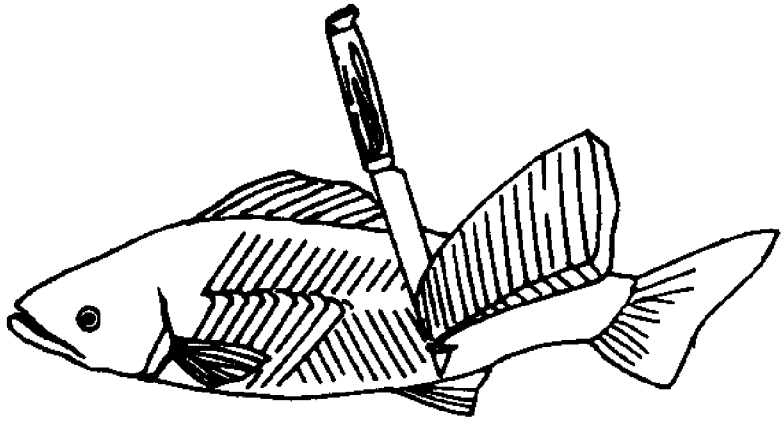
The Effectiveness of Recommended Fat-Trimming Procedures on the Reduction of PCB and Mirex Levels in Lake Ontario Brown Trout (Salmo trutta)

A FINAL REPORT



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INTRODUCTION

Concern over detectable levels of organochlorine contaminants in Lake Ontario fish flesh has existed since at least the mid-1970's (Spagnoli and Skinner, 1977). In New York's Great Lakes waters, levels of polychlorinated biphenyls (PCB's) and most other pesticides and environmental contaminants have declined in fish during this time (Armstrong and Sloan, 1980; Sloan, 1987; International Joint Commission, 1989; Skinner, 1989). In 1989, however, controversy over the risk associated with eating Great Lakes fish was renewed with the issuance of a fish consumption health advisory by a private environmental group, the National Wildlife Federation (Gibbs, 1989; National Wildlife Federation, 1989). This non-governmental advisory suggested that the health risk from consuming Great Lakes (Lake Michigan) fish greatly exceeded the risk estimated by state and provincial health agencies in the Great Lakes Basin.

One response to this controversy by the angling and fish consuming public has been renewed interest in the effectiveness of certain fish trimming and preparation techniques in reducing the contaminant burden in the edible portion of Great Lakes fish, particularly the more popular but more contaminated salmonid species. A series of earlier investigations found that organochlorines were concentrated in the fattier portions of fish, and therefore could be removed by using special fat-trimming and cooking methods (Reinert et al., 1972; Smith et al., 1973; Lindsay et al., 1976; Skea et al., 1979, 1981; Zabik et al., 1979; Clark et al., 1984, Lewis and Makarewicz, 1985; Williams et al., 1989).

Because of their well-conceived experimental research design, which analyzed and compared contaminant levels in both pre- and post-trimmed fillets from the same fish, and their focus on some pervasive chemical contaminants and commonly caught species, a series of studies by Skea et al. (1979, 1981) were at least partly responsible for the removal of a ban on possession of Lake Ontario salmonids in 1978, and led to the direct mention of trimming recommendations in New York State's fish consumption health advisory and to a separate New York State Department of Environmental Conservation (NYSDEC) brochure on trimming methods (Horn and Skinner, 1985; New York State Department of Environmental Conservation, 1981). The research led by Skea is still the most frequently cited on the topic in the literature, and for over a decade has remained the most robust scientific analysis of the effectiveness of fillet trimming in reducing organochlorine contaminant burdens in anadromous species in general, and in Great Lakes (Lake Ontario) salmonids and smallmouth bass in particular.

To date, however, no replicates of the Skea studies have been carried out to validate their findings. Furthermore, significant declines in many environmental contaminants such as PCB's and DDT have been observed in Great Lakes fish since the Skea studies were conducted, but no investigations have explored whether trimming techniques remain consistently effective when carried out on fish exhibiting relatively higher or lower initial contaminant levels.

PURPOSE

The primary purpose of this study was to verify the efficacy of the New York State recommended fillet-trimming technique on reducing organochlorine contaminant levels in the fillets of Lake Ontario brown trout (*Salmo trutta*). The hypothesis to be tested was that recommended fillet-trimming methods would significantly reduce PCB and mirex levels in the trout fillets, and that such reductions would approximate those observed in the Skea studies. PCB's and mirex were selected for the study because they are generally considered to be the contaminants of primary health risk concern in Lake Ontario fish, and represent two of the three contaminants analyzed in the Skea studies. Brown trout was selected as the test species because this popular and commonly caught Lake Ontario salmonid was the most thoroughly examined species in the earlier work by Skea et al. and would thus facilitate and strengthen comparison of results.

Beyond the attempt to verify the results of the Skea work, a secondary purpose of the study was to provide some basic answers to questions often posed by fish consumers and educators concerned with the fish contaminant issue. These questions included:

What are the edible yields that result after recommended fillet trimming procedures are carried out?

What bearing might such variables as fish fat content, sex, age, physical condition, weight/length, and location of fish capture in Lake Ontario have on accumulated contaminant levels and on the effectiveness of trimming methods?

No attempt was made to determine the effects of cooking procedures on contaminant levels. Previous studies suggest that cooking trimmed fillets can further reduce contaminant residues, although the exact amounts and concentrations may vary widely depending on cooking method, fat loss and moisture loss during cooking (Wanderstock et al., 1971; Reinert et al., 1972; Smith et al., 1973; Skea et al., 1979, 1981; Zabik et al., 1979; Lewis and Makarewicz, 1985; Armbruster et al., 1987, 1989).

METHODOLOGY

The Sample

Thirty-six (36) Lake Ontario brown trout caught close to shore (depth < 20 feet) by rod and reel in late April/early May 1990 were collected by members of the Lake Ontario Charter Boat Association (LOCBA) for use in the study. The fish were taken from four geographically distinct locations dispersed along the Lake's southern shore, including Fair Haven, Sodus Point, Rochester/Irondequoit, and the Niagara River/ Wilson areas (see Figure 1).

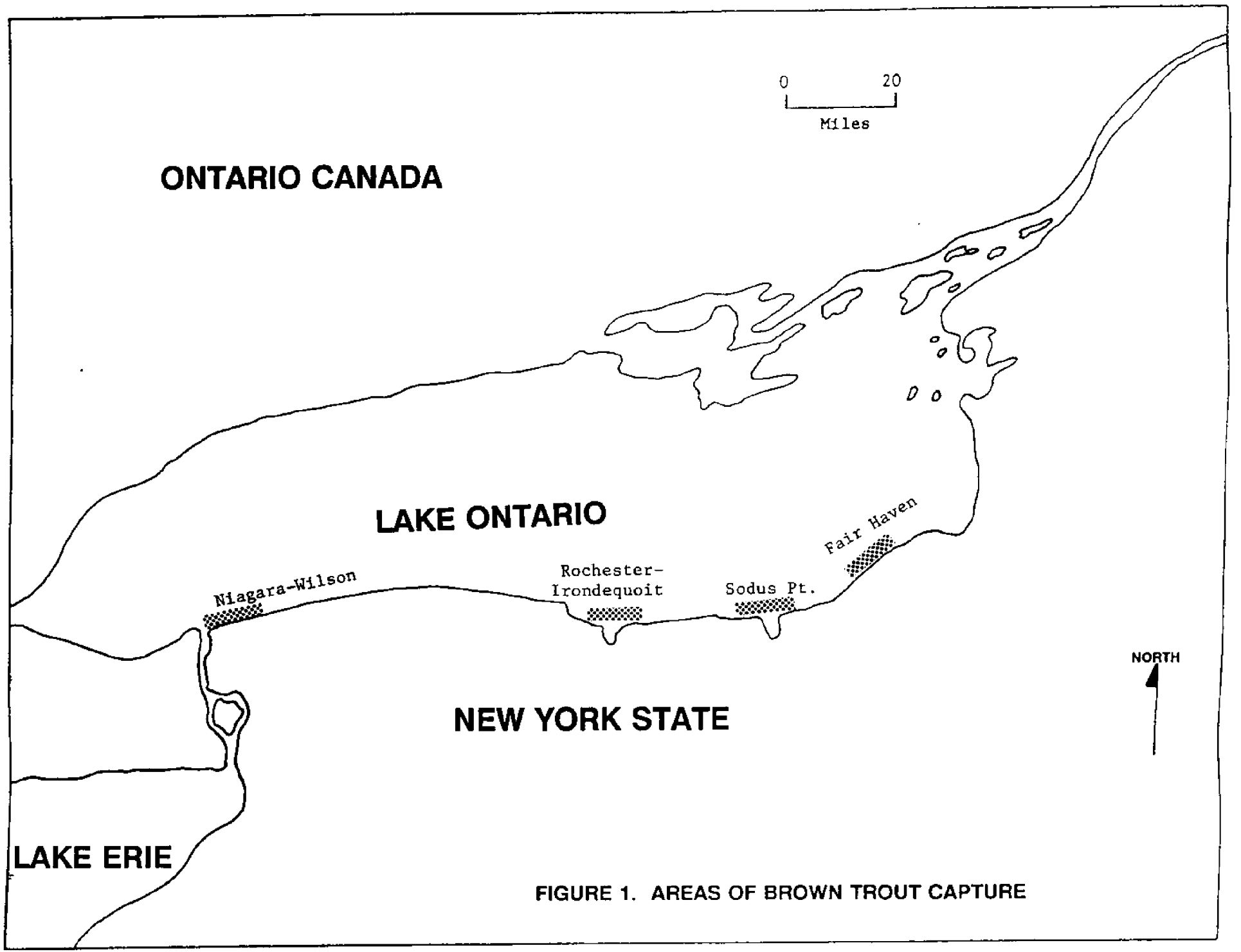

FIGURE 1. AREAS OF BROWN TROUT CAPTURE

Each fish was wrapped individually in aluminum foil, frozen within 24 hours of capture, and held in frozen storage at 0°F-10°F. After transport to the preparation laboratory, the fish were thawed, numbered, and then 20 fish (5 from each of the 4 areas of capture noted above) were randomly selected for further preparation and analysis.

Sample Preparation

Total (whole) weight, total length, sex[1], age[2], and condition factor[3] of each of the 20 randomly selected trout were determined and recorded. Each fish was gutted, scaled, and then prepared by alternately selecting and removing its left or right side, resulting in an entire fillet portion (inclusive of skin and half rib-cage) labeled the "standard fillet." This standard fillet was described and used by Skea et al. in their earlier work, and is also currently utilized as the standard test sample by fisheries and health agency contaminant analysis programs in New York and the Great Lakes states. The opposing fillet of each fish, labeled the "trimmed fillet", was trimmed of the half rib-cage and fatty areas (skin, lateral line muscle and dorsal and belly muscle) according to methods developed by Skea et al. and recommended by the NYSDEC in its publication, Reducing Toxics: Fish Filleting Guide (New York State Department of Environmental Conservation, 1981) (see Figure 2). Weights of the standard and trimmed fillets and all trimmings were taken and recorded. Standard and trimmed fillets for each fish were rewrapped in foil, numbered and labeled, and held in frozen storage (0°F-10°F) for further analysis.

Analytical Procedures

All chemical analyses were conducted at the Toxic Chemicals Laboratory at Cornell University. A total of 40 samples (1 standard and 1 trimmed fillet from each of the 20 fish) was analyzed for total lipid content and PCB and mirex residues. Each of the samples was ground, mixed, and sub-sampled, and the total lipid content was determined using Association of Official Analytical Chemists (AOAC) methods for measuring total lipid in fish and other foods. Each sample was then tested for PCB and mirex levels using standard isolation and analytical gas chromatographic techniques as outlined and described by the U.S. Food and Drug Administration (U.S. Food and Drug Administration, 1971).

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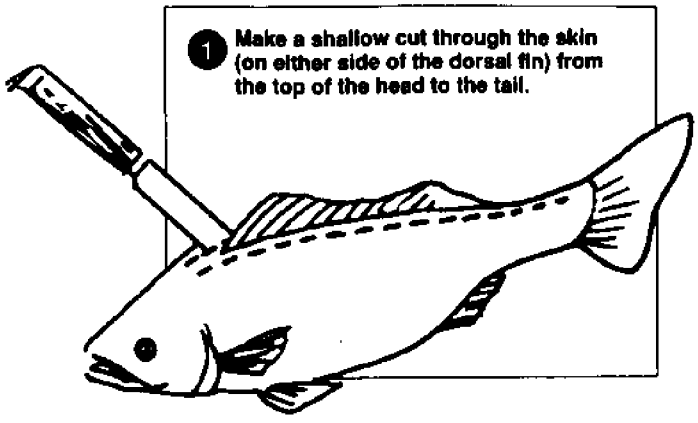
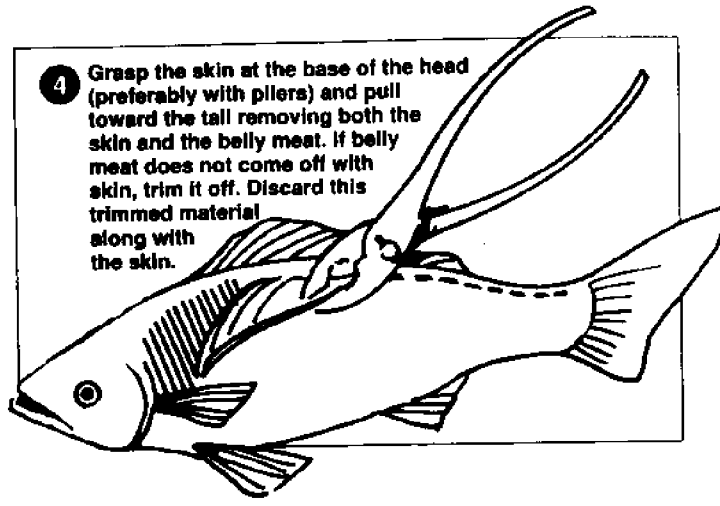
1 Sex of individual fish was determined from gonad inspection via ventral incision from vent to isthmus.

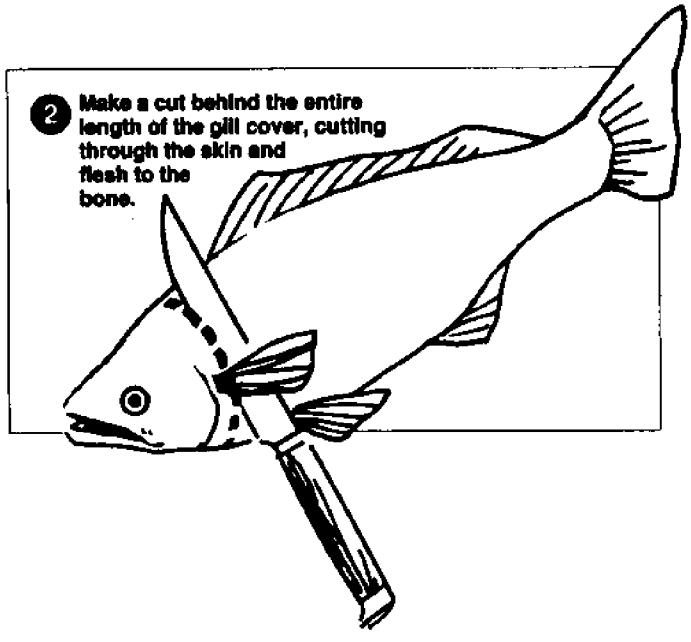
2 Scale samples were taken posterior to operculum and superior to lateral line. Scales were examined microscopically (40X) for age determination.

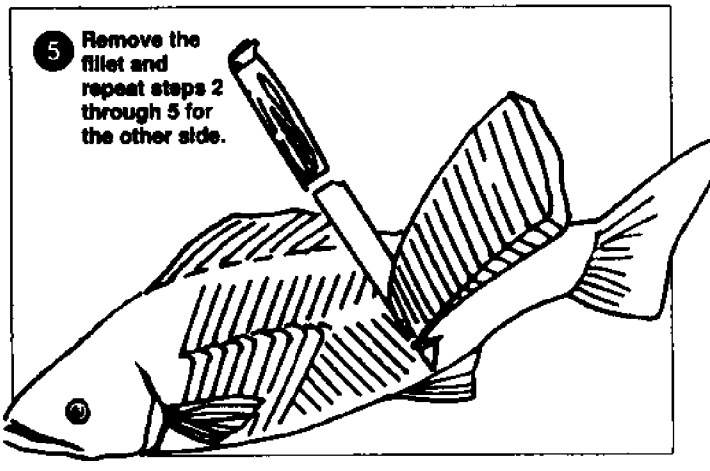
3 Condition factor (K) was determined for individual fish using the formula: $K = 100W \div L^3$, where W = total body weight and L = total length (Bagenal, 1978).

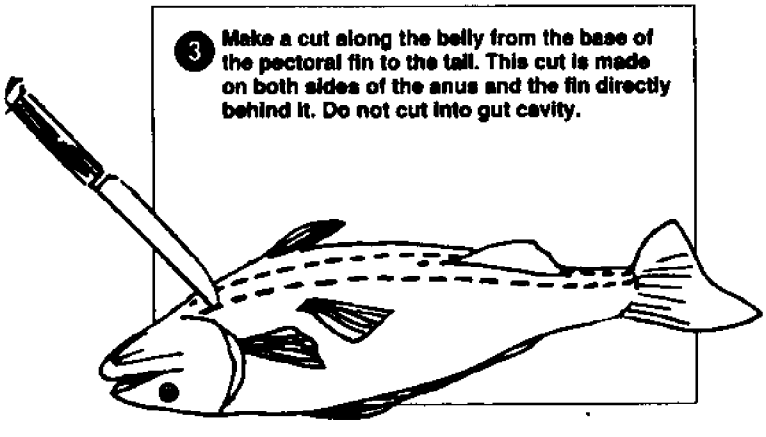
FIGURE 2.

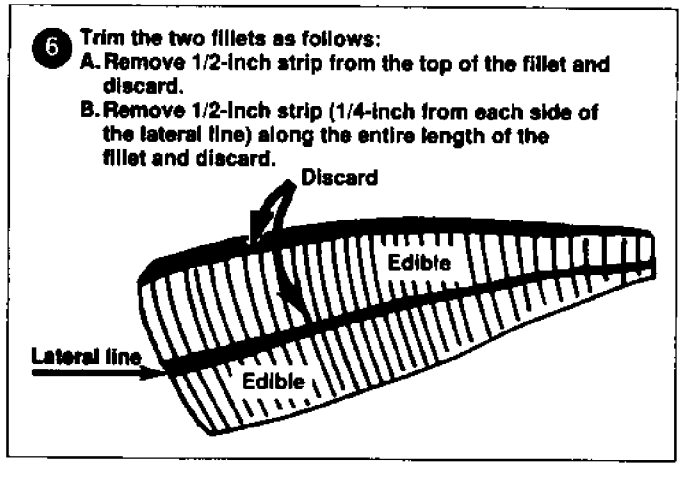












7 The four fillets are now ready to be cooked.

Adapted from NYSDEC, 1984. Reducing toxics: Fish filleting guide. Publ. No. FW-P116, Albany, NY. 2 pp.

Specifically, each sample was freeze-dried and subjected to Soxhlet lipid extraction with hexane for 8 hours. Compound isolation was carried out on a Florisil column according to procedures described by Mills et al. (1972). Electron capture gas chromatography was employed for dissemination of PCB's (quantitated as Aroclor 1260) eluted from a 2m x 4mm column packed with 1.5%SP-2250 and 1.95%SP-2401 on 100/120 mesh Supelcoport at 200°C[4]. Mirex eluted from a 15m x 0.5mm fused silica megabore capillary column with DB-608 as the liquid phase operated at 200°C. The detection limits of the method were set at less than 0.6 ppm (dry weight) for Aroclor 1260 and less than 0.02 ppm (dry weight) for mirex.

RESULTS

Sample Characterization

All data measured, calculated, and recorded for the sample of 20 brown trout, including specimen identification number, total weight, total length, sex, age, physical condition, approximate date(s) of capture, and areas of capture are displayed in Table 1. With a mean weight of 1595.3 ± 189 grams (3.5 ± 0.4 lbs.) and weight range of 542-3637 grams (1.2 to 8.0 lbs.); a mean length of 465.1 ± 14.5mm (18.3 ± 0.57 inches) and length range of 362-610 mm (14.3 to 24.0 inches); 1:1 ratio of males to females; a mean age of 2.95 years (range: 2-4 years); and a condition factor of 1.45 ± 0.05, the sample was judged as very typical of the late April-early May springtime angler catch of brown trout common for the south shore of Lake Ontario (personal communication, L. Wedge, Senior Aquatic Biologist, New York State Department of Environmental Conservation, Region 7, Cortland, NY).

Fillet Yields

Yields, expressed as a percentage of whole fish weight, were calculated for standard fillets and trimmed fillets. Because each fish was to supply a standard and a trimmed fillet for analysis, fillet yields were extrapolated for each fish using the following formulas:

$$\text{Standard Fillet Yield} = \frac{\text{weight of standard fillet} \times 2}{\text{whole fish weight}} \times 100$$

$$\text{Trimmed Fillet Yield} = \frac{\text{weight of trimmed fillet} \times 2}{\text{whole fish weight}} \times 100$$

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[4] It should be noted that in the Skea studies, PCB's were quantitated as Aroclor 1254. Characterization of either Aroclor 1254 or 1260 is such that there is considerable overlap of the mixture of PCB compounds, so that the PCB compounds present in aged residues of Aroclor 1254 and 1260 are not significantly different. Aroclor 1260 most likely represents a better measure of the long-term, environmentally-weathered PCB residues. It was assumed that reference to Aroclor 1260 in this study would not compromise or preclude comparison of trimming results with those recorded by Skea.

Yields, expressed as a percentage of standard fillet weight, were calculated for the removed skin, the removed trimmings (including excised rib cage and the dorsal, ventral and lateral line 1/4" trimmings as noted in Figure 2), and the fully trimmed fillet.

All yields are reported in Table 2. In general, standard filleting resulted in retention of an average of 58% of the whole fish, while trimmed filleting resulted in an average retention of 34% of the whole fish. An average of 40.2% of the standard fillet weight was lost when skin and fat were removed to produce a trimmed fillet. The skin portion represented an average of 26% of the standard fillet. Other trimmings averaged 14.2% of the standard fillet. This left 59.8% of the standard fillet remaining as edible flesh after trimming.

Fillet Fat Content and Contaminant Concentrations

Total fat content (g/100g wet weight basis) and PCB and mirex concentrations (ppm-wet weight basis) for the standard and trimmed fillets, as well as the calculated percentage reductions in fat, PCB and mirex levels due to trimming, are presented in Table 3. Standard fillets averaged 12.1% fat, 1.05 ppm PCB's, and 0.05 ppm mirex. Trimmed fillets averaged 4.9% fat, 0.57 ppm PCB's, and 0.03 ppm mirex. All PCB concentrations for both standard and trimmed fillets fell well below the current federal tolerance limit for PCB's (2.0 ppm), and only 2 of the 20 standard fillets were found to exceed the current federal tolerance limit for mirex (0.10 ppm).

Trimming Effectiveness and Fat-Contaminant Correlations

On average, approximately 62%, 46% and 44% of the total fat, PCB and mirex levels respectively were removed from the standard fillet when the recommended trimming procedure was used (Table 3). Comparision of the mean reductions using the paired t-test showed significant differences in total fat, PCB and mirex levels ($P \leq .001$) in trimmed fillets when compared to the corresponding standard fillet.

Correlation analysis revealed strong, positive and statistically significant ($P \leq .05$) correlations between percentage reductions in fat and PCB's and between percentage reductions in fat and mirex; between fat and contaminant levels in the standard fillets; and between fat and contaminant levels in the trimmed fillets (Table 4).

Variance Among Areas of Capture

Analysis of variance among the 4 locational groupings of fish indicated that these groupings were homogeneous subsets, having no significant differences ($P \leq .05$) in standard fillet mean fat content or in PCB and mirex levels. In short, there were no significant differences in fat or contaminant levels across collection sites.

Weight, Length, Age, Sex and Condition Relationships to Contaminant Concentrations and Reductions

Correlation analysis was conducted between several physical attribute variables (weight, length, sex, age and condition), and fat, contaminant, and percentage reduction variables. Results are shown in Table 5.

Based on the general patterns and relationships of stronger or statistically significant correlations, it can be generally stated that as brown trout increase in size (weight, length), "fatness" or healthiness (condition), and age, fat content and fat-soluble contaminant levels in the edible portions of the flesh also increase, and contaminant-reducing trimming techniques become less effective. It also appears that the sex of the brown trout had little bearing on fat content, contaminant levels, or any observed reduction in these variables due to trimming.

COMPARISON WITH THE SKEA STUDIES AND FURTHER DISCUSSION

The reductions in fat content, PCB and mirex levels determined in this study were compared to those reported by Skea et al. (1979, 1981) (Table 6). Fat and contaminant reductions observed in this study were similar to those found in the Skea studies, which were also found to be statistically significant at the $P \leq .001$ level. Contaminant reduction percentages found in the two studies were equivalent despite the fact that initial standard fillet contaminant levels in the two studies differed markedly[5]. These findings tend to support two conclusions: (1) fat-soluble organo-chlorine contaminants such as PCB's and mirex are removed when recommended fat-trimming procedures are carried out on brown trout, and (2) the efficacy of contaminant removal by trimming is consistent despite wide variation in the initial standard fillet contamination level.

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[5] It should be noted that Skea et al. reported mean PCB levels in the standard fillets of their brown trout (collected in 1976) that were substantially higher than those reported here (2.85 ppm vs. 1.05 ppm). In contrast, Skea noted mean mirex levels in brown trout standard fillets that were considerably lower (0.027 ppm vs. 0.052 ppm) than those observed in the present study. The difference in PCB levels between the two studies appears to reflect the documented decline in PCB levels occurring in Lake Ontario and Great Lakes fish in general. The difference in mirex levels is more difficult to explain. Trend data for mirex in Lake Ontario fish shows only a slight decline at best over the last 14 years, but there is clearly no evidence of a general increase in levels. The mirex levels in Skea's standard fillets appear to be considerably lower than average levels in Lake Ontario brown trout standard fillets observed in 1978 (0.09 ppm), while the present study's standard fillet mirex levels are in close keeping with the most recent State findings for brown trout collected in 1987. One is therefore left to speculate that the marked difference in standard fillet mirex levels between the two studies may simply reflect the significant fluctuations seen in Lake Ontario brown trout mirex levels over the last 14 years, which, in turn, could be due to variation in forage, or to environmental perturbations that may release and expose mirex-contaminated sediments to the food chain or water column. In addition, random sampling error cannot be ruled out since standard deviations overlap.

Study results also reinforce the trimming and risk management advice dispensed through health agency fish consumption advisories, and other public educational programs undertaken by university-based outreach efforts. These programs have long emphasized that larger and older (as indicated by such variables as weight, length, and age) fish are likely to be more contaminated than smaller and younger specimens, and therefore should be eaten less often, if at all. Findings in this study clearly support this straightforward and simple advice.

Although confined to a limited sample of 20 fish, the study also suggests that springtime contaminant levels in Lake Ontario brown trout do not significantly differ between locations along the south shore of the Lake.

Application of the recommended fillet trimming technique substantially reduces the yield of the edible portion (by about 40%). However, it must pointed out that a significant portion of the trimmings, including skin and rib bones, would not normally be eaten. Therefore, the actual waste stemming from the trimming procedure may not be as great as yield calculations suggest or as the consumer may think.

Despite significant mean reductions in contaminant levels achieved through the trimming procedure, wide variation in reductions occurred between the individual fish--from 29% to 63% in the case of PCB's, and from 15% to 60% in the case of mirex. While this may make it difficult to confidently assure a fish consumer that trimming a specific Lake Ontario brown trout reduces his or her ingestion of PCB's or mirex by "almost half," mean data clearly indicate that, over time and over numerous meals of brown trout, significant reductions in a consumer's intake of PCB and mirex residues would most assuredly occur.

Reasons for significant variability encountered in trimming effectiveness between individual fish, and for the unexplained variation observed in correlation analysis of fat, contaminant and physical attribute variables are unclear. One possible cause could be the "static" nature of step #6 (Figure 2) in the State-recommended trimming method in relation to the size of the fish (i.e. the prescribed advice to trim away exactly 1/2 inch of flesh centered along the lateral line regardless of the size of the fish or fillet). This advice may too often result in the retention of more red muscle (which is known to be fattier) on the fillets of larger fish. A future test of this hypothesis could involve analysis of the fat and contaminant reductions achieved when trimmed fillets are stripped of <u>all</u> observable red muscle along the lateral line.

A second possible cause of the variation observed in the results may be that complex and distinctly different contaminant migration-deposition patterns and processes may be occurring within individual fish. Such patterns and processes may be dependent upon a multitude of physical, dietary and environmental factors at play on or in the organism. Exploration of these aspects would appear to be fruitful areas for further research, and could result in additional and more effective trimming or fish selection guidelines for the consumer.

REFERENCES

Armbruster, G., K. Gerow, W. Gutenmann, C. Littman and D. Lisk. 1987. The effects of several methods of fish preparation on residues of polychlorinated biphenyls and sensory characteristics in striped bass. *J. Food Safety* 8:235-243.

Armbruster, G., K. Gall, W. Gutenmann, and D. Lisk. 1989. Effects of trimming and cooking by several methods on polychlorinated biphenyls (PCB) residues in bluefish. *J. Food Safety* 9:235-244.

Armstrong, R. and R. Sloan. 1980. Trends in levels of several known chemical contaminants in fish from New York State waters. Tech. Rep. 80-2, Div. of Fish and Wildlife, New York State Department of Environmental Conservation, Albany. 77 pp.

Bagenal, T. (ed.) 1978. Methods for assessment of fish production in fresh water. IBP Handbook No. 3. Blackwell Scientific Publications, Great Britain. 365 pp.

Clark, J., D. DeVault, R. Bowden, and J. Weishaar. 1984. Contaminant analysis of fillets from Great Lakes coho salmon. *J. Great Lakes Res.* 10:38-47.

Gibbs, J. 1989. Are Lake Michigan fish safe to eat? *Outdoor Life.* December: 72-74, 94, 96-97.

Horn, E. and L. Skinner. 1985. Final environmental impact statement for policy on contaminants in fish. Div. of Fish and Wildlife, New York State Department of Environmental Conservation, Albany. 150 pp.

International Joint Commission. 1989. 1987 Report on Great Lakes Water Quality. Appendix B. Great Lakes Surveillance-Vol. I. 285 pp.

Lewis, T. and J. Makarewicz. 1985. Effect of smoking on mirex levels in brown trout from Lake Ontario. *NY Fish and Game J.* 31(1):84-86.

Lindsay, R., G. Myrdal, and J. Daubert. 1976. Can We Remove PCBs from fish? Pub. No. 12-3600 (78), Wisconsin Dept. of Natural Resources, Madison. 13 pp.

Mills, P., B. Bong, L. Kamps and J. Burke. 1972. Elution solvent system for florisil column cleanup in organochlorine pesticide residue analyses. *J. Assoc. Off. Anal. Chem.* 55(1):39-43.

National Wildlife Federation. 1989. Lake Michigan sport fish: Should you eat your catch? Washington, D.C. 17 pp.

New York State Department of Environmental Conservation. 1981. Reducing Toxics: Fish Filleting Guide. FW-P116. Div. of Fish and Wildlife, Albany. 2 pp.

Reinert, R., D. Stewart and H. Seagran. 1972. Effects of dressing and cooking on DDT concentrations in certain fish from Lake Michigan. *J. Fish. Res. Bd. Can.* 29:525-529.

Skea, J. C., H. Simonin, E. Harris, S. Jackling, J. Spagnoli, J. Symula and J. Colquhoun. 1979. Reducing levels of mirex, Aroclor 1254, and DDE by trimming and cooking Lake Ontario brown trout (*Salmo trutta linnaeus*) and smallmouth bass (*Micropterus dolomieui lacepede*). *J. Great Lakes Res.* 5(2): 153-159.

Skea, J., S. Jackling, J. Symula, H. Simonin, E. Harris, an J. Colquhoun. 1981. Summary of fish trimming and cooking techniques used to reduce levels of oil soluble contaminants. Unpublished technical report. Div. of Fish and Wildlife, New York State Department of Environmental Conservation, Albany. 36 pp.

Skinner, L. 1989. Lake Ontario fish contaminants: New York's 1987 data. Unpublished report. Div. of Fish and Wildlife, New York State Department of Environmental Conservation, Albany. 6 pp.

Sloan, R. 1987. Toxic substances in fish and wildlife analyses since May 1, 1982. Tech. Rep. 87-4 (BEP), Div. of Fish and Wildlife. New York State Department of Environmental Conservation, Albany. 182 pp.

Smith, W. E., K. Funk and M. Zabik. 1973. Effects of cooking on concentrations of PCB and DDT compounds in chinook and coho salmon from Lake Michigan. *J. Fish. Res. Bd. Can.* 30(5):702-706.

Spagnoli, J. and L. Skinner. 1977. PCB's in fish from selected waters of New York State. *Pesticides Monitoring J.* 2(2):69-87.

U.S. Food and Drug Adminisration. 1971. Pesticide analytical manual: Vol. 1. Washington, D.C.

Wanderstock, J., W. Iskat, W. Gutenmann and D. Lisk. 1971. Effect of several cooking methods on concentration of DDT residues in lake trout and coho salmon. *NY Fish and Game J.* 18(1):70-72.

Williams, L., J. Giesy, N. DeGalan, D. Verbrugge, D. Tillitt, and G. Ankley. 1989. Size and seasonal variation of PCBs on chinook salmon fillets from Lake Michigan near Ludington, Michigan USA. Publ. No. MSUATL-1989-1. Aqua. Toxicology Lab., Michigan State Univ., E. Lansing. 53 pp.

Zabik, M., C. Hoojjat, and D. Weaver. 1979. Polychlorinated biphenyls, dieldrin, and DDT in lake trout cooked by broiling, roasting or microwave. *Bull. Environ. Contamin. Toxicol.* 21:136-143.

TABLE 1. CHARACTERIZATION OF SAMPLE

SPECIMEN NUMBER	AREA OF CAPTURE	CAPTURE DATE (S)	AGE (YEARS)	CONDITION (K)	SEX	WEIGHT IN GRAMS (LBS.)	LENGTH IN MM (INCHES)
1	Niagara/Wilson	4/25-4/28	2	1.26	F	1240 (2.7)	462 (18.2)
2	Niagara/Wilson	4/25-4/28	3	1.72	F	2742 (6.0)	542 (21.3)
3	Niagara/Wilson	4/25-4/28	2	1.26	F	1606 (3.5)	459 (18.1)
4	Niagara/Wilson	4/25-4/28	2	1.40	M	1558 (3.4)	479 (18.9)
5	Niagara/Wilson	4/25-4/28	2	1.55	M	962 (2.1)	396 (15.6)
6	Sodus Point	4/26-5/5	2	1.52	M	1751 (3.9)	487 (19.2)
7	Sodus Point	4/26-5/5	2	1.23	M	1156 (2.6)	455 (17.9)
8	Sodus Point	4/26-5/5	2	1.17	M	862 (1.9)	419 (16.5)
9	Sodus Point	4/26-5/5	2	1.51	F	1070 (2.4)	414 (16.3)
10	Sodus Point	4/26-5/5	2	1.73	F	1528 (3.4)	445 (17.5)
11	Fair Haven	5/12	2	1.38	F	840 (1.9)	393 (15.5)
12	Fair Haven	5/12	2	1.14	F	542 (1.2)	362 (14.3)
13	Fair Haven	5/12	2	1.37	F	1568 (3.5)	485 (19.1)
14	Fair Haven	5/12	2	1.78	M	2069 (4.6)	488 (19.2)
15	Fair Haven	5/12	2	1.70	M	1778 (3.9)	471 (18.5)
16	Rochester/Irondequoit	4/27-5/6	2	1.38	F	883 (2.0)	393 (15.5)
17	Rochester/Irondequoit	4/27-5/6	3	1.61	F	3637 (8.0)	609 (24.0)
18	Rochester/Irondequoit	4/27-5/6	3*	1.57	M	3553 (7.8)	610 (24.0)
19	Rochester/Irondequoit	4/27-5/6	2	1.07	M	1121 (2.5)	472 (18.6)
20	Rochester/Irondequoit	4/27-5/6	2	1.16	M	1440 (3.2)	462 (18.2)
			$\bar{x}$=2.95 ± 0.14	$\bar{x}$=1.45 ± 0.05	M:F=1:1	$\bar{x}$=1595.3 ± 189	$\bar{x}$=465.1 ± 14.5

ERRATA

"The Effectiveness of Recommended...." (November 1990 edition)

Reinterpretation of scale annulus position for specimen brown trout required the following corrections in age data and related analytical results:

Page 6: Under "Sample Characterization", The mean age and age range should read as follows: "...a mean age of 2.15 years (range: 2-3 years)..."

Table 1: The age data column should read as follows:

TABLE 1. CHARACTERIZATION OF SAMPLE

SPECIMEN NUMBER	AGE (YEARS)
1	2
2	3
3	2
4	2
5	2
6	2
7	2
8	2
9	2
10	2
11	2
12	2
13	2
14	2
15	2
16	2
17	3
18	3*
19	2
20	2
	$\bar{x}$=2.15 ± 0.08

* Scale samples for specimen #18 were lost after initial aging examination. Given the weight and length of this fish and other recollections of the physical characteristics of this fish by project investigators, it was confidently assumed that this specimen was age 3.

- OVER -

Table 5: The age correlations should read as follows:

TABLE 5. MATRIX OF PEARSON CORRELATION COEFFICIENTS*

	FAT (STD)	FAT (TRM)	% RED FAT	PCB (STD)	PCB (TRM)	% RED PCB	MIREX (STD)	MIREX (TRM)	% RED MIREX
AGE	.2977	.4903*	-.4881*	.4879*	.6024*	-.3366	.4974*	.5065*	-.1884

* Significant at $P \leq .05$ level

TABLE 2. FILLET YIELDS

SPECIMEN NUMBER	STANDARD FILLET YIELD	TRIMMED FILLET YIELD	SKIN YIELD	TRIMMINGS YIELD	TRIMMED FILLET YIELD
	(AS % OF WHOLE WEIGHT)		(AS % OF STANDARD FILLET WEIGHT)		
1	56.8	32.6	22.7	18.4	58.9
2	47.6	31.7	16.6	14.7	68.7
3	57.8	35.6	20.0	17.1	62.9
4	59.9	33.5	33.8	6.6	59.6
5	58.4	35.8	28.0	9.5	62.5
6	58.8	35.3	24.5	14.1	61.4
7	56.4	33.4	35.6	9.4	55.0
8	58.7	33.9	30.2	11.9	57.9
9	59.1	36.6	29.2	8.6	62.2
10	53.1	37.7	25.3	12.9	61.8
11	59.3	35.0	20.5	19.3	60.2
12	56.1	33.6	26.1	18.8	55.1
13	57.4	33.7	18.4	15.1	66.5
14	58.6	36.9	25.6	14.8	59.6
15	59.4	30.9	27.4	18.0	54.6
16	58.4	31.0	29.2	14.4	56.4
17	62.6	31.8	23.0	16.0	61.0
18	55.3	29.6	27.7	12.0	60.3
19	60.5	34.3	27.9	14.4	57.7
20	65.8	32.2	28.3	17.3	54.4
MEAN	58.0	33.8	26.0	14.2	59.8
RANGE	47.6-65.8	29.6-37.7	16.6-35.6	6.6-19.3	54.4-68.7

TABLE 3. FILLET FAT CONTENT AND CONTAMINANT CONCENTRATIONS (WET WEIGHT) AND PERCENT REDUCTION

SPECIMEN NUMBER	FAT CONTENT grams/100 grams			PCB CONCENTRATION ppm (ug/g)			MIREX CONCENTRATION ppm (ug/g)		
	STD	TRIMMED	% RED.	STD	TRIMMED	% RED.	STD	TRIMMED	% RED.
1	15.2	4.5	70.4	0.77	0.55	28.6	0.033	0.017	48.5
2	11.4	4.5	60.5	1.54	0.88	42.9	0.064	0.031	51.6
3	15.8	7.8	50.6	0.89	0.55	38.2	0.039	0.023	41.0
4	12.3	4.7	61.8	1.56	0.86	44.9	0.078	0.039	50.0
5	14.3	5.9	58.7	1.74	0.87	50.0	0.129	0.076	41.1
6	10.7	4.3	59.8	1.65	0.98	40.6	0.065	0.055	15.4
7	12.8	4.0	68.8	1.14	0.39	58.8	0.037	0.017	54.1
8	7.0	2.4	65.7	0.45	0.27	31.3	0.022	0.010	54.5
9	13.0	5.7	56.2	1.14	0.61	46.5	0.054	0.028	48.1
10	16.1	7.4	54.0	1.00	0.57	43.0	0.044	0.033	25.0
11	8.9	3.6	59.6	0.75	0.45	40.0	0.030	0.025	16.7
12	7.6	1.9	75.0	0.37	0.17	54.1	0.017	0.007	58.8
13	8.5	3.4	60.0	0.69	0.30	56.5	0.034	0.015	55.9
14	17.4	7.2	58.6	0.80	0.41	48.8	0.046	0.020	56.5
15	12.9	4.8	62.8	1.15	0.51	55.7	0.047	0.029	38.3
16	10.3	1.1	89.3	0.73	0.27	63.0	0.025	0.010	60.0
17	17.3	12.4	28.3	1.40	0.93	33.6	0.080	0.058	27.5
18	15.4	6.9	55.2	1.61	0.99	38.5	0.113	0.073	35.4
19	3.4	0.7	79.4	0.68	0.35	48.5	0.039	0.018	53.8
20	12.3	4.9	60.2	0.86	0.45	47.7	0.043	0.021	51.2
MEAN **S.E.**	12.1 ±0.83	4.9 ±0.60	61.75 ±2.71	1.05 ±0.09	0.57 ±0.06	45.6 ±2.07	0.052 ±0.01	0.030 ±0.01	44.2 ±3.07
RANGE	3.4-17.4	0.7-12.4	28.3-89.3	0.37-1.74	0.17-0.99	28.6-63.0	0.017-0.129	0.007-0.076	15.4-60.0

TABLE 4. SIGNIFICANT ($P \leq .05$) PEARSON CORRELATION COEFFICIENTS BETWEEN FAT CONTENT AND CONTAMINANT CONCENTRATIONS

	FAT CONTENT
I. STANDARD FILLETS	
PCB CONCENTRATIONS	0.459
MIREX CONCENTRATION	0.444
II. TRIMMED FILLETS	
PCB CONCENTRATION	0.588
MIREX CONCENTRATION	0.566

TABLE 5. MATRIX OF PEARSON CORRELATION COEFFICIENTS*

	FAT (STD)	FAT (TRM)	% RED FAT	PCB (STD)	PCB (TRM)	% RED PCB	MIREX (STD)	MIREX (TRM)	% RED MIREX
WEIGHT	.528*	.697*	-.657*	.562*	.674*	-.3394	.5420*	.5778*	-.3032
LENGTH	.409*	.590*	-.576*	.5202*	.630*	-.3603	.4819*	.5042*	-.2336
SEX	.0772	.1253	-.1145	-.2912	-.1570	-.1020	-.3494	-.2818	-.0642
AGE	~~.3530~~ .2977	~~.5207*~~ .4903*	~~-.5510*~~ -.4881*	~~.4190*~~ .4879*	~~.5350*~~ .6024*	~~-.4877*~~ -.3366	~~.3215~~ .4974*	~~.3107~~ .5065*	~~-.1136~~ -.1884
CONDITION	.6985*	.6450*	-.5290*	.5216*	.5219*	-.0653	.4203*	.4591*	-.3917*

* Significant at $P \leq .05$ level

TABLE 6. LAKE ONTARIO BROWN TROUT FAT/PCB/MIREX CONCENTRATIONS (WET WEIGHT) AND PERCENT REDUCTIONS: SKEA ET AL. (1979, 1981) VS. VOILAND ET AL. (1990)

	SKEA (N=60)	VOILAND (N=20)
FAT CONTENT (G/100G)		
STANDARD FILLET	16.5 (N.A.)	12.1 (3.7)
TRIMMED FILLET	8.8 (N.A.)	4.9 (2.7)
% REDUCTION	53.0 (N.A.)	61.8 (12.1)
PCB CONCENTRATION (PPM)		
STANDARD FILLET	2.85 (1.15)	1.05 (0.42)
TRIMMED FILLET	1.62 (0.73)	0.57 (0.26)
% REDUCTION	43.2 (N.A.)	45.6 (9.25)
MIREX CONCENTRATION (PPM)		
STANDARD FILLET	.027 (0.02)	.052 (0.03)
TRIMMED FILLET	.015 (0.01)	.030 (0.02)
% REDUCTION	44.5 (N.A.)	44.2 (13.7)

Standard deviation in parentheses.