns have decreased, except for Sandwich Tern, which has showed a 3.2% per year increase on the east and south coast from 1920 to 1964 (1000 to 4000 pair). Following release from persecution, Arctic Skuas have increased; for example, at a rate of 11.6% per year on Fair Isle. Great Skuas have been increasing in number; for example, 3.3% per year on Foula between 1880 and 1963, and 9.3% in Orkney between 1915 and 1963. The population appears to be shifting from Iceland to Scotland.
Great Black-backed Gulls have been exhibiting a marked and widespread increase

since about 1880, prior to which they were decreasing. From the end of the 19th century (c. 1880) until 1930 they increased to about 1100 pairs in England and Wales (c. 15% per year); thereafter numbers increased only on islands and, to 1956, increased more slowly (c. 1.4% per year). On the Isles of Scilly from 1930 until 1966 they increased at a rate of 1.5% per year. The reason for the increase was primarily the increase in refuse and offal, and secondarily a relaxation of persecution. Lesser Black-backed Gulls have exhibited trends that differ from region to region but as a whole have been increasing slowly. Populations have returned to historical levels. At Walney Island, Lancashire, where the colony was founded about 1930, numbers had reached 10,000 pair by 1966 (29% per year increase!). It appeared that many of these birds had emigrated from two other islands which were abandoned by the gulls before 1940. Herring Gulls have increased throughout the British Isles, especially during the past 20 years. The colony on Walney Island is likely the largest (15,000 pair); the rate of increase from 1904, when it was founded, to 1964 is c. 17% per year. Populations in the Bristol Channel increased at 6% and at the Isle of May at 13% during this century (up to about 1956; though still increasing as of 1966). Between 1938 and 1958, Black-headed Gulls increased 11.2% per year throughout England and Wales; in 1966 numbered about 50,000 pair. In North Kent, on salt dikes, the population increased at rate of 10.4% per year during the 1950s and 1960s. As indicated by Coulson, the Kittiwake population, released from persecution, has increased at about 3% per year during this century.

Pasquet, E. (1986). Demographie des Alcides: analyse critique et application aux populations Francaises (suite et fin). *Oiseau et la Revue Francaise d'Ornithologie* **56(2)**:113-170; **56(1)**:1-57.

Pehrsson, O. (1989). Effects of food abundance and population density on duck reproduction. (abstract only) *Wader Study Group Bulletin* **57**:19.

Piatt, J.F. and D.G. Reddin. (1982). Recent trends in the west Greenland salmon fishery, and implications for Thick-billed Murres. **In:** *Marine birds: their feeding ecology and commercial fisheries relationships.* (D.N. Nettleship, G.A. Sanger and P.F. Springer, eds.), pp. 208-211. Special Publication. Ottawa: Canadian Wildlife Service.

Dept. of Biology, Memorial University, St. John's, Newfoundland, Canada A1B 3X9.

Pierce, R.J. (1980). Seasonal and long-term changes in bird numbers at Lake Wainono. *Notornis* **27**:21-44.

The numbers of breeding Southern Black-backed Gulls increased 10-fold (33% per year) at Lake Wainono, South Island, New Zealand, between 1969 and 1977. Increased food supply was at least partly responsible for the increase. Paradise Shelducks increased 30 fold (53% per year) during the period. This is in response to improved habitat, but mainly prohibition of hunting at this particular lake. Immigration is likely. Other species discussed, which were not "seabirds", remained stable, though a heron decreased and a shorebird increased during the period.

Podolsky, R.H. (1990). Effectiveness of social stimuli in attracting Laysan Albatross to new potential nesting sites. *Auk* **107(1)**:119-124.

Porter, J.M. and J.C. Coulson. (1987). Long-term changes in recruitment to the breeding group, and the quality of recruits at a Kittiwake *Rissa tridactyla* colony. *Journal of Animal Ecology* **56**:675-689.

Department of Zoology, University of Durham, South Road, Durham City DH1 3LE

Investigated Black-legged Kittiwakes at North Shields colony 1949-1984. Recruitment rate increased inversely to colony size and directly with adult mortality, indicating a pool of non-breeding birds capable of breeding. Annual variation in the mortality of immatures was not in concert with that of adults indicating that the decline in numbers of adults during the late 1960s was due to factors in the prebreeding period. The colony is apparently not a closed one and is sustained by immigration. Immigrants are more attracted to small colonies. The annual growth rate of 47 colonies throughout Britain 1959-1969 was 4% (Coulson 1983), with rates higher at small colonies. This rate, however, can not be sustained; rather it decreases as population increases. The authors compared the history of the North Shields colony to that predicted by the model. The population duplicated the model until 1967 when population size reached an asymptote and later decreased somewhat. Breeding space limits population size at North Shields.

Potts, G.R. (1969). The influence of eruptive movements, age, population size and other factors on the survival of the Shag (*Phalacrocorax aristotelis)* (L.)) *Journal of Animal Ecology* **38**:53-102.

Dept. of Zoology, University of Durham

Investigated the ecology of the European Shag on the Farne Islands and Firth of Forth. The total population in the latter area decreased from 25 to 10 pairs from 1885 to 1910 and then increased to 1100 pair by 1965 at a rate of 9% per year. Within this area, at the Farne Islands, breeding began in 1930 and reached 1250 nests by 1965, at a similar rate of increase. Wintering populations increased at the same rate. On the Isle of May, the population ceased to breed in 1900, but by 1953 about 50 pair bred

(7.7% per year increase). Discusses how population has increased in response to release from persecution by humans. During this century other species have also increased for the same reason: European Cormorants at 4.6% and Atlantic Gannets at 4.2%.

Potts, G.R., J.C. Coulson and I.R. Deans (1980). Population dynamics and breeding success of the Shag *Phalacrocorax aristotelis,* on the Farne Islands, Northumberland. *Journal of Animal Ecology* **49**:465-484.

Department of Zoology, University of Durham

Investigated European Shags on the Farne Islands 1961-1971, with data on population size to 1978. Population is limited by nesting space. As the latter becomes unavailable, and more and more birds nest in suboptimal sites, reproductive success decreases. After a large dieoff due to red tide in 1968, success increased markedly especially among first-time breeders which moved to recently vacated but better sites. Immigration sustained the population and was especially high following large dieoffs. Generated a computer model that duplicated the overall annual rate of increase of 11%, except during the two years following large mortalities (1968 and 1975) when immigration increased recovery rate markedly.

Pryor, M.E. (1968). The avifauna of Haswell Island, Antarctica, pp. 57-82 in *Antarctic Bird Studies* (O.L. Austin, Jr., ed.) pp. 57-82. Antarctic Research Series, Vol. 12, Washington, D.C.: American Geophysical Union,

The population of Adelie Penguins increased from 10,000 birds in 1912 to 15,000 in 1956 (0.9% per year) to 35,600 in 1962 (15.5%, 2.6% overall).

Randall, R. and G.J.B. Ross. (1978). Increasing population of Cape Gannets on Bird Island, Algoa Bay, and observations on breeding success. *Ostrich* **50**:168-175.

Reviewed population trends of Cape Gannets, Atlantic Gannets and Australasian Gannets and summarized literature. Calculated per cent increase by dividing percent change in number by the number of years between counts. The Cape Gannet at Bird Island, Algoa Bay, decreased at 2-6% per year between 1936 and 1945 and thereafter increased by 2.9-5.2% per year 1945-1974 (for the period 1956-1974, when the population increased 1.9 fold the rate is given as 5.2% but when using the exponential rate, the increase comes to 3.6%). For the Atlantic Gannet in the British Isles, using the first mentioned method of calculation, rates of increase ranged 1.7-5.9% per year and in Canada 1.2-3.5% between the 1940s and 1970s. In New Zealand, the Australasian Gannet increased at a rate of 4.9% per year at Colville between 1928 and 1947, and 2.5% at Hawkes Bay between 1931 and 1946. The increase in the African population is due to less disturbance from guano collections.

Rattiste, K. and V. Lilleleht. (1986). Some aspects of the demography of the Common Gull *Larus canus* in Estonia. *Var Fagelvarld Suppl.* **11**:179-186.

Reid, W.V. (1988). Population dynamics of the Glaucous-winged Gull. *Journal of Wildlife Management* **52(4)**:763-770.

Department of Zoology NJ-15, University of Washington, Seattle, WA 98195.

Constructed a demographic model for Glaucous-winged Gulls at Protection Island, Washington and reviewed changes in populations in British Columbia and Washington. No historical change in distribution has occurred but populations have increased at the southeastern end of the breeding range. Citing other references, between the early 1900s and 1960, 4 colonies in southwest British Columbia increased at mean annual rate of 3-5%. At 7 colonies in northwest Washington, numbers increased 2% per year between 1963 and 1970; one of these colonies (Colville Is) increased at 3% between 1963 and 1976. At Protection Island, the largest colony outside of Alaska, numbers increased 5.9% per year between 1976 and 1984. On the basis of the population model, which in turn was based on field data, the growth rate was estimated at 5.1% per year. The population growth has resulted from decreased human disturbance and increased food availability.

Reilly, P.N. and J.M. Cullen (1979). The Little Penguin *Eudyptula minor* in Victoria, I: Mortality of adults. *Emu* **79(3)**:97-102.

Reilly, P.N. and J.M. Cullen (1981). The Little Penguin *Eudyptula minor* in Victoria, II: Breeding. *Emu* **81(1)**:1-19.

Reilly, P.N. and J.M. Cullen (1982). The Little Penguin *Eudyptula minor* in Victoria III. Dispersal of chicks and survival after banding. *Emu* **82(3)**:137-142.

19 Lialeeta Ave. Fairhaven, Victoria 3221.

Rice, D.W. and K.W. Kenyon (1962). Breeding distribution, history, and populations of North Pacific Albatrosses. *Auk* **79(3)**:365-386.

U.S. Fish and Wildlife Service, Sand Point Naval Air Station, Bldg. 192, Seattle 15, Washington.

Discuss the factors that affect nest counts relative to determination of the total nesting population of Laysan and Black-footed Albatross. Provides some data on count results during this century. For Sand Island (Midway), constructed by eye logistic growth curves for the two species as representative of trends though the data used are rough. Both species numbered c. 1000 pair around 1900. Following release from persecution (feather hunters etc) and revegetation of the island (following replanting and removal of feral rabbits), during subsequent exponential phase of growth, the two species' populations grew at the same rate i.e. at 26-28% per year. Growth of the Black- footed population stabilized at 5-6000 pair after reaching a peak of 20,000; the decline may have been due to the WWII or ecological change in vegetation. Laysans continued to increase, though more slowly (4%) between 1945 and 1958, and reached c. 60,000 by 1958. Other islands were also affected by feather hunters and ecological damage due to introduction of rabbits. On Lisianski Island Black-foots increased 3.0% per year (1000 to 2700 pair) and Laysans increased 10.4% per year (1000 to 29000 pair) between 1923 and 1957. On Laysan, Black-foots increased by 8.7% per year (7000 to 320000) and Laysans by 5.3% (12000 to 131000) between 1911 and 1957. Elsewhere, such as French Frigate Shoals, populations did not change noticeably, but on many islands in the western Pacific (Johnston, Torishima) the two species were extirpated during this century and never recolonized.

Richdale, L.E. (1957). *A Population Study of Penguins.* Oxford: Clarendon Press. 195p. 14B Arcadia Road, Epsom, Auckland, 3, New Zealand.

Summarizes 18-year study of demography and breeding biology of Yellow-eyed Penguins at Otago, New Zealand, 1936-1954. Adult survival and breeding success were affected during some years by (supposed) food availability. Population decreased from 36 pairs in 1938-39 to 26 in 1942-43 (c. 7% per yr) then increased steadily until 1952-53 season (82 pair) (c. 12.2% per yr). Adult survivorship increased from c. 74% in early years to 87-94% during the years of increase. Lessening of persecution, as well as immigration, were responsible.

Richdale, L.E. and J. Warham (1973). Survival, pair bond retention and nest-site tenacity in Buller's Mollymawk. *Ibis* **115**:257-263.

14B Arcadia Road, Epsom, Auckland, 3, New Zealand.

Ricklefs, R.E. (1973). Fecundity, mortality, and avian demography. **In:** *Breeding Biology of Birds: Proceedings of a Symposium on Breeding Behavior and Reproductive Physiology in Birds; Denver, Colorado, Feb. 1972* (D.S. Farmer, ed.), pp.366-435. Washington, DC: National Academy of Sciences.

Discusses effects of variation in demographic parameters on growth potential of populations. Growth potential and actual growth can not be easily equated because density-dependant factors absorb surplus productivity. Growth potential represents ability of population to recover from decimation and the rate at which it can be exploited under controlled management. After reviewing critical parameters, the paper discusses life tables and recruitment. Uses Yellow-eyed Penguin data of Richdale, among other examples, to demonstrate life table analysis. Discusses annual variability among the various life table parameters.

Risebrough, R.W. (1986). Pesticides and bird populations. **In:** *Current Ornithology,* Vol.3 (R.F. Johnston, ed.), pp.397-427. New York: Plenum Press.

Bodega Bay Institute, Berkeley, CA 94705.

Pesticide contamination has lowered the growth potential of affected bird populations by reducing nesting success and negatively affecting the food supply.

Rodway, M.S. (1990). Status and conservation of breeding seabirds in British Columbia. **In:** *Seabird Status and Conservation: a Supplement* (Croxall, J.P., ed.), pp. 43-102. ICBP Technical Publ. No. 11. Cambridge, Eng.: International Council for Bird Preservation.

Provides current status of seabirds throughout British Columbia in much detail. Referred to increasing trends in several species, many of which have been discussed elsewhere, but provide quantitative data only for Rhinoceros Auklet at Cleland Island. The species increased from 25 pair in 1967, soon after colonization, to about 1000 pair in 1988 (19.2% per year). Much more detail is presented for species that have been declining.

Rounsevell, D.E. and G.R. Copson (1982). Growth rate and recovery of a King Penguin, *Aptenodytes patagonicus,* population after exploitation. *Australian Wildlife Research.* 9:519-525.

Tasmanian National Parks and Wildlife Service, P.O. Box 210, Sandy Bay, Tas 7005

King Penguins at MacQuarie Island have increased 78 fold between 1930 and 1980.

The logarithmic growth rate is 7.9% (exponential is 9.1% per year), calculated on the basis of 600 chicks produced in 1930 and 46595 in 1980. Two large colonies were reduced to one at Lusitania Bay of 1700 pair due to exploitation for blubber; exploitation ceased in 1918. A second colony was started only in 1975 after the Lusitania Bay colony had reached its former size (109,000 pr). The calculated growth rate of the Lusitania population is likely close to the intrinsic growth rate. The time of recovery is actually 70-80 years, however, rather than the 50 years mentioned above; the colony apparently existed in a "lag phase" for a number of years post exploitation before beginning to increase (a 6.0% exponential rate of increase).

Rutschke, E. (1985). Status and developmental trends in the waterfowl population in the DDR. (In German with English summary.) *Beitraege zur Vogelkunde* **31(1/3)**:7-34.

Safriel, U.N., M. P. Harris, M. de L. Brooke and C.K. Britton (1984). Survival of breeding oystercatchers *Haematopu ostralegus. Journal of Animal Ecology* **53**:867-877.

Edward Grey Institute, Dept. of Zoology, University of Oxford, Oxford OX1 3PS, England.

The number of breeding oystercatchers on Skokholm remained stable, with narrow fluctuation, from 1946 to 1982. Annual survival was high (0.902).

Samuels, W.B. and A. Ladino (1983). Calculations of seabird population recovery from potential oilspills in the mid-Atlantic region of the United States. *Ecological Modelling* **21**:63-84.

US Minerals Management Service, Mailstop 644, Reston, VA 22092 USA

Used a deterministic, density-dependent model to estimate the recovery times, at various levels of mortality, for Herring Gull and Common Tern populations. Data input was from Kadlec & Drury (1968) and Chabryzk & Coulson (1976) for Herring Gulls and from Austin & Austin (1956) and Nisbet & Drury (1972) for Common Terns. In worst-case scenario of 95% mortality to all age classes, gulls required 45 years and terns 100 years to recover to pre-spill population levels. Recovery times 1.4 times slower using logistic growth. Both model and census data showed annual growth rate of about 5% per year for gulls. Model estimated 3% growth rate for terns. Data from Korschgen (1979) indicated that terns increased 5-6% per year in Maine, 1900-1940. Populations were most sensitive to loss of adults due to oil spill mortality, rather than loss of pre-breeders.

Samuels, W.B. and K.J. Lanfear (1982). Simulations of seabird damage and recovery from oilspills in the Northern Gulf of Alaska. *Journal of Environmental Management* **15(2)**:169-182.

Modeled recovery rates for Common Murres and Glaucous-winged Gulls using Wiens et al. (1979) age-specific survival model. Used data from Herring Gulls to model the gulls and data from Birkhead (1977) as modified by Wiens et al. for the murres. Modeled on the basis of logistic and density-dependant growth, with carrying capacity assumed to be the pre-spill population size. Post-spill population assumed to be 5% of original. The gull population recovered in 20 years (3% per year) and the murres in 70 years (1%).

Schnakenwinkel, G. (1970). Studien an der Population des Austerfischers *Haematopus ostralegus* auf Mellum. *Die Vogelwarte* **25**:336-355.

During this study the oystercatcher population in Germany increased at a rate of 5% per year for a 14-year period. On average c. 23% of adult oystercatchers did not breed in any given year. Annual survival was high (0.937).

Schreiber, E.A. and R.W. Schreiber (1989). Insights into seabird ecology from a global "natural experiment." *Natl. Geographic Res.* **5(1)**:64-81.

Los Angeles County Natural History Museum, Los Angeles, CA 90007

Hypothesize that seabird populations in the equatorial Pacific are not regulated by density-dependent factors.

Seip, K.L., E. Sandersen, F. Mehlum and J. Ryssdal (1991). Damages to seabirds from oil spills comparing simulation results and vulnerability indexes. *Ecological Modelling* **53(1-2)**:39-60.

Cent. Industrial Res., Forskningsvn. 1, 0134 Blindern Oslo 3, Norway.

Serventy, D.L. and P.J. Curry (1984). Observations on colony size, breeding success, recruitment & inter-colony dispersal in a Tasmanian colony of Short-tailed Shearwaters *Puffinus tenuirostris* over a 30-year period. *Emu* **84(2)**:71-79.

CSIRO Division and Wildlife Rangelands Research, Fyfe St., Helena Valley, WA 96056

Numbers of Short-tailed Shearwaters breeding on Fisher Island decreased by 71%

from 1948 to 1972, and thereafter (until 1980) numbers increased slightly to 67% of the 1948 total. In spite of the 30 year ringing effort, the study had not yet covered an entire generation of this species. Only 14% of fledglings recruited to their natal colony. Emigration from Fisher Island appears to be about 50%, and is balanced by immigration. The population decline is thought to be due to disturbance, as the species' population in the region is expanding.

Simons, T.R. (1984). A population model of the endangered Hawaiian Dark-rumped Petrel. *Journal of Wildlife Management* **48(4)**:1065-1076.

Wildlife Science Group, College of Forest Resources, University of Washington, Seattle, WA 9819d5.

Derives a population model for Dark-rumped Petrels in Hawaii. The model shows particularly sensitivity to reduction in breeding success and especially adult mortality.

Southern, H.N. (1966). Distribution of Bridled Guillemots in east Scotland over eight years. *Journal of Animal Ecology* **35(1)**:1-11.

Bureau of Animal Population, Oxford University.

Using bridled plumage morphs provide estimates of recruitment into a murre population near Aberdeen.

Southward, A.J., E.I. Butler and L. Pennycuick (1975). Recent cyclic changes in climate and in abundance of marine life. *Nature* **253**:714-717.

Marine Biological Association, Citadel Hill, Plymouth PL1 2PB, UK.

Spaans, A.L. (1980). Gull demography in the Netherlands. *Bulletin Gull Study Group* **No.2**:4-9.

Spaans, A.L., A.A.N. de Wit, and M.A. van Vlaardingen (1987). Effects of increased population size in Herring Gulls on breeding success and other parameters. *Studies in Avian Biology* **10**:57-65.

Compared nest density, clutch initiation date, egg volume, reproductive success and chick growth in Herring Gulls on Terschelling Island, Netherlands, between two periods 1967-69 and 1983-84. All factors were retarded at the 3-fold higher densities.

Spear, L.B., T.M. Penniman, J.F. Penniman, H. Carter, and D. Ainley (1987). Survivorship and mortality factors in population of Western Gulls. *Studies in Avian Biology* **10**:44-56.

Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, California 94970.

Provides data for demographic parameters in a stable population of Western Gulls.

Spina, F., F. Bolognesi, S. Frugis and D. Piacentini (1986). The return of the Cormorant, *Phalacrocorax carbo sinensis,* as a breeding bird in continental Italy: new colony discovered in Val Campotto (Ferrara) (in Italian). *Rivista Italiana di Ornitologia* **56(1-2)**:127-129.

Spitzer, P.R. A.F. Poole and M. Scheibel (1985). Initial population recovery of breeding Ospreys *(Pandion haliaetus)* in the region between New York City and Boston. *International Ornithological Congress XVIII, Proceedings,* Vol.II, pp.705-714. Moscow: USSR Academy of Sciences.

Section of Ecology & Systematics Langmuir Lab., Cornell Univ., Ithaca, NY 14850.

Osprey populations in the northeast decreased 10% per year over the period 1957-1969 owing to 3-6 fold reductions in natality (from 1.0-2.0 young per nest to 0.2-0.4 young). Though natality then increased significantly (to 1.5 per nest), the population continued to decline though more slowly (3%) and then leveled off at its historical low point in 1976. Population size began to increase at 7-12% per annum thereafter (through 1981).

Spitzer, P.R., A.F. Poole and M. Scheibel (1983). Initial population recovery of breeding Ospreys in the region between New York City and Boston. **In:** *Biology and Management of Bald Eagles and Ospreys,* (D.M. Bird, ed.), pp.231-241. Ste. Anne de Bellevue, Quebec: Harpell Press.

Section of Ecology & Systematics, Langmuir Lab., Cornell University, Ithaca, NY 14850.

Stowe, T.J. (1982). Recent population trends in cliff-breeding seabirds in Britain and

Ireland. *Ibis* **124**:502-510.

Reviewed changes in the population size of Northern Fulmars, Black-legged Kittiwakes, Razorbills and Common Murres in Britain 1971-79 to update Cramp, Bourne & Saunders (1974). Only the fulmars were counted annually. At 26 of 38 sites no change in fulmar numbers occurred, but at others increases ranged 3.1-21.0% per year. Kittiwake trends ranged from decreases of 29.5% to increases of 17.7% in total population size; majority of decreases were in Orkney and the majority of increases were in northwest Ireland. For Razorbills, count errors were high and no changes were detectable at 34 of 57 sites; at the remainder increases ranged 10-14% with only a few decreases. Murres numbers were either stable or increasing at all sites, with increases modeled at 3.7-6.3% per year.

Stowe, T.J. (1982). An oil spillage at a guillemot colony. *Marine Pollution Bulletin* **13(7)**:237-239.

Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK.

Studied the impact and recovery among Common Murres at colonies in Humberside (NE England) following an oil spill. Two study plots had been censused annually from 1972 to 1976; annual rates of increase were 6.2 and 8.7%. In June 1977, two months after a local spill that killed 1400 birds, the populations had decreased 20.5 and 19.6%, respectively, from 1976 levels. Overall, the numbers of murres in the total colony had decreased from an estimated 12200 in 1975 to 9224 in 1977. In 1978, the plot counts had increased 43.9 and 35.6% above pre-spill levels; total counts were estimated at 13250. A model in which growth was 7.5% and the other population parameters were from Birkhead & Hudson (1977) did not adequately explain the increase; prespill numbers were reached in year 3 post-spill. It is likely that an unusually large number of murres chose not to breed in the oil-spill year for whatever reason (deterrence owing to the spill?).

Swann, R.L. and A.D.K. Ramsay (1983). Movements from and age of return to an expanding guillemot colony. *Bird Study* **30**:207-214.

The Common Murre population on the Isle of Canna, Inner Hebrides increased 10-16% per year 1973-1982 (the former being the minimum estimated rate and the latter being the maximum). Provide data on several age-specific demographic parameters. Philopatry is thought to be high.

Tanner, J.T. (1966). Effects of population density on growth rates of animal populations. *Ecology* **47**:733-745.

Radiation Ecology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Tested the hypothesis that population growth is density dependent in 111 populations of 71 species where adequate data were available, including data for gannets in the North Atlantic over a 24- year period (Fisher and Vevers 1949) and Northern Fulmars in Britain over a 14-year period (Fisher 1952). Correlated growth to change in density. Found negative correlation coefficients, but only that for the fulmar was significant. Found that for most animals population growth rate is a decreasing function of density.

Taylor, R.H., P.R. Wilson and B.W. Thomas (1990). Status and trends of Adelie Penguin populations in the Ross Sea region. *Polar Record* **26(159)**:293-304.

Reviewed nest counts at 20 rookeries in the Ross Sea, 1981-1987, using aerial photographs. No change was evident at two rookeries that exceeded 150,000 pair, but at smaller ones increases ranged between 4.3 and 15.8% per year (mean = 8.5%). The most frequently censused rookeries were Cape Hallett (9.8%) and Beaufort Island (5.7%); the remaining sites had only 2-4 censuses for comparison. Ascribed increase to lighter pack ice conditions due to an ameliorating climate.

Taylor, R.H. and P.R. Wilson (1990). Recent increase and southern expansion of Adelie penguin populations in the Ross Sea, Antarctica, related to climatic warming. *New Zealand Journal of Ecology* **14**:25-29.

The Adelie Penguin populations at Capes Royds and Bird, McMurdo Sound, increased over the period 1966-1987, at 5.2 and 4.7% per year, respectively. The most marked increase occurred after 1980. During the mid-1980s a more southern locality was recolonized after an hiatus of at least several decades. Lessened ice conditions in McMurdo Sound appear to be the cause.

Temple, S.A. and J.A. Wiens (1989). Bird populations and environmental changes: can birds be bio-indicators? *American Birds* **43(2)**:260-270.

Dept Wildlife Ecology, Univ Wisconsin, Madison, WI 53706

Discusses the meaning of trends in primary (fecundity, mortality, etc) and secondary (density, population size) demographic parameters. Primary data are much more difficult to obtain than secondary ones, but monitoring of primary data are much more sensitive to environmental change after ruling out annual variability. Two fundamental questions can be asked: Has a significant change occurred in a monitored population, and what temporal and spatial correlates of that change may help to identify the underlying cause? Duration of a change in a primary parameter is more important than the extent, and changes are species specific (some populations are eruptive).

Thomas, T. (1986). L'effectif des oiseaux nicheurs de l'archipel de Pointe Geologie (Terre Adelie) et son evolution au cours des trente dernieres annees. L'Oiseau et la Revue Francaise d'Ornithologie **56:**349-368.

Reviewed the status and populations of birds nesting at Pointe Geologie, Antarctica, 1958-1984. Adelie Penguins increased 53.6% at a rate of 1.7% per year, Emperor Penguins decreased c. 50% (- 1.6% per year) especially after the early 1970's, Giant Fulmars decreased 7 fold from 1955 to 1964 and then remained stable, and Antarctic Fulmars doubled at a rate of 6.0% per year. The Giant Fulmar numbers decreased owing to establishment of a research base, but reasons behind changes in populations of the other species are not known.

Thomson, R.B. (1977). Effects of human disturbance on an Adelie Penguin rookery and measures of control. **In:** *Adaptations within Antarctic Ecosystems* (G.A. Llano, ed.). pp. 1177-1180. Washington, D.C.: Smithsonian Institution.

Antarctic Division, Department of Scientific and Industrial Research, Christchurch, New Zealand.

The number of Adelie Penguins breeding at Cape Royds, Ross Island, began to decline in 1956, and reached a low point in 1963, due to disturbance from tourists. In 1963, visitiation by people was controlled. The population grew at an annual rate of 4.2% thereafter (through 1973).

Toft, G.O. (1983). Changes in the breeding seabird population in Rogaland, SW Norway, during 1949-1979. *Fauna Norvegica Ser. C Cinclus* **6(1):**8-13.

Dept. Anim.Ecol, Zool. Mus., Univ. Bergen, N-5000 Bergen, Norway.

Determined trends in the population status of 17 species of seabirds in southwest Norway by comparing census results between 1948-50 and 1976-79. All breeding population sizes discussed are small (<2000 pair). Auks increased (Black Guillemot, 0.9% per year; Atlantic Puffin, 1.8%), declined (Razorbill, -1.3% per year) or disappeared (Thick-billed Murre). Larids decreased (Common Gull, 1% per year; Common Tern, 2%), increased (Lesser Black-back, 3.7% per year; Herring Gull, 3.6%; Great Black-backed, 1.7%; Kittiwake, 7.4%) or colonized (Black-headed Gull, Little Gull, Sandwich Tern and Arctic Tern, with a subsequent increase of 17.3% per year in the latter). The Arctic Skua population remained stable, that of the European Shag increased by 6.8% per year and that of the Northern Fulmar colonized and continued to grow at 10.2% per year. These rates are all exponential assuming colonization just after the initial survey. Those species that feed on fish offal have increased. Some of the auks have decreased because of mortality in fishing nets.

Tovar, H., V. Guillen and M.E. Nakama (1987). Monthly population size of three guano birds species off Peru, 1953 to 1982. **In:** *The Peruvian anchoveta and its upwelling ecosystem: three decades of change.* (D. Pauly and I. Tsukayama, eds.), pp. 208-218. ICLARM Studies and Reviews 15. Callao, Peru: Instituto del mar del Peru.

Instituto del Mar del Peru, P.O. Box 22, Callao, Peru.

Summarized estimates of population size of Peruvian Boobies, Guanay Cormorants and Peruvian Pelicans on guano islands of Peru 1953-1982. Respective populations of the booby and cormorant showed periods of increase followed by crash during El Nino in 1957-58 and 1965, though the overall trend was down. Over the entire 29-year period populations declined as follows, 1955-1982: cormorants a maximum of 33.5 to 5.2 million; the booby population from about 3.2 million to 2.8 million; and the pelican population from 1.3 million to 0.23 million. Exponential rate of increase in the cormorant and booby population from 1953 to the 57-58 event was approximately 50% and 10%, respectively; from then to the 1965 event was 10% and 8%, respectively; from then to the 1972-73 event was 1.2% and 7.8%; and from then to the 1982-83 event was 8.2% and 1%, respectively. The pelican population declined gradually throughout the period at about 4% per year. Increased fishing pressure on seabird prey accounted for the overall decline and the slowing of recovery rates following the catastrophic El Nino-related mortalities.

Van Impe, J. (1975). Estuarine pollution as a probable cause of increase of estuarine birds. *Marine Pollution Bulletin* **16(7)**:271-267.

Dept. of Environment, Institute of Hygiene and Epidemiology, J. Wytsmanstraat, 14, 1050 Brussels, Belgium.

Increased food supply in a Dutch estuary resulted in changes in the occurrence patterns of wading birds, including oystercatchers. With more food (due to eutrophication) the birds lingered longer before migration.

Veldkamp, R. (1986). Neergang en herstel van de Aalscholver *Phalacrocora carbo* in

NW-Overijssel [Decline and recovery of the Cormorant *Phalacrocora carbo* in NW Overijssel]. *Limosa* **59**:163-168.

Reviewed history of Great Cormorants at NW Overijssel from 1820 to 1986. The population decreased and increased repeatedly based on a number of factors ranging from human disturbance to direct control. For a time the site was protected, whereupon a dramatic increase occurred (c. 17% per year, 1930-1940, 500 to 2400 pr). The species was then controlled and reduced in number. During more recent years, recoveries have been slow perhaps due to pesticide pollution (c. 12% per year, 1970-1986, 100 to 600 pr)).

Vermeer, K. and S.G. Sealy (1984). Status of the nesting seabirds of British Columbia. **In:** *Status and Conservation of the World's Seabirds* (J.P. Croxall, P.G.H. Evans and R.W. Schreiber, eds.), pp.29-40. ICBP Tech. Publ. No. 2. Cambridge, Eng.: International Council for Bird Preservation.

Reviewed status of seabirds in British Columbia and included some information on trends in certain species. Alcids appeared to be decreasing. The Glaucous-winged Gull has been increasing since the early 1900s following cessation of egging and the rapid increase in the availability of refuse dumps. The largest known colony, on Mandarte Island, increased from 225 pair in 1915 to about 1800 pair in the 1960s (4.7% per year); that on Mitlenatch Island increased from 250 pair in 1922 to 1600 pair in 1975 (3.6% per year). The overall size of the Double-crested Cormorant population in BC increased from 219 pair in 1959 to 1600 pair in 1983 (8.6% per year); the largest colony, on Mandarte, increased from 10 pair in 1927 to 1100 pair in 1983 (10.8% per year). One colony that had been founded in 1978 grew to 198 pair by 1983, obviously by immigration. Pelagic Cormorants increased at Mandarte from 25 pair in 1915 to 550 by 1983 (4.7% per year) and at Bare Point from 50 pair in 1959 to 375 by 1983 (8.8% per year).

Voisin, J.F. (1988). Breeding biology of the Northern Giant Petrel *Mactonectes halli* and the S. Giant Petrel *M. giganteus* at Ile de la Possession, Iles Crozet 1966-80. *Cormorant* **16(2)**:65-97.

Laboratoire de Zoologie, Ecole Normale Superieure, 46 rue d'Ulm, 75230 Paris cedex 05, France.

Wanless, S., D.D. French, M.P. Harris and D.R. Langslow (1982). Detection of annual changes in the numbers of cliff-nesting seabirds in Orkney 1976-80. *Journal of Animal Ecology* **51**:785-795.

Nature Conservancy Council, Godwin House, George Street, Huntingdon,

Kincardineshire AB3 4BY

Warheit, K.I., D.R. Lindberg & R.J. Boekelheide (1984). Pinniped disturbance lowers reproductive success of black oystercatcher *Haematopus bachmani* (Aves). *Marine Ecology Progress Series* **17**:101-104.

Dept. of Paleontology, University of California, Berkeley, California 94720, USA.

Disturbance by people and pinnipeds reduces the breeding success of Black Oystercatchers. This limits oystercatcher breeding birds to disturbance-free areas.

Weimerskirch, H. and P. Jouventin (1987). Population dynamics of the Wandering Albatross, *Diomedea exulans*, of the Crozet Islands: causes and consequences of the population decline. *Oikos* **49(3)**:315-322.

Centre d'Etudes Biologiques des Animaux Sauvages, C.N.R.S., F-79360 Beauvoir-sur-Niort, France.

The numbers of Wandering Albatross at the Crozet Islands have been decreasing between 1966 and 1985 at a rate, in three colonies, of 2.6, 4.9 and 6.0% per year. Reasons for the decline are entanglement in fishing gear and shooting by fishermen. Present various demographic parameters for the species. During the period of most rapid decline adult survivorship was 90.5%, and during slower decline later in the period it was 94.4%. Age of fish breeding has become earlier.

Weimerskirch, H., J. Clobert and P.Jouventin (1987). Survival in five Southern Albatrosses and its relationship with their life history. *Journal of Animal Ecology* **56**:1043-1055.

Centre d'Etudes sur la Biologie des Animaux Sauvages, C.N.R.S., Villiers en Bois, 79360 Beauvoir/Niort, France.

Conducted studies on 5 albatross species between 1967 and 1984 at Amersterdam, Kerguelan and Crozet islands. Demographic parameters were used to predict growth rates of the populations which were either stable or decreasing depending on species.

Wesoloh, D.V. and P. Mineau (1982). Demography, productivity, and contaminant levels in Herring Gulls in Lake Erie. *Colonial Waterbirds* **5**:179.

Canadian Wildlife Service, Box 5050, Burlington, Ontario, Canada L7R 4A6

Wiens, J.A., R.G. Ford, D. Heinemann, and C. Fieber (1982). *Simulation Modeling of Marine Bird Population, Energetics, Food Consumption and Sensitivity to Perturbation.* Final Report Outer Continental Shelf Environmental Assessment Program. Research Unit No.108, pp. 599-643. Boulder, CO: U.S. NOAA.

Wiens, J.A., R.G. Ford and D. Heinemann (1984). Information needs and priorities for assessing the sensitivity of marine birds to oil spills. *Biological Conservation* **28**:21-49.

Wilson, K.J. (1990). Fluctuations in populations of Adelie penguins at Cape Bird, Antarctica. *Polar Record* **26(159)**:305-308.

Reviewed nest counts at the various rookeries at Cape Bird, 1966- 1987, when the population grew from about 21,000 to 54,000 pair (4.6% per year).

Winkler, D.W. and W.D. Shuford (1988). Changes in the numbers and locations of California Gulls nesting at Mono Lake, California, in the period 1863-1986. *Colonial Waterbirds* **11(2)**:263-274.

Section of Ecology and Systematics, Cornell University, Ithaca. New York 14853.

Chronicled the increase in California Gulls at Mono Lake from the 1860s until 1986. As a result of egging, the population decreased to reach a low point in the early part of this century (c.2000 pr); between 1916 and 1976, after egging ended, the population grew at a rate of 4.6% per year (3400 to 50,000 pr). This compares with the rate of 5.5% calculated by Jehl (1984) and Conover's estimate of a rate of 3.5% for the entire population in western United States. The population has stabilized 1976-1986, but does not appear to be limited by nesting space.

Woehler, E.J. (1991). Status and conservation of the seabirds of Heard Island and the McDonald Islands. **In:** *Seabird Status and Conservation: a Supplement* (Croxall, J.P., ed.), pp. 263-277. ICBP Technical Publ. No. 11. Cambridge, Eng.: International Council for Bird Preservation.

Detailed the population size of a number of species, at least three of which appear to be increasing as documented by quantitative data. The Black-browned Albatross increased from 124 nests in 1954 to about 500 pair in 1987 (4.3% per year). The King Penguin increased from about 160 pair in 1969 (Budd 1974) to about 3800 in 1988 (18.1%). The Gentoo Penguin increased from about 9000 pair in 1954 to 16,574 pair in 1987 (1.9%). The Blue-eyed Shag increased from 27 pair in 1951 to 90 pair in 1985 (3.8%). Several species have been declining. A Wandering Albatross banded at

MacQuarie Island may be the start of a colonization. Reasons for the increase were not offered, but a release from persecution and disturbance by sealers may be involved.

Woehler, E.J. ms. *The Distribution and Abundance of Antarctic and Subantarctic Penguins.* Spec. Sci. Rept., SCAR Bird Biol. Subcommittee. 83 pp.

Reviewed reports and literature on the present status of penguins at all known breeding sites in the Southern Ocean including details at sites where successive censuses have been made. The following are details not presented in other papers reviewed herein. Emperor Penguins increased at the following sites: Kloa Point (5.0% per year) 1977-1985, Taylor Glacier (6.7%) 1980-1988, Amanda Bay (7.1%) 1961-1987, Haswell Island (2.3%) 1962-1970, Cape Washington (9.5%) 1968-1986, and Franklin Island (5.8%) 1964-1983, and decreased at three sites (4.5-12.8% per year). The large King Penguin population on South Georgia, recovering from exploitation, increased at 17.3% per year 1978-1985. The data on Adelie Penguins are extensive. The following trends were apparent at sites where repeated counts had been made: at two sites in MacRobertson Land increases of 9.9 and 3.4% per year, 1972-1981; at two sites in Terre Adelie increases of 11.8 and 7.4% 1960's to 1980s; in the Ross Sea at sites surveyed during the 1980's increases occurred at 17 (mean = 3.7% per year, range 0.4-9.2), two were unchanged and a decrease of -3.5% per year occurred at another (two small, recently established colonies grew at 27.1 and 42.8% per year); along the Antarctic Peninsula, increases occurred at five (0.5-4.6%, though one additional small colony increased by 18%) and decreases occurred at two (-1.0 and -5.6%); in the South Shetland Islands, one colony increased at 3.2% and another decreased at -0.6%; and in the South Orkney's a colony increased by 0.6% per year, 1965-1983. Changes among Chinstrap Penguins were much more marked during the same general period: along the Antarctic Peninsula increases occurred at 10 colonies (mean = 17.2, range 3.2-59.0%) and decreases occurred at 6 (mean = 11.9, range 0.2-25.0%); in the South Shetland Islands increases occurred at 11 (mean = 6.2, range 1.4-15.4%), one remained stable and decreases occurred at 6 (mean = -3.6, range - 1.7 to -5.0%). Among Gentoo penguins changes were noted as follows: decrease of -3.2% per year occurred at Marion Island 1974- 1984; increase of 12.6% at Prince Edward Island in the same period; Illes de la Possession decrease of -3.4%, 1970-1984; along the Antarctic Peninsula increases at 4 colonies (mean = 8.3, 8.8- 22.6%) and a decrease of -1.0 at another; in the South Shetlands numbers decreased by -1.7% at one colony; and in the South Sandwich Islands an increase of 20.2% per year occurred at Thule Island 1966-1979.

Woehler, E.J., D.J. Slip, L.M. Robertson, P.J. Fullagar and H.R. Burton (1991). The distribution, abundance and status of Adelie Penguins Pygoscelis Adeliae at the Windmill Islands, Wilkes Land, Antarctica. *Marine Ornithol*olgy 19: (in press).

Reviewed changes in the number of breeding Adelie Penguins at 14 rookeries in the Windmill Islands, 1961-1989. All showed increases, which ranged 1.7-8.7% per year (mean = 4.6%). The increase slowed after about 1970 especially near to where a permanent base was established.

Wooller, R.D. and J.D. Coulson (1977). Factors affecting the age of first breeding of the Kittiwake *Rissa tridactyla. Ibis* **119**:339-349.

Biological Sciences, Murdoch Univ., Western Australia 6150.

Wooller, R.D., J.S. Bradley, I.J. Skira, and D.L. Serventy (1989). Short-tailed Shearwater. **In:** *Lifetime Reproduction in Birds* (I. Newton, ed.), pp.405-417. London: Academic Press.

Biological Sciences, Murdoch University, Western Australia 6150.

Wooller, R.D., J.S. Bradley, I.J.Skira, and D.L. Serventy (1990). Reproductive success of Short-tailed Shearwaters *Puffinus tenuirostris* in relation to their age and breeding experience. *Journal of Animal Ecology* **59**:161-170.

Biological Sciences, Murdoch University, Western Australia 6150.

Yochem, P.K., J.R. Jehl, Jr., B.S. Stewart, S. Thompson and L. Neel (1991). Distribution and history of California Gull colonies in Nevada. *Western Birds* **22**:1-13.

Reviewed counts of California Gull populations in Nevada up to 1990. At Pyramid Lake, population size grew from 7 pr in 1927 to about 2500 pr by 1960 (19.5% per year); thereafter numbers fluctuated around that level. At Stillwater NWR, numbers fluctuated widely, but if there is a trend, numbers increased from about 15 pr in 1950 to 1200 by about 1977 (17.6% per year). At Lahontan Dam numbers increased from 172 pr in 1941 to about 3000 by 1983 (7.0% per year). At Fallon NWR, numbers during recent years have fluctuated between 0 and 1200 pr. Overall, the Nevada population decreased from several thousand during the 1870s to a few hundred by the 1920s, with increase to 7500 pr by the 1960s. Exploitation may have reduced the numbers initially but high winter survival may be responsible for the latest increase.