

**U.S. FISH AND WILDLIFE SERVICE
MAINE FIELD OFFICE
SPECIAL PROJECT REPORT FY09-MEFO-7-EC**



**Summary of Existing Information Pertinent to
Environmental Contaminants and Oil Spills
on Breeding Atlantic Coast Piping Plovers**



April 2009

Mission Statement
U.S. Fish and Wildlife Service

“Our mission is working with others to conserve, protect, and enhance the nation’s fish and wildlife and their habitats for the continuing benefit of the American people.”

Suggested citation: Mierzykowski S.E. 2009. Summary of existing information pertinent to environmental contaminants and oil spills on breeding Atlantic Coast piping plovers. USFWS. Spec. Proj. Rep. FY09-MEFO-7-EC. Maine Field Office. Old Town, ME. 22 pp.

Cover photos: Clutch of piping plover eggs
Oiled piping plover
(Both photos taken by report preparer)

U.S. Fish and Wildlife Service
Maine Field Office
Special Project Report: FY09-MEFO-7-EC



**Summary of Existing Information Pertinent to Environmental Contaminants
and Oil Spills on Breeding Atlantic Coast Piping Plovers**

Region 5 ID: 53411-1113-0000
(filename: 2009 PIPL Contaminant and Oil Spill Review.pdf)

Prepared by:

Steven E. Mierzykowski
U.S. Fish and Wildlife Service
Maine Field Office – Ecological Services
1168 Main Street
Old Town, Maine 04468
(207) 827-5938 x 17
steve_mierzykowski@fws.gov

April 2009

Executive Summary

Information regarding environmental contaminants and oil spills on breeding Atlantic Coast piping plovers (*Charadrius melodus*) was solicited from state and federal biologists, and through database and literature searches. The results are summarized in this report.

Since 1990, thirty-three composite or individual non-viable or abandoned piping plover egg samples from Maine, New York, New Jersey, and Delaware have been analyzed for residues of organochlorine compounds and trace elements. No contaminant egg data are known to exist for piping plovers from Massachusetts, Rhode Island, Connecticut, Maryland, Virginia, North Carolina or South Carolina. Several piping plover egg samples from the northern states have been collected and archived over the years, but not analyzed due to lack of funds.

Mean concentrations of total polychlorinated biphenyl (PCB), dichloro diphenyl dichloroethylene (DDE), and mercury in piping plover eggs that have been analyzed since 1990 were not highly elevated compared to suggested toxicity threshold effect levels. Some individual piping plover samples from the Atlantic Coast population, however, exceeded suggested toxicity threshold effect levels. Polybrominated diphenyl ether (PBDE) and perfluorooctanesulfonate (PFOS) have been detected in recent samples of piping plover eggs. Avian egg threshold effect levels for these two compounds are still in development. However, one piping plover egg from Maine in 2007 had a PFOS concentration greater than a hatchability effect level reported in a laboratory study.

Oil spills along the Atlantic seaboard pose a continuing threat to piping plovers. Between 1989 and 2003, seven Atlantic Coast oil spills have had a direct impact on piping plovers or their habitat. Scores of adult and juvenile piping plovers, and some eggs were affected by the spills. Oiled piping plovers have also been reported in Newfoundland and Nova Scotia during banding operations (Amirault-Langlais *et al.* 2007).

Management recommendations include analysis of non-viable or abandoned eggs throughout the Atlantic Coast population, particularly in the southern part of the recovery unit (i.e., Virginia, North Carolina, South Carolina) where no data currently exists. The development of a checklist or protocol for responding to spills on piping plover beaches is also suggested.

Keywords: piping plover, contaminants, oil spills, Atlantic Coast

TABLE OF CONTENTS

	Page
Title Page	1
Executive Summary	2
Keywords	2
Table of Contents	3
List of Tables	4
List of Acronyms and Abbreviations	4
Preface and Acknowledgements	5
1. Introduction	6
2. Objective	6
3. Review Area	6
4. Methods	6
4.1 Database and literature searches	
4.2 Personal contacts	
4.3 Data presentations	
5. Results	7
5.1 Environmental contaminants	
5.2 Oil spills	
6. Discussion	8
6.1 Environmental contaminants	
6.2 Oil spills	
7. Summary and Management Recommendations	10
7.1 Summary	
7.2 Management Recommendations	
8. Literature Cited	13

List of Tables

- Table 1. Persons contacted for piping plover information
Table 2. Atlantic Coast piping plover eggs analyzed for environmental contaminants
Table 3. Environmental contaminants in Atlantic Coast piping plover eggs
Table 4. Archived piping plover eggs by state
Table 5. Major oil spills that have impacted Atlantic Coast piping plovers

List of Acronyms and Abbreviations

DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EC	environmental contaminants
ECDMS	Environmental Contaminants Database Management System (USFWS)
ESA	Endangered Species Act
fw	fresh wet weight
FY	fiscal year
Hg	mercury
LC ₅₀	estimated median lethal concentration of a contaminant
LOAEL	lowest-observed-adverse-effect level
MEFO	Maine Field Office (USFWS)
µg/g	micrograms per gram (parts-per-million)
M/T	motor tanker
NJDEP	New Jersey Department of Environmental Protection
No.	number
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PFOS	perfluorooctanesulfonate
ppm	parts per million (µg/g)
SOP	Standard Operating Procedure
T/B	tank barge
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
ww	wet weight

PREFACE

This report summarizes existing information pertinent to environmental contaminants and oil spills on breeding Atlantic coast piping plovers. Analytical work was completed under the following U.S. Fish and Wildlife Service (USFWS) Analytical Control Facility Catalogs

Chesapeake Bay Field Office – Catalog 5020015
Long Island Field Office – Catalog G100001
Maine Field Office – Catalog 5100005
New Jersey Field Office – Catalog 6344
New York Field Office – Catalog 5050030
New York Field Office – Catalog 5050048

Analytical work for Maine piping plover egg samples (four in 2007, two in 2008) was completed for the BioDiversity Research Institute at the Wadsworth Center, New York State Department of Health (Goodale 2008, 2009).

All salvage activities associated with non-viable or abandoned piping plover egg collections, examinations, and analyses were conducted pursuant to provisions and authorizations of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.).

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY09-MEFO-7-EC and be directed to:

Steve Mierzykowski
U.S. Fish and Wildlife Service
1168 Main Street
Old Town, Maine 04468

The U.S. Fish and Wildlife Service requests that no part of this report be taken out of context, and if reproduced, the document should appear in its entirety. This report complies with the peer review and certification provisions of the Information Quality Act (Public Law 106-554, Section 515).

ACKNOWLEDGEMENTS

Information and data for this summary were generously shared by several federal, state, and other biologists (see Table 1). I especially thank Wing Goodale for sharing his recent data for Maine birds. Peer review was provided by Barnett Rattner Ph.D, U.S. Geological Survey, Patuxent Wildlife Research Center, Beltsville, Maryland. Final editorial review was provided by Wende Mahaney, USFWS.

1. Introduction

The Atlantic Coast piping plover (*Charadrius melodus*) population was listed as a threatened species under the U.S. Endangered Species Act in 1986. The 1996 recovery plan for the Atlantic Coast piping plover population contained limited information regarding environmental contaminants and reports of oil spills impacting piping plovers (USFWS 1996). On September 30, 2008, the U.S. Fish and Wildlife Service published a notice of initiation for a 5-year review and requested information on the piping plover (Federal Register 2008). To supplement the 5-year review for the Atlantic Coast piping plover population, a more expansive search of information pertinent to environmental contaminants and oil spills was conducted. Historical and current information were obtained through literature and database reviews and through contacts with biologists, contaminant specialists, and spill responders. The existing information is summarized in this report.

2. Objective

To summarize existing information pertinent to environmental contaminants and oil spills on breeding Atlantic Coast piping plovers.

3. Review Area

The Atlantic Coast piping plover population breeds on sandy beaches along the east coast of North America, from Newfoundland to South Carolina (USFWS 1996).

4. Methods

4.1 Database and Literature Searches. The USFWS Environmental Contaminants Database Management System (ECDMS) was searched by Bruce Nierwienski from the USFWS Analytical Control Facility. ECDMS search parameters included the species name, sample type, and the geographic range of the Atlantic Coast population. Other data were acquired from peer-reviewed papers and unpublished reports (Table 2). Internal oil spill reports were provided by Tim Fannin, Region 5 Spill Coordinator.

4.2 Personal Contacts. Over 30 active and retired environmental contaminant specialists, endangered species specialists, state biologists, and others were contacted by email or telephone regarding piping plover egg data and oil spill information (Table 1).

4.3 Data presentations. Contaminant data in this summary are expressed in $\mu\text{g/g}$ (parts per million) on a wet weight basis. If contaminant concentrations in papers, reports, or raw data packages were expressed on a dry weight basis, the data were converted to wet weight based on percent moisture. If egg contaminant concentrations were corrected for moisture loss (Stickel *et al.* 1973) and reported on a fresh wet weight basis, both expressions are presented (Table 3).

5. Results

5.1 Environmental Contaminants. Since 1990, thirty-three composite or individual piping plover egg samples from Maine, New York, New Jersey, and Delaware have been analyzed for residues of organochlorine compounds and trace elements (Tables 2 and 3). Some of these results have been previously reported by Augspurger (1991), Munavali (1992), Mierzykowski and Carr (2004), and Goodale (2008, 2009).

No contaminant egg data were located for piping plovers from Massachusetts, Rhode Island, Connecticut, Maryland, Virginia, North Carolina, or South Carolina. Several piping plover egg samples from the northern states have been collected and archived over the years, but were not analyzed due to lack of funds (Table 4).

5.2 Oil Spills. Several oil spills in the U.S. have had a direct impact on Atlantic Coast piping plovers or their habitat. Table 5 lists seven oil spills with documented occurrences of oiled piping plovers, oiled habitat, or missing chicks. Oiled piping plovers have also been reported in Newfoundland and Nova Scotia during banding operations (Amirault-Langlais *et al.* 2007). Each U.S. spill and its impact on piping plover are briefly described below. Since additional numbers of birds may be oiled and unobserved or scavenged from beaches or dune vegetation, the observations below should not be considered the total number of piping plovers lost or injured by an individual oil spill.

5.2.1 World Prodigy, RI – On June 26, 1989, the tanker World Prodigy ran aground on Brenton Reef at the mouth of Narragansett Bay and spilled 290,000 gallons of No. 2 fuel oil over a 123 square mile area (NOAA 2008a). No oiled adults were observed, but chicks were absent from affected beaches after the spill (A. Hecht. 2009. Personal communication).

5.2.2 B.T. Nautilus, NY and NJ – On June 7, 1990, the tankship B.T. Nautilus grounded in the Kill van Kull waterway of New York Harbor and spilled approximately 280,000 gallons of No. 6 fuel oil. As the spill spread, over 200 miles of shoreline in New York and New Jersey were oiled. Twenty seven adult piping plover and two eggs were oiled as a result of the spill (USFWS 1995).

5.2.3 M/T Anitra, NJ and DE – On May 9, 1996 during lightering operations, the motor tanker M/T Anitra released approximately 42,000 gallons of crude oil into Delaware Bay. Over 50 miles of beach were oiled in New Jersey and Delaware. At least 51 adult piping plovers, two chicks, as well as some eggs, were affected by the spill (NJDEP *et al.* 1999).

5.2.4 North Cape, RI – On January 19, 1996 during stormy weather, the tug boat Scandia caught fire while towing the oil barge North Cape. The barge grounded off of Moonstone Beach at Trustom Pond NWR spilling 828,000 gallons of No. 2 fuel oil (NOAA 2008b). The natural resource damage assessment estimated lost productivity, primarily due to reduced foraging resources during the subsequent nesting season, equivalent to five fledged piping plover chicks (Donlan *et al.* 2003).

5.2.5 Mystery Spill at Assateague Island, VA – On May 30, 1997, a visitor to Assateague Island in the Chincoteague NWR reported oil on the beach. Tar balls suspected to be from No. 6 fuel oil were found on several beaches and as many as six adult piping plovers may have been oiled (USFWS 1997, unpublished spill reports).

5.2.6 T/B Rhode Island, NY – On May 23, 2001, No. 6 fuel oil was found rolling up on the north shore of Long Island. The suspected source was the tank barge T/B Rhode Island. After the vessel transited from New York City to New Haven, CT, an eight inch by one and one-half inch crack was discovered in its hull by the U.S. Coast Guard (NOAA 2001). An estimated 10,000 gallons of product oiled 25 miles of Long Island beach habitat, including four piping plover beaches. Four oiled piping plovers were observed during the spill response (USFWS 2001, unpublished spill reports).

5.2.7 Bouchard B120, MA and RI – On April 27, 2003, as the Bouchard B120 barge was being towed in Buzzards Bay, the vessel hit an obstacle and spilled 98,000 gallons of No. 6 fuel oil into the bay (NOAA 2008c). The spill spread throughout the entire bay and as far south as Rhode Island affecting 90 miles of shoreline including many piping plover beaches. Over 50 adult piping plovers may have been oiled during the spill (Coley and McCollough 2004).

6. Discussion

6.1 Environmental Contaminants. Mean concentrations of certain organochlorine compounds and mercury in piping plover eggs do not appear highly elevated compared to suggested threshold effect levels for other bird species. However, some individual piping plover samples with the highest contaminant concentrations exceed suggested toxicity threshold effect levels for different avian species.

Nearly all the piping plover egg contaminant data from the Atlantic Coast population were not corrected for moisture loss. Since piping plover eggs are typically not collected until abandonment is certain, the eggs may be completely exposed to sunlight for days. Wet weight data reported below would likely be lower, as much as 20%, if corrected for moisture loss (Stickel *et al.* 1973).

6.1.1 Total Polychlorinated Biphenyl (Total PCB) – Total PCB in piping plover eggs ranged from 0.16 µg/g (Maine 2007) to 10.0 µg/g (New York 1995)(Table 3). Since collections spanned 18 years, and total PCB concentrations appear to be declining in eggs of coastal bird species (Elliott *et al.* 2005, Jayaraman *et al.* 2007), a mean was not calculated for the 33 piping plover egg samples. A total PCB threshold effect level specific to piping plover eggs does not exist. Hoffman *et al.* (1996) reported that common terns with greater than 7.5 µg/g of total PCBs had decreased hatching success. Only one piping plover sample had a total PCB concentration greater than 7.5 µg/g (10.00 µg/g, New York 1995). Six of the 33 samples had total PCB concentrations greater than 5.00 µg/g, and all were collected prior to 2000. Of the six egg samples collected after 2000, the highest concentration of total PCB was 2.50 µg/g in an individual egg sample from Long Island, NY in 2001.

6.1.2. Dichlorodiphenyldichloroethylene (DDE) – *p,p'*-DDE was detected in all piping plover eggs (Table 3). The highest DDE concentration was reported in a piping plover egg sample from New Jersey in 1990 (1.10 µg/g) and the lowest was reported in a sample from Maine in 2007 (0.06 µg/g). Piping plover egg collections spanned 18 years. DDE concentrations have been declining in eggs of coastal and other bird species since the insecticide dichlorodiphenyltrichloroethane (DDT), the parent compound of *p,p'*-DDE, was banned for use in the U.S. in 1972. Consequently, a mean *p,p'*-DDE concentration was not calculated for the 33 piping plover egg samples. A suggested avian egg threshold effect level for *p,p'*-DDE has not yet been established, but the brown pelican (*Pelecanus occidentalis*) appears to be one of the most sensitive species with reproductive failure occurring when DDE residues in eggs exceed 3.7 µg/g (Blus 1996). Only two of the piping plover eggs from the Atlantic Coast had *p,p'*-DDE levels in excess of 1.00 µg/g, both from New Jersey in 1990 (Augsburger 1991).

6.1.3 Total Polybrominated Diphenyl Ether (PBDE) – Total PBDE has only been measured in recent piping plover egg collections from Maine (Goodale 2008, 2009). Mean total PBDE in four Maine egg samples from 2007 was 0.09 µg/g with a range of 0.02 µg/g to 0.21 µg/g (Goodale 2008). In 2008, total PBDE in two Maine egg samples was 0.09 µg/g and 0.14 µg/g (Goodale 2009). An avian egg threshold effect level for total PBDE has not yet been established. McKernan *et al.* (2009) suggested a lowest observable effect level on American kestrel (*Falco sparverius*) pipping and hatching success for total PBDE may be as low as 1.80 µg/g. In the six piping plover egg samples analyzed to date for total PBDE, concentrations are well below the 1.80 µg/g threshold for kestrels, but more data are needed to adequately characterize PBDE contamination in the Atlantic Coast population.

6.1.4 Perfluorooctanesulfonate (PFOS) – PFOS has only been measured in recent piping plover egg collections from Maine (Goodale 2008, 2009). Mean PFOS in four Maine egg samples from 2007 was 0.09 µg/g with a range of 0.04 µg/g to 0.20 µg/g (Goodale 2008). In 2008, PFOS in two Maine egg samples was 0.047 µg/g and 0.048 µg/g (Goodale 2009). PFOS is a new compound in most analytical catalogs and limited effects data are available. In a study of white leghorn chicken (*Gallus domesticus*) eggs injected with PFOS, the lowest-observed-adverse-effects-level (LOAEL) based on reduced hatchability was 0.10 µg/g (Molina *et al.* 2006). One of the six piping plover egg samples from Maine had a PFOS concentration greater than 0.10 µg/g.

6.1.5 Mercury – Mercury was measured in 33 individual or composite piping plover egg samples – mean 0.36 µg/g. Mercury ranged from below detection (< 0.18 µg/g, Delaware 1991) to a high of 1.07 µg/g in a sample from New Jersey in 1990 (Table 3). An avian egg threshold effect level for mercury has not been established for piping plovers, but several researchers have suggested mercury effect thresholds based on laboratory and field investigations with other bird species. Scheuhammer *et al.* (2007) suggested that egg mercury concentrations greater than 1 µg/g would be associated with impaired hatchability and embryonic mortality in a number of bird species. In snowy plovers (*Charadrius alexandrinus*), a Pacific coast plover species that also nests on beaches like the piping plover, mean mercury in eggs from failed nests was 1.07 µg/g, fww (Schwarzbach *et al.* 2005). Lower mercury toxicity thresholds have been suggested based on studies with mallards (*Anas platyrhynchos*)(0.80 µg/g, Heinz 1979) and ring-necked

pheasants (*Phasianus colchicus*) (0.50 µg/g, Fimreite 1971). A recently reported dosing study with methylmercury showed species differences in the sensitivity of avian embryos (Heinz *et al.* 2009). Highly sensitive species with LC₅₀s less than 0.25 µg/g included white ibis (*Eudocimus albus*), snowy egret (*Egretta thula*), and tri-colored heron (*Egretta tricolor*). Moderately sensitive species with LC₅₀s greater than 0.25 µg/g, but less than 1 µg/g, included clapper rail (*Rallus longirostris*), common tern (*Sterna hirundo*), and royal tern (*Sterna maxima*). Low sensitive species with LC₅₀s 1 µg/g or higher included lesser scaup (*Aythya affinis*), Canada goose (*Branta canadensis*), and laughing gull (*Larus atricilla*).

It is not known where piping plovers would reside within the three mercury sensitivity categories suggested by Heinz *et al.* (2009). In piping plover egg samples from the Atlantic Coast population, mercury was below detection (< 0.18 µg/g) in one sample, less than 0.25 µg/g in 12 samples, between 0.26 µg/g and 0.50 µg/g in 12 samples, between 0.51 µg/g and 0.75 µg/g in six samples, between 0.76 µg/g and 1.00 µg/g in one sample, and greater than 1.00 µg/g in one sample. If samples greater than 0.50 µg/g are assumed to have elevated levels of mercury, then 24% of the piping plover egg samples from the Atlantic Coast were elevated.

6.2 Oil Spills. Oil spills along the Atlantic Coast pose a continuing threat to piping plovers. Oil spills may have a direct or indirect impact on birds. Adult piping plover and foraging chicks will become oiled to varying degrees as they feed in the wrack line. Oiled adults may spend more time preening and less time foraging, feeding their young, or incubating. Toxic effects may occur in adults and older chicks from oil ingested during feather preening. Eggs may be coated with petroleum product from stained or coated adults. Spills that occur prior to the arrival of birds on the beaches may degrade foraging habitat for plovers. After the January 1996 North Cape oil spill in Rhode Island, lower prey abundance was recorded during the breeding season in piping plover habitat (Donlan *et al.* 2003).

Response operations during a spill also impact piping plovers (Coley and McCollough 2004). Spill response operations on beaches typically involve many responders and a variety of motorized equipment. The potential for disturbance towards piping plovers during these response operations is high and steps must be taken during the assessment and cleanup to protect birds and their habitat.

7. Summary and Management Recommendation

7.1 Summary.

7.1.1 Environmental Contaminants - Piping plover beaches along the Atlantic Coast occur in several of the important bird areas of the northeastern United States (Rattner and Ackerson 2008), however little contaminant information for the species is available. Legacy contaminants such as PCB and DDE appear to be declining in eggs of other bird species from some coastal areas (Elliott *et al.* 2005, Jayaraman *et al.* 2007) and a similar trend appears evident in eggs of piping plovers from the Atlantic Coast. Total PCB and DDE levels in piping plover eggs in recently-collected samples do not exceed suggested avian egg threshold effect levels. However, there are too few samples, too few recently-collected samples, and too many nesting

areas without any egg data to fully assess the degree of contamination in the Atlantic Coast piping plover population.

The amount of exposure to newly-analyzed contaminants such as the PBDE and perfluorinated compounds such as PFOS in piping plover eggs is currently limited to only six samples from Maine (Goodale 2008, 2009). More information regarding exposure levels in piping plovers is needed for these compounds. Total PBDE levels in eggs appear to be increasing or stabilizing in other coastal bird species investigations (Elliott *et al.* 2005, Jayaraman *et al.* 2007, Gauthier *et al.* 2008) and new analytical catalogs of piping plover eggs should include these compounds.

Mercury continues to be a contaminant of concern in the northeastern U.S., particularly in the New England region (Evers *et al.* 2007). Mercury in piping plover eggs from the Atlantic Coast does not approach acutely toxic levels in the most recent collections, but as noted above, the number of eggs analyzed and the geographic coverage is limited. More mercury information is needed to assess the degree of exposure in piping plovers.

The presence of abandoned eggs on piping plover beaches should not be immediately attributed to environmental contaminants. Adult birds may abandon nests because of human disturbance from foot or vehicular traffic or because of pets such as dogs. Feral cats, raccoons, skunks, foxes, and coyotes may take adult birds during the nesting season leaving nests unattended. Inundation from storm tides may also lead to nest failure.

7.1.2 Oil Spills - Oil spills have impacted scores of piping plovers along the Atlantic Coast. Oiled adults, chicks, and eggs have been reported (Table 5).

7.2 Management Recommendations.

7.2.1 Environmental Contaminants - Contaminant analysis of opportunistically-collected non-viable or abandoned piping plover eggs should be conducted to establish concentration baselines for the Atlantic Coast population, particularly in the states where no information is currently available. The selection of contaminants for the analyses would depend on known or suspected contaminant sources in the vicinity of the nesting locations, and the amount of analytical funding available.

Several archived piping plover eggs samples from the Atlantic Coast are available for contaminant analyses (Table 4). The eggs were packaged in a variety of ways (e.g., zip-loc bags, plastic containers, chemically clean jars). Some eggs were cracked and leaking prior to freezing. Cross-contamination or freezer desiccation would be issues affecting sample and data quality, so these samples should be carefully inspected prior to expending analytical funds.

Nest wardens typically wait several days to confirm that a nest is abandoned and to collect eggs. Since piping plover eggs may be exposed to sunlight and significant drying prior to collection, contaminant concentrations, particularly for organochlorine compounds, should be corrected for moisture loss and reported on a fresh wet weight basis.

7.2.2 Oil Spills – Several oil spills have affected the Atlantic Coast piping plover population and endangered species biologists have dealt with a variety of time-critical, response-related issues to protect nesting birds and habitat. Since there is a likelihood that another spill will affect piping plovers, a checklist or Standard Operating Procedure (SOP) or protocol should be developed by the USFWS to ensure plovers are adequately protected during a spill response and that appropriate information is collected for actions associated with the Endangered Species Act and for Natural Resource Damage Assessments. This checklist or SOP should be provided to the Wildlife Branch of the spill's Incident Command Center as soon a threat to piping plovers or a piping plover beach is identified. Based on the Biological Evaluation after the Bouchard B120 spill in Buzzards Bay (Coley and McCollough 2004), the checklist or SOP should include the following elements:

- Identify expert piping plover biologists (e.g., USFWS, state, other)
- Identify piping plover habitat at risk from oiling
- Develop adaptive strategies to protect nesting birds from disturbance during response activities
- Develop procedures that allow wildlife biologists to monitor response activities and direct response personnel away from nesting birds
- Develop decision procedures regarding the need to capture and rehabilitate oiled plovers or to leave them undisturbed
- Develop data sheets for oiled bird observations that would satisfy response and damage assessment needs

The checklist, SOP, or protocol should be developed by federal and state biologists with experience protecting piping plovers during previous spills.

8. Literature Cited

- Amirault-Langlais D.L., P.W. Thomas and J. McKnight. 2007. Oiled piping plovers (*Charadrius melodus melodus*) in eastern Canada. *Waterbirds* 30(2):271-274.
- Augsburger T. 1991. Environmental contaminants in New Jersey coast piping plover (*Charadrius melodus*) eggs. USFWS. New Jersey Field Office. Pleasantville, NJ. 12 pp.
- Blus L.J. 1996. DDT, DDD, and DDE in birds. Pages 49-71 in Beyer W.N., G.H. Heinz and A.W. Redmon-Norwood (eds.). *Environmental contaminants in wildlife - interpreting tissue concentrations*. Lewis Publishers. Boca Raton, FL. 494 pp.
- Coley T. and M. McCollough. 2004. Biological evaluation for the response to Bouchard Barge 120 Buzzards Bay oil spill. Report to the U.S. Coast Guard. USCG, Portland, OR, and USFWS, Old Town, ME. 44 pp.
- Donlan M., M. Sperduto and C. Hebert. 2003. Compensatory mitigation for injury to a threatened or endangered species: scaling piping plover restoration. *Marine Ecology Progress Series* 264:213-219.
- Elliott J.E., L.K. Wilson and B. Wakeford. 2005. Polybrominated diphenyl ether trends in eggs of marine and freshwater birds from British Columbia, Canada, 1979-2002. *Environ. Sci. Technol.* 39:5584-5591.
- Evers D.C., Y. Han, C.T. Driscoll, N.C. Kamman, M.W. Goodale, K. Fallon Lambert, T.M. Holsen, C.Y. Chen, T.A. Clair and T. Butler. 2007. Biological mercury hotspots in the northeastern United States and southeastern Canada. *BioScience* 57(1):29-43.
- Federal Register. 2008. Notice of initiation of review; request for information on the piping plover (*Charadrius melodus*). September 30, 2008. Vol. 73, Number 190, Pages 56860-56862.
- Fimreite N. 1971. Effects of dietary methylmercury on ring-necked pheasants. Canadian Wildlife Service. Occasional Paper No. 9. 39 pp.
- Gauthier L.T., C.E. Hebert, D.V. Chip Weseloh and R.J. Letcher. 2008. Dramatic changes in the temporal trend of polybrominated diphenyl ethers (PBDEs) in herring gull eggs from the Laurentian Great Lakes: 1982 – 2006. *Environ. Sci. Technol.* 42(5):1524-1530.
- Goodale W. 2008. Preliminary findings of contaminant screening in Maine birds – 2007 field season. BioDiversity Research Institute. Gorham, ME. 76 pp.
- Goodale W. 2009. Preliminary findings of contaminants screening in Maine bird eggs – 2008 field season. BioDiversity Research Institute. Gorham, ME. 50 pp.

Heinz G.H. 1979. Methylmercury: reproductive and behavioral effects on three generations of mallard ducks. *J. Wildl. Manage.* 43(2):394-401.

Heinz G.H., D.J. Hoffman, J.D. Klimstra, K.R. Stebbins, S.L. Kondrad and C.A. Erwin. 2009. Species differences in the sensitivity of avian embryos to methylmercury. *Arch. Environ. Contam. Toxicol.* 56(1):129-138.

Hoffman D.J., C.P. Rice and T.J. Kubiak. 1996. PCBs and dioxins in birds. Pages 165-207 in Beyer W.N., G.H. Heinz and A.W. Redmon-Norwood (eds.). *Environmental contaminants in wildlife - interpreting tissue concentrations.* Lewis Publishers. Boca Raton, FL. 494 pp.

Jayaraman S., M.C. Cantwell, D.E. Nacci, C.S. Mostello and I.C.T. Nisbet. 2007. Polychlorinated biphenyl (PCBs) and polybrominated diphenyl ethers (PBDEs) in current and historical samples of avian eggs from nesting sites in Buzzards Bay, MA, USA. Poster WP99. 28th Annual Meeting of the Society of Environmental Toxicology and Chemistry. Milwaukee, WI.

McKernan M.A., B.A. Rattner, R.C. Hale and M. Ottinger. 2009. Toxicity of polybrominated diphenyl ethers (DE-71) in chicken (*Gallus gallus*), mallard (*Anas platyrhynchos*), and American kestrel (*Falco sparverious*) embryos and hatchlings. *Environ. Toxicol. Chem.* 28:1007-1017.

Mierzykowski S.E. and K.C. Carr. 2004. Environmental contaminants in piping plover, least tern, and common tern eggs from coastal Maine – 2003 nesting season. USFWS. Spec. Proj. Rep. FY04-MEFO-1-EC. Maine Field Office. Old Town, ME. 34 pp.

Molina E.D., R. Balander, S.D. Fitzgerald, J.P. Giesy, K. Kannan, R. Mitchell and S.J. Bursian. 2006. Effects of air cell injection of perfluorooctane sulfonate before incubation on development of the white leghorn chicken (*Gallus domesticus*) embryo. *Environ. Toxicol. Chem.* 25(1):227-232.

Munavali A. 1992. Contaminants in a clutch of piping plover eggs from the Atlantic coast, Delaware. USFWS. Progress Report – Study ID 5217. Chesapeake Bay Field Office. Annapolis, MD. 5 pp.

NJDEP (New Jersey Department of Environmental Protection), U.S. Department of the Interior, National Oceanic and Atmospheric Administration. 1999. Draft restoration plan for the May 1996 Anitra oil spill. NJDEP. Trenton, NJ. 25 pp.

NOAA (National Oceanic and Atmospheric Administration). 2001. Incident News – Barge Rhode Island. Office of Response and Restoration. National Ocean Service.
<http://www.incidentnews.gov/incident/7547>

NOAA (National Oceanic and Atmospheric Administration). 2008a. Case: World Prodigy, RI. Damage Assessment, Remediation, and Restoration Program. Northeast Region.

<http://www.darrp.noaa.gov/northeast/world/index.html>

NOAA (National Oceanic and Atmospheric Administration). 2008b. Case: North Cape, RI. Damage Assessment, Remediation, and Restoration Program. Northeast Region.

http://www.darrp.noaa.gov/northeast/north_cape/

NOAA (National Oceanic and Atmospheric Administration). 2008c. Case: Buzzards Bay/Bouchard 120, MA. Damage Assessment, Remediation, and Restoration Program. Northeast Region.

<http://www.darrp.noaa.gov/northeast/buzzard/index.html>

Rattner B.A. and B.K. Ackerson. 2008. Potential environmental contaminant risks to avian species at important bird areas in the northeastern United States. *Integ. Environ. Assmnt. Mgt* 4(3):344-357.

Scheuhammer A.M., M.W. Meyer, M.B. Sandheinrich and M.W. Murray. 2007. Effects of environmental methylmercury on the health of wild birds, mammals, and fish. *Ambio* 36(1):12-18.

Schwarzbach S.E., M. Stephenson, T. Ruhlen, S. Abbott, G.W. Page and D. Adams. 2005. Elevated mercury concentrations in failed eggs of snowy plovers at Point Reyes National Seashore. *Mar. Poll. Bull.* 50:1444-1447.

Stickel L.F., S.N. Wiemeyer and L.J. Blus. 1973. Pesticide residues in eggs of wild birds: adjustment for loss of moisture and lipid. *Bull. Environ. Contam. Toxicol.* 9(4):193-196.

USFWS (U.S. Fish and Wildlife Service). 1995. Final restoration plan for the piping plover to compensate for losses from the B.T. Nautilus Spill in New Jersey. USFWS. New Jersey Field Office.

USFWS (U.S. Fish and Wildlife Service). 1996. Piping plover (*Charadrius melodus*), Atlantic Coast population revised recovery plan. USFWS. Region 5. Hadley, MA. 285 pp.

Table 1. Persons contacted for piping plover information

Contact		Affiliation	Office	Location
Augspurger	Tom	USFWS	Raleigh Field Office	Raleigh, NC
Bimbi	Melissa	USFWS	Charleston Field Office	Charleston, SC
Boyne	Andrew	Canadian Wildlife Service	Species at Risk Recovery Unit	Dartmouth, Nova Scotia
Buffa	Joelle	USFWS	Chincoteague NWR	Chincoteague Island, VA
Burgess	Neil	Canadian Wildlife Service	Atlantic Region	Mount Pearl, Newfoundland
Carr	Ken	USFWS (retired)	New England Field Office	Concord, NH
Clark	Kathy	NJ Division of Fish and Wildlife	Endangered and Nongame Species Program	Woodbine, NJ
Fannin	Tim	USFWS	Region 5 Environmental Contaminants	Hadley, MA
Goodale	Wing	BioDiversity Research Institute	Seabird Program	Gorham, ME
Hecht	Anne	USFWS	Region 5 Endangered Species	Hadley, MA
Heubel	Robin	USFWS	Region 5 Environmental Contaminants	Hadley, MA
Kane	Cindy	USFWS	Virginia Field Office	Gloucester, VA
Karowski	Ken	USFWS	New York Field Office	Cortland, NY
Kubiak	Tim	USFWS	New Jersey Field Office	Pleasantville, NJ
Larson	Annie	USFWS	Prime Hook NWR	Milton, DE
Lingenfelser	Susan	USFWS	Virginia Field Office	Gloucester, VA
Melvin	Scott	MA Division of Fisheries and Wildlife	Natural Heritage and Endangered Species Program	Westborough, MA
Moore	Craig	USFWS	Division of Environmental Quality	Arlington, VA
Munney	Ken	USFWS	New England Field Office	Concord, NH
Niederriter	Holly	DE Division of Fish and Wildlife	Natural Heritage and Endangered Species Program	Smyrna, DE
Nierwienski	Bruce	USFWS	Analytical Control Facility	Shepherdstown, WV
O'Brien	Kate	USFWS	Rachel Carson NWR	Wells, ME
Paton	Suzanne	USFWS	Rhode Island NWR Complex	Charlestown, RI
Pau	Nancy	USFWS	Parker River NWR	Newburyport, MA
Ponce	Azucena	USFWS	Long Island NWR Complex	Shirley, NY
Potvin	Rick	USFWS	Stewart B. McKinney NWR	Westbrook, CT
Pover	Todd	NJ Division of Fish and Wildlife	Endangered and Nongame Species Program	Woodbine, NJ
Prior	Tim	USFWS (retired)	Eastern Massachusetts NWR Complex	Sudbury, MA
Raithel	Chris	RI Department of Environmental Management	Division of Fish and Wildlife - Heritage Program	West Kingston, RI
Sperduto	Molly	USFWS	New England Field Office	Concord, NH
Stern	Clay	USFWS	New Jersey Field Office	Pleasantville, NJ
Turner	Vinnie	USFWS	Edwin B. Forsythe NWR	Oceanville, NJ
Victoria	Julie	CT Department of Environmental Protection	Wildlife Division	North Franklin, CT
von Oettingen	Susi	USFWS	New England Field Office	Concord, NH
Williams	Monica	USFWS	Monomoy NWR	Chatham, MA

Table 2. Atlantic Coast piping plover eggs analyzed for environmental contaminants

Sample Number	Collection Date	Individual Egg or Composite	No. Eggs in Composite	State	County	Town	Location	Latitude	Longitude	Investigator	Affiliation
WP1	6/27 - 7/28/1990	Composite	3	NJ	Cape May	Strathmere	Whale Beach	39 10 00	-74 40 00	Augspurger, Tom	USFWS, NJFO
WB2	6/27 - 7/28/1990	Individual	n/a	NJ	Cape May	Cape May	Whale Beach	38 56 34	-74 51 50	Augspurger, Tom	USFWS, NJFO
SC	6/27 - 7/28/1990	Individual	n/a	NJ	Cape May	Strathmere	S. Corsons Beach	39 12 30	-74 39 00	Augspurger, Tom	USFWS, NJFO
NC	6/27 - 7/28/1990	Composite	4	NJ	Cape May	Strathmere	N. Corsons Beach	39 12 30	-74 39 00	Augspurger, Tom	USFWS, NJFO
BB	6/27 - 7/28/1990	Individual	n/a	NJ	Atlantic	Brigantine	Brigantine Beach	39 26 00	-74 20 00	Augspurger, Tom	USFWS, NJFO
BT	6/27 - 7/28/1990	Composite	2	NJ	Ocean	Brick Township	Brick Township	40 02 30	-74 03 00	Augspurger, Tom	USFWS, NJFO
CPE1	7/11/1991	Composite	4	DE	Sussex	Lewes	Cape Henlopen	38 47 40	-75 06 00	Munavali, Anoop	USFWS, CBFO
LIPP0194	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 32 49	-73 56 07	Hickey, John	USFWS, NYFO
LIPP0294	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 33 04	-73 55 31	Hickey, John	USFWS, NYFO
LIPP0494	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 33 25	-73 54 21	Hickey, John	USFWS, NYFO
LIPP0794	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 33 18	-73 56 15	Hickey, John	USFWS, NYFO
LIPP0994	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 32 51	-73 56 25	Hickey, John	USFWS, NYFO
LIPP1094	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 33 03	-73 55 36	Hickey, John	USFWS, NYFO
LIPP1694	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 32 51	-73 56 25	Hickey, John	USFWS, NYFO
LIPP1994	6/5/1994	Individual	n/a	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 32 51	-73 56 25	Hickey, John	USFWS, NYFO
PPBP0195	6/20/1995	Composite	4	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 32 43	-73 56 19	Hickey, John	USFWS, NYFO
PPBP0295	6/20/1995	Composite	4	NY	Queens	Rockaway Point	Breezy Pt, Gateway NRA	40 33 25	-73 54 21	Hickey, John	USFWS, NYFO
PPJB0195	6/5/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0295	6/5/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0395	6/5/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0495	6/13/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0595	6/20/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0695	6/20/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0795	6/29/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PPJB0895	6/29/1995	Composite	4	NY	Nassau	Hempstead	Jones Beach	40 35 50	-73 29 10	Hickey, John	USFWS, NYFO
PLWD0120	6/30/2001	Individual	n/a	NY	Suffolk	Westhampton Beach	Westhampton Dunes	40 46 39	-72 42 20	Cohen, Jonathan	USFWS, LIFO
LAU-P1	7/1/2003	Composite	4	ME	York	Wells	Laudholm Beach	43 20 00	-70 32 29	Mierzykowski, Steve	USFWS, MEFO
			(2 from each beach)			Kennebunk	Parson Beach	43 20 42	-70 31 00		
COMP043	6/26/2007	Composite	3	ME	York	Saco	Ferry Beach	43 29 37	-70 23 07	Goodale, Wing	BRI, Maine Audubon
COMP046	6/31/2007	Composite	2	ME	York	Biddeford	Hills Beach	43 27 03	-70 21 49	Goodale, Wing	BRI, Maine Audubon
COMP042	6/12/2007	Composite	4	ME	Sagadahoc	Phippsburg	Popham Beach	43 44 06	-69 48 28	Goodale, Wing	BRI, Maine Audubon
COMP020	6/28/2007	Composite	2	ME	York	Wells	Wells Beach	43 18 48	-70 33 40	Goodale, Wing	BRI, Maine Audubon
COMP011	6/4/2008	Composite	2	ME	Cumberland	Scarborough	Scarborough Beach	43 32 48	-70 18 17	Goodale, Wing	BRI, Maine Audubon
COMP012	5/30/2008	Composite	12	ME	York	Kennebunkport	Gooserocks Beach	43 23 48	-70 25 07	Goodale, Wing	BRI, Maine Audubon

Table 3. Environmental contaminants in Atlantic Coast piping plover eggs

Collection Year	No. of Samples	Composite or Individual Egg Samples	No. Eggs in Each Composite	State	Contaminant Concentrations µg/g Mean or Individual Sample Results (Range)				
					Total PCB	p,p'-DDE	Total PBDE	PFOS	Mercury
1990 ^a	6	Both	1 to 4	NJ	4.38 ww (3.3 - 6.9 ww)	0.64 ww (0.20 - 1.1 ww)	not measured	not measured	0.30 ww (0.08 - 1.07 ww)
1991 ^b	1	Composite	4	DE	0.42 ww ^g	0.45 ww	not measured	not measured	< 0.180 ww ^h
1994 ^c	8	Individual	n/a	NY	3.85 ww (1.90 - 6.20 ww)	0.42 ww (0.19 - 0.69 ww)	not measured	not measured	0.44 ww (0.25 - 0.77 ww)
1995 ^c	10	Composite	4	NY	3.34 ww (1.30 - 10.00 ww)	0.55 ww (0.20 - 0.96 ww)	not measured	not measured	0.43 ww (0.27 - 0.72 ww)
2001 ^c	1	Individual	n/a	NY	2.50 ww	0.72 ww	not measured	not measured	0.50 ww
2003 ^d	1	Composite	4	ME	0.75 ww / 0.56 fww	0.13 ww / 0.10 fww	not measured	not measured	0.23 ww / 0.17 fww
2007 ^e	4	Composite	2 to 4	ME	1.06 ww (0.16 - 1.88 ww)	0.23 ww (0.06 - 0.42 ww)	0.09 ww (0.02 - 0.21 ww)	0.09 ww (0.04 - 0.20 ww)	0.23 ww (0.11 - 0.36 ww)
2008 ^f	2	Composite	2 and 12	ME	0.26 and 0.78 ww	0.13 and 0.37 ww	0.09 and 0.14 ww	0.047 and 0.048 ww	0.07 and 0.13 ww

µg/g = parts-per-million, n/a = not applicable

PCB = polychlorinated biphenyl, DDE = dichlorodiphenyl dichloroethylene, PBDE = polychlorinated diphenyl ether, PFOS = perfluorooctanesulfonate

Data Sources: ^a Augspurger 1991 ^b Munavali 1992 ^c USFWS unpublished data, ^d Mierzykowski and Carr 2004, ^e Goodale 2008, ^f Goodale 2009

^g reported as Aroclor 1254, ^h sample concentration was below the mercury detection limit of 0.18 µg/g

ww = wet weight concentration, fww = fresh wet weight concentration (i.e., corrected for moisture loss)

Table 4. Archived piping plover egg samples by state

State	Year of Collection	Collection Areas	Number of Eggs	Storage Container	Storage Location
Maine	2008	Goose Rocks Beach, Kennebunkport	1	zip-loc bag	Maine Audubon Society, Falmouth, ME
	2008	Higgins Beach, Scarborough	4	zip-loc bag	Maine Audubon Society, Falmouth, ME
Massachusetts	2002	Monomoy NWR	7	zip-loc bag or plastic container	USFWS, New England Field Office, Concord, NH
	2003	Monomoy NWR	9	zip-loc bag or plastic container	USFWS, New England Field Office, Concord, NH
	2003	Horseneck Beach, Bakers Beach	2	I-Chem jar	USFWS, New England Field Office, Concord, NH
	2006	Parker River NWR	8	zip-loc bags	USFWS, Parker River NWR, Newburyport, MA
	2008	Monomoy NWR	10	zip-loc bag or plastic container	USFWS, Monomoy NWR, Chatham, MA
Rhode Island			None reported		
Connecticut	1994	Milford Point	2	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	1996	Griswold Point (5), Long Beach (2), Hatchett's Point (1)	8	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	1999	Hammonasset (2), Hatchett's Point (1), Mile Creek (1)	4	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	2003	Griswold Point	1	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	2004	Harkness	2	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	2007	Bluff Point	1	plastic containers	CT Division of Fish and Wildlife, North Franklin, CT
	2008	Griswold Point (3), Bluff Point (1), East Broadway (1), Milford Point (3)	8	plastic containers	CT Division of Fish and Wildlife, Burlington, CT
New York			None reported		
New Jersey	1996	West Ocean City	4	I-Chem jar	USFWS, New Jersey Field Office, Pleasantville, NJ
	2001	Barneгат Light (4), Cape May City (1), Sea Bright (4)	9	7 in plastic containers, 2 in foil	NJ Division of Fish and Wildlife, Woodbine, NJ
	2002	North Brigantine (15), Ocean City (16), Avalon (1), North Wildwood (2), Cape May City (3)	37	plastic containers	NJ Division of Fish and Wildlife, Woodbine, NJ
	2003	Ocean City (1), Avalon (1)	2	all in foil	NJ Division of Fish and Wildlife, Woodbine, NJ
	2004	Corson's Inlet State Park (3), Avalon (8), Stone Harbor (2), Monmouth Beach (4)	17	6 in plastic containers, 11 in foil	NJ Division of Fish and Wildlife, Woodbine, NJ
	2005	Ocean City (3), Corson's Inlet State Park (1)	4	all in foil	NJ Division of Fish and Wildlife, Woodbine, NJ
	Delaware			None reported	
Virginia			None reported		
North Carolina			None reported		
South Carolina			None reported		

Table 5. Oil spills that have impacted Atlantic Coast piping plovers

<u>Incident</u>	<u>Date</u>	<u>State (s)</u>	<u>Affected Area (s)</u>	<u>Product</u>	<u>Impact on Piping Plovers</u>
World Prodigy	Jun-89	RI	Narragansett Bay	No. 2 fuel oil	missing chicks and oiled habitat
B.T. Nautilus	Jun-90	NY/ NJ	Moriches NY to Cape May NJ	No. 6 fuel oil	oiled birds and habitat
M/T Anitra	May-96	DE / NJ	Cape May	crude oil	oiled birds and habitat
North Cape	Jan-96	RI	Moonstone Beach	No. 2 fuel oil	oiled habitat
mystery spill	May-97	VA	Assateague Island / Chincoteague NWR	No. 6 fuel oil	oiled birds and habitat
T/B Rhode Island	Mar-01	NY	north shore of Long Island	No. 6 fuel oil	oiled birds and habitat
Bouchard No. 120	Apr-03	MA / RI	Horseneck Beach / Buzzards Bay	No. 6 fuel oil	oiled birds and habitat