

## Observations of El Niño off Oregon: July 1997 to Present (October 1998)

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Every few months since July 1997 we have made CTD/ADCP sections off Newport, Oregon (44.6°N) from the coast to 150 km; a base of historical (1962–69) hydrographic data exists for this section. See our website (Monitoring the Coastal Ocean off Oregon: El Niño and beyond) under <http://www.oce.orst.edu/po/coastal.html>

The surface layer off Oregon was already warmer than normal in July 1997 (Figure 1a). The largest anomalies (>6°C) occurred offshore (>90 km) in July 1997, and inshore (<50 km) in September 1997 (Figure 1a). In September 1997, the surface layer was everywhere warm (>17°C) with low salinity; subsurface slope waters were >1°C above normal with an isotherm slope indicating northward advection (Figure 1a). In November 1997 (Figure 1a), the surface layer was 1°C warmer than normal; subsurface waters over the slope were even warmer than in September and steric height rose steeply toward shore over 60 km, consistent with strong northward flow on the shelf (Figure 2). In February 1998 (Figure 1a), all water on the shelf was >12°C (>2°C above normal). Temperatures over the shelf remained above normal from July 1997 to June 1998 but were near normal by August 1998 (Figure 1b). Temperature and salinity fields suggest that upwelling was suppressed from September 1997 to June 1998. (The PFEL Upwelling Index for 45°N was negative or anomalously weak from June 1997 to June 1998.) Subsurface waters over the upper slope (100–400 m) remained warmer than normal from July 1997 through September 1998 (Figure 1). The winter and spring sections showed evidence of enhanced poleward advection, with a local anomaly maximum near the shelf break. The geostrophic currents were consistent with ADCP data (Figure 3) showing a strong current jet flowing poleward beyond the shelf break off Newport during the El Niño winter (November 1997 and February 1998). This poleward jet was surface-intensified with speed

~ 0.5 m/s, width ~ 20 km, and extending to depths > 200 m. By August 1998 the equatorward surface jet associated with normal coastal upwelling was present over the shelf, shelf temperatures were near normal, and the upwelling index was above the mean for August and September 1998.

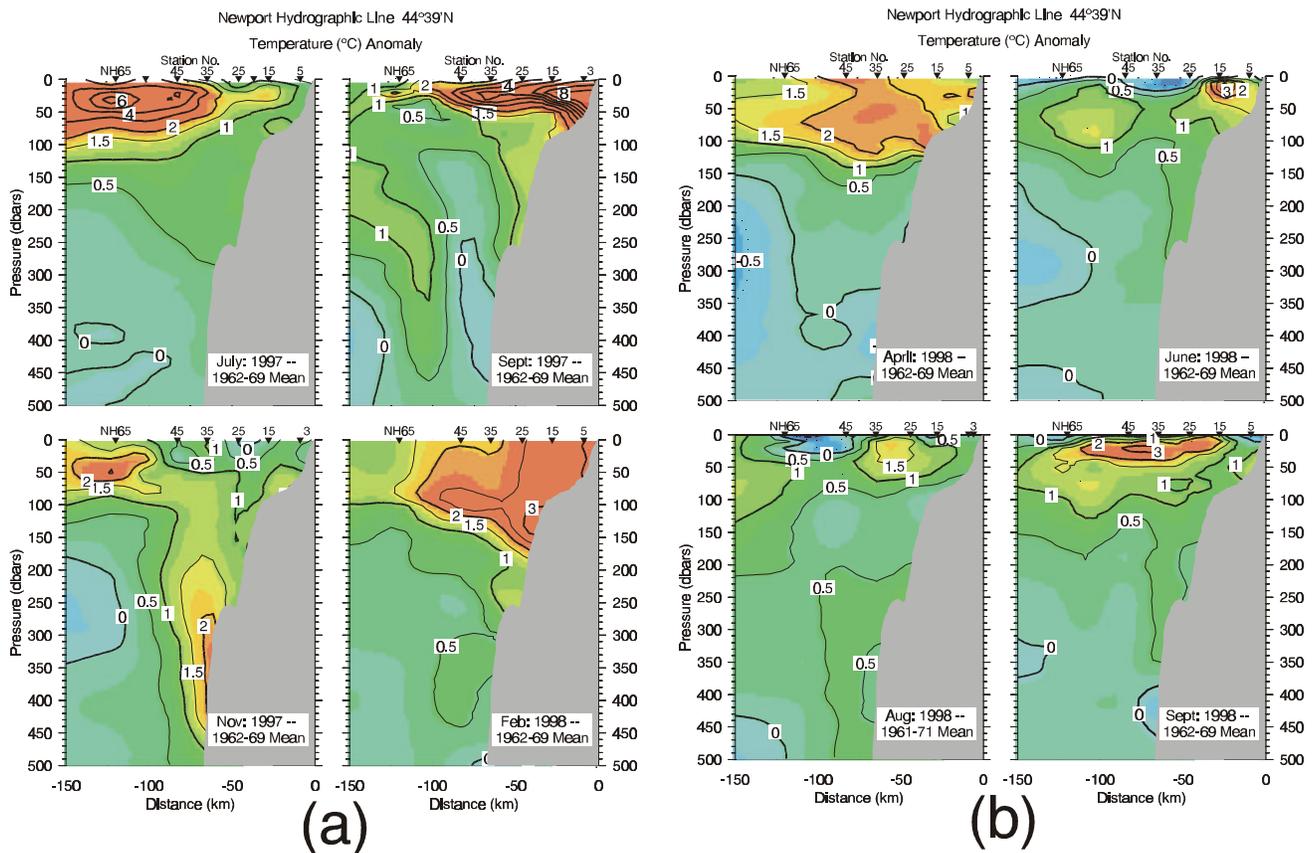
Sections were also made at several latitudes between Newport, Oregon and San Francisco, California in November 1997, April 1998, and August 1998. These extended cruises showed much along-shore homogeneity. In November 1997, sections at 39°, 42°, 43.2°, and 44.7°N all showed the steric height of the sea surface rising steeply toward shore (~20 cm in ~ 60 km), while the 7° and 8°C isotherms slanted down toward the continental slope, indicating enhanced poleward flow over the shelf and upper slope (Figure 2). In April 1998, steric height profiles were flat (at 39° and 44.7°N) or slanting down toward the coast (at 42° and 43.2°N), indicating that the anomalous poleward flow had weakened or ceased. In August 1998, these sections show evidence of near-normal coastal upwelling inshore although subsurface waters offshore remained warmer than normal; they also show the 6.5° and 9°C isotherms diverging toward shore, suggesting geostrophic poleward flow with a subsurface core offshore of the continental slope. At this time, the ADCP observations along each section showed a band of poleward flow 20–40 km wide, with a subsurface maximum centered at 150–200 m, typical of the scales of the poleward undercurrent but with the core of the flow detached from the continental slope and offshore of the shelf break by 15 to 40 km (Figure 3).

Satellite-tracked drifters (drogued at 15 m) were released off Newport on all of the 1998 cruises (Figure 4). Eight drifters released off Newport in January 1998 (Figure 4a) moved coherently to the north, with strongest (up to 0.65 m/s) poleward flow near the continental shelf break. Four eventually

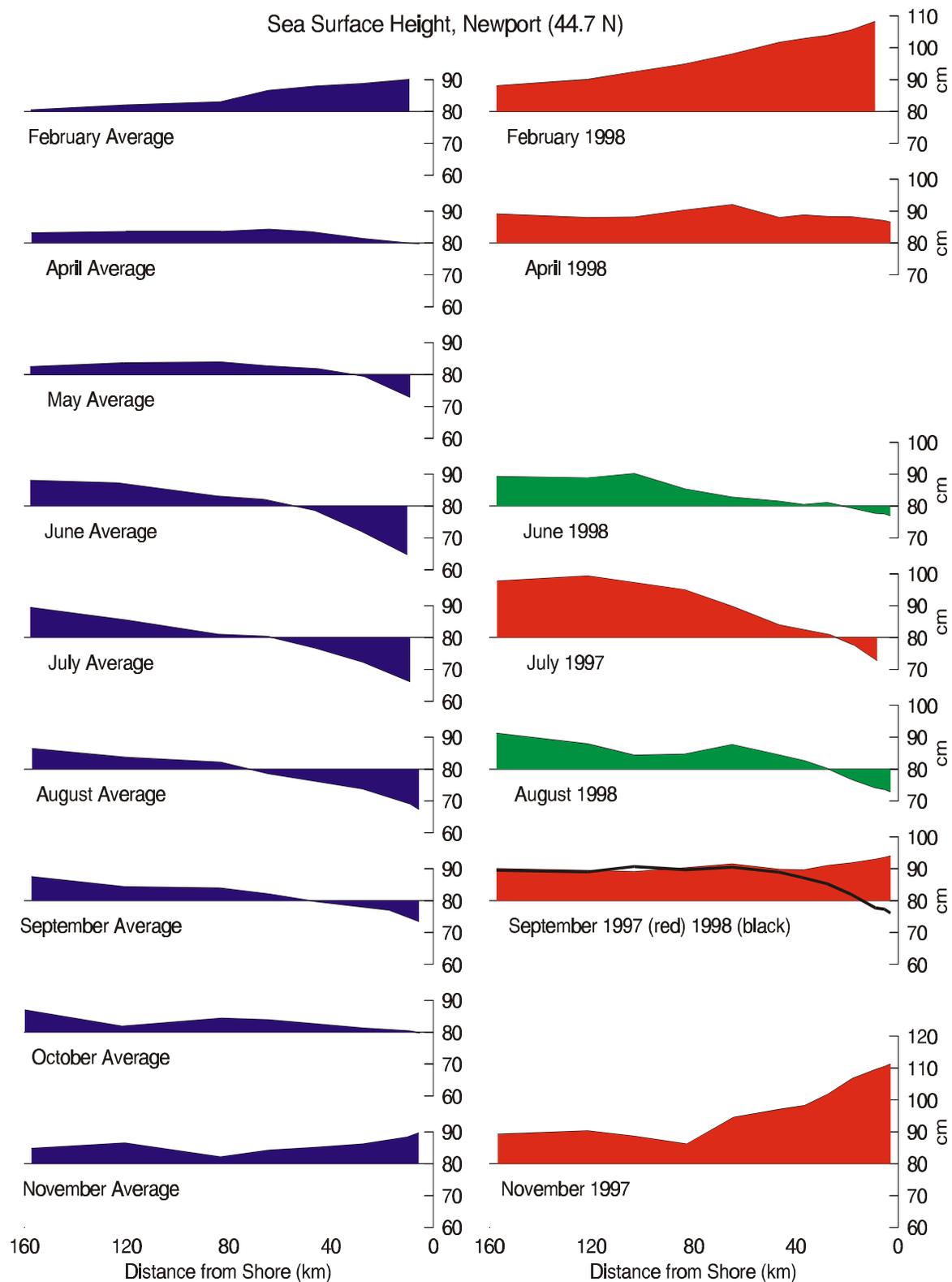
beached between 47° and 56°N, one was still off Vancouver Island in October, and two reached 49.5°N (and one 48°N) before reversing direction about 1 March. These observations are consistent with above normal sea level, warm water and enhanced poleward advection typical of El Niño conditions in winter. Of the seven drifters released off Newport in April 1998 (Figure 4b), the five released over the shelf and slope were advected by variable wind-driven currents, including some initial northward motion. Through August and September most drifters were moving equatorward and offshore, de-

lineating the meandering jets of the California Current (Figure 4f); by October some drifters from the January, April, June and August releases off Newport (44.6°N) were between 35° and 39°N (Figure 4a–d). The drifters released in late September (Figure 4e) initially moved offshore and southward but, with the onset of fall storms, have not yet shown consistent trajectories.

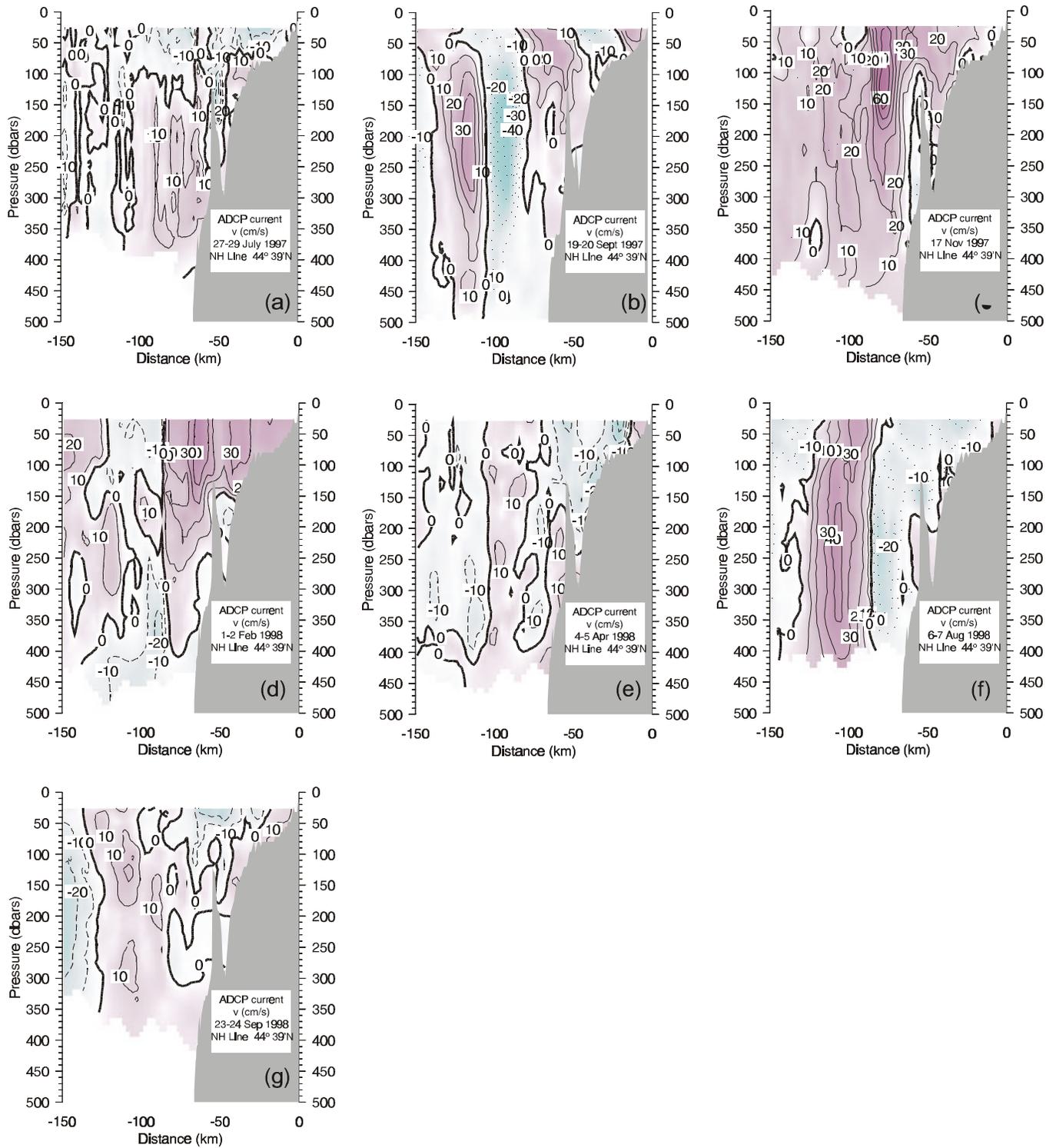
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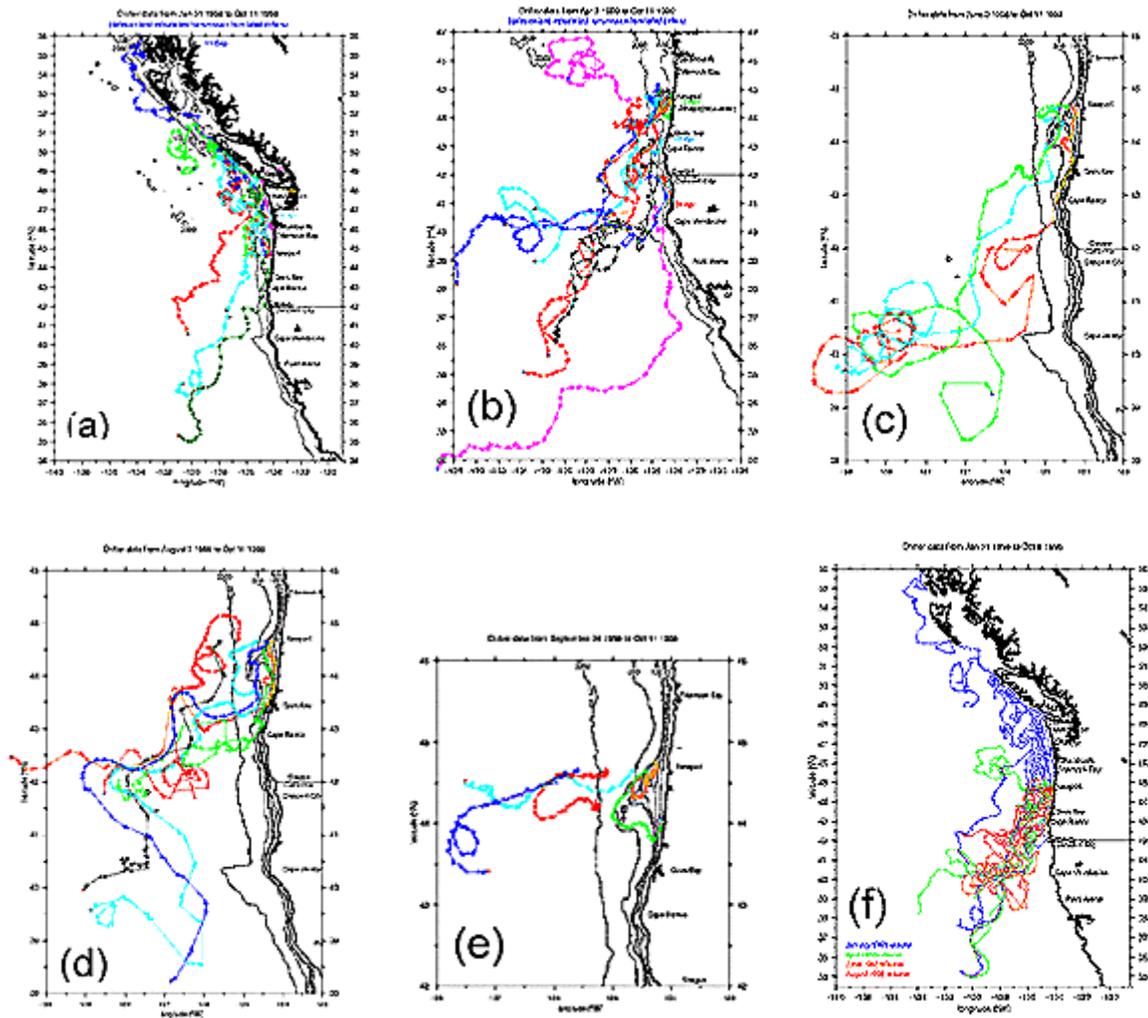
**Figure 1.** Distributions of temperature anomalies from the historical average (1961–1971 for August, 1962–1969 for all other months) along the Newport Hydro Line at 44° 40' N (a) July, Sept., Nov. 1997, and Feb. 1998, (b) April, June, August and September 1998.



**Figure 2.** Offshore profiles of the steric height of the sea surface (relative to 500 dbar), calculated from historical-average (left) and contemporary (right) density data along the Newport Hydro Line. The fill-color of the contemporary profiles indicates whether the section was during (red) or after (green) the 1997–8 El Niño.



**Figure 3.** Distributions of alongshore current (positive northward) measured with the ADCP on the Newport Hydro Line (a) 28–30 July 1997, (b) 19–20 Sept. 1997, (c) 15–16 Nov. 1997, (d) 1–2 Feb. 1998, (e) 5 April 1998, (f) 6–7 August 1998, and (h) 24–25 Sept. 1998.



**Figure 4.** Trajectories of satellite-tracked drifters deployed during the project: a) 31 Jan. to 11 Oct. 1998, (b) 3 April to 11 Oct. 1998, (c) 3 June to 11 Oct. 1998, (d) 7 Aug. to 11 Oct. 1998, (e) 24 Sept. to 11 Oct. 1998, (f) summary of drifters deployed along Newport Hydro Line, 31 Jan. to 11 Oct. 1998.