

Exxon Valdez Oil Spill
Restoration Project Annual Report

Ecology and Demographics of Pacific Sand Lance,
Ammodytes hexapterus Pallas, in Lower Cook Inlet, Alaska

Restoration Project 99306
Final Report

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John Piatt

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April 2000

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Study History: The purpose of this study was to characterize the basic ecology, distribution, and demographics of sand lance in lower Cook Inlet. Recent declines of upper trophic level species in the northern Gulf of Alaska have been linked to decreasing availability of forage fishes. Sand lance is the most important forage fish in most nearshore areas of the northern Gulf. Despite its importance to commercial fish, seabirds, and marine mammals, little is known or published on the basic biology of this key prey species. Therefore, restoration project 98306 was established to work in coordination with restoration APEX project 98163M to help characterize the relationship between seabird population dynamics and forage fish abundance.

Abstract: Distinct sand lance populations occur within the relatively small geographic area of Lower Cook Inlet, Alaska. Marked meso-scale differences in abundance, growth, and mortality exist as a consequence of differing oceanographic regimes. Growth rate within populations (between years) was positively correlated with temperature. However, this did not extend to inter-population comparisons where differing growth rates were better correlated to marine productivity. Most sand lance reached maturity in their second year. Field observations and indices of maturity, gonad development, and ova-size distribution all indicated that sand lance spawn once each year. Sand lance spawned intertidally in late September and October on fine gravel/sandy beaches. Embryos developed over 67 days through periods of intertidal exposure and sub-freezing air temperatures. Mean dry-weight energy value of sand lance cycles seasonally, peaking in spring and early summer (20.91 kJg⁻¹ for males, 21.08 kJg⁻¹ for females), and subsequently declining by about 25% during late summer and fall (15.91 kJg⁻¹ for males, 15.74 kJg⁻¹ for females). Sand lance enter the winter with close to their minimum whole body energy content. Dry weight energy densities of juveniles increased from a minimum 16.67 kJg⁻¹ to a maximum of 19.68 kJg⁻¹ and are higher than adults in late summer.

Keywords: *Ammodytes*; bioenergetics; growth; *hexapterus*; otolith; proximate composition; sand lance, spawning.

Project Data: *Description of Data* – this project collected data on Pacific sand lance from lower Cook Inlet, Alaska between 1996 and 1997. *Format* – The data for this project were entered into Excel spreadsheets and have been archived with USGS Biological Resources Division in Anchorage, Alaska. By archiving the data in this manner, subsequent researchers can access information collected concurrently and complementary to this project in relation to productivity, other fish, and predators. *Custodian* – Contact Dr. John Piatt, USGS Biological Resources Division, 1011 E. Tudor

Road, Anchorage, Alaska 99503, (phone: (907) 786-3549, fax: (907)786-3636).
Availability – copies of the data for this project can be provided on diskette.

Citation: Robards, M.D. and J.F. Piatt. 2000. Ecology and demographics of Pacific Sand Lance, *Ammodytes hexapterus* Pallas, in lower Cook Inlet, Alaska. *Exxon Valdez Oil Spill Restoration Project Final Report* (Restoration Project 99306), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

This project funded a student, Martin Robards, to study sand lance as part of a graduate program in fisheries conservation at Memorial University of Newfoundland. This final report consists of the attached manuscript, which has been submitted for final publication as a Masters Thesis at Memorial University of Newfoundland.

Ecology and Demographics of Pacific Sand Lance, *Ammodytes hexapterus* Pallas, in Lower Cook Inlet, Alaska

The final report consists of a thesis, which in itself is comprised of three manuscripts. The first two of these have already been published in the peer-reviewed scientific literature and the third is in review:

Robards, M.D., J.F. Piatt, and G.A. Rose. 1999. Maturation, Fecundity, and Intertidal Spawning of Pacific Sand Lance (*Ammodytes hexapterus*) in the Northern Gulf of Alaska. *Journal of Fish Biology* 54: 1050-1068.

Robards, M.D., J.A. Anthony, G.A. Rose, and J.F. Piatt. 1999. Changes in proximate composition and somatic energy content for Pacific sand lance (*Ammodytes hexapterus*) relative to maturity, season, and location. *Journal of Experimental Marine Biology and Ecology* 242: 245-258.

Robards, M.D. G.A. Rose, and J.F. Piatt. 1999. Somatic growth and otolith development of Pacific sand lance (*Ammodytes hexapterus*) under different oceanographic regimes. (Submitted to *Fisheries Oceanography*).

The following manuscripts have also been published as a result of collaboration between this project and Exxon Valdez Oil Spill Restoration Projects 98346 or 98163M. These manuscripts were outside the original scope of this project and are not included in this final report (although they are readily available at their respective publishers).

Robards, M.R., J.F. Piatt, A.B. Kettle, and A.A. Abookire. 1999. Temporal and geographic variation in fish communities of Lower Cook Inlet, Alaska. *Fishery Bulletin* 97, 962-977.

- Robards, M.R., M.F. Willson, R.H. Armstrong, and J.F. Piatt. 1999. Sand Lance: A Review of Biology and Predator Relations and Annotated Bibliography. U.S. Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP 521, September, 1999.
- Robards, M.D. and J.F. Piatt. 1999. Biology of the Genus *Ammodytes* – The Sand Lances. *In*: Robards, M.R., M.F. Willson, R.H. Armstrong, and J.F. Piatt (editors). Sand Lance: A Review of Biology and Predator Relations and Annotated Bibliography. U.S. Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP 521, September, 1999.
- Willson, M.F., R.H. Armstrong, M.D. Robards, and J.F. Piatt. 1999. Sand lance as cornerstone species for predator populations. *In*: Robards, M.R., M.F. Willson, R.H. Armstrong, and J.F. Piatt (editors). Sand Lance: A Review of Biology and Predator Relations and Annotated Bibliography. U.S. Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP 521, September, 1999.
- Willson, M.F., R.H. Armstrong, M.D. Robards, and J.F. Piatt. 1999. An annotated bibliography of sand lance. *In*: Robards M.R., M.F. Willson, R.H. Armstrong, and J.F. Piatt (editors). Sand Lance: A Review of Biology and Predator Relations and Annotated Bibliography. U.S. Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP 521, September, 1999.

Chapter 1

Maturation, Fecundity, and Intertidal Spawning of Pacific Sand Lance in the Northern Gulf of Alaska

Reprinted from Journal of Experimental Marine Biology and Ecology, Vol 242, Robards, M.D., J.F. Piatt, and G.A. Rose, Maturation, Fecundity, and Intertidal Spawning of Pacific Sand Lance in the Northern Gulf of Alaska, p. 1050-1068, Copyright 1999, with permission from Elsevier.

Chapter 2

Changes in proximate composition and somatic energy content for Pacific sand lance relative to maturity, season, and location

Reprinted from Journal of Experimental Marine Biology and Ecology, vol. 242, M.D. Robards, J.A. Anthony, J.F. Piatt, and G.A. Rose, Changes in proximate composition and somatic energy content for Pacific sand lance relative to maturity, season and location, pp. 245-258, Copyright 1999, with permission from Elsevier.